Company Name Here

Prevention through Design

Design Risk Management

Guidance Document

NOTE:

Document provided for the purpose of enabling companies adopt PtD within each business.

**Document History:**

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# Introduction

### Overview

Welcome to this Design Risk Management Guidance Document.

The Center for Construction Research and Training (CPWR) is a nonprofit dedicated to reducing occupational injuries, illnesses and fatalities in the construction industry.Through our research, training, and service programs, we serve the industry nationwide by collaborating with key partners, including workers, contractors, project owners, health and safety professionals, researchers, key government agencies, unions, and associations.

Created by North America’s Building Trades Unions (NABTU), CPWR is a world leader in construction safety and health research and training. CPWR’s mission, as stated in our Articles of Incorporation, is as follows:

* Encourage the elimination or reduction of conditions constituting hazards to the safety or health of U.S. construction workers, and to promote the maintenance and improvement of safe and healthy working conditions for workers in the construction industry;
* Publicize the results of research findings, and to make them widely available to construction industry owners/users, employers, associations, unions, workers, academia, government, and others with an interest in construction industry safety and health;
* Provide training resources and technical services to apply research findings at the work site and to direct research in defining and addressing issues of importance to workers; and
* Conduct research concerning the quality of working conditions; the social, economic, and psychological factors influencing work organization; the impacts on workers and working conditions of new technologies and industry change; and analyses of corporate and government policies and consensus standards that affect the worksite.

### Purpose

The primary purpose of this guidance document is to apply ANSI/ASSP Z590.3-2021 Prevention through Design as part of the design risk management process for built environment projects, to increase designer competence and collaboration towards design risk management in consideration of the asset’s whole lifecyle.

### Why do we need this guidance document?

Design decisions are inherently complex, involving multiple stakeholders and whole asset lifecycle risks. This guidance document has been created to provide clear and practical guidance on design risk management and equips design stakeholders with guidance and tools necessary to apply ANSI/ASSP Z590.3-2021 to your project.

### Who Should Use This Document

This guidance document is applicable to all design stakeholders involved in the design, construction, operation, maintenance, decommissioning and demolition of built environment assets across the U.S.

# Dos and Don’ts

The following table provides an initial quick reference of Do’s and Don’ts for design risk management and the preparation of Design Risk Assessments (DRA).

|  |  |
| --- | --- |
| Do's | Don’ts |
| * Apply this guidance document before design work commences. | * Commence design risk assessments at the end of the design phase |
| * Identify and mitigate design hazards throughout the design phase | * Complete risk assessments as an afterthought. |
| * Document what the designer has specifically done to mitigate the identified design hazard. | * Document how the Contractor will mitigate the design hazard in the future. |
| * Use DRA’s to guide the design process. | * Use DRA’s to justify the design when the design process is complete. |
| * Continuously update the DRA as the project evolves. | * Treat the risk assessment as a static document completed at the end of the design process. |
| * Seek DRA’s from the earlier design phase designers to understand existing hazards and residual risks. | * Design in isolation of the previous design phase and any inherent design hazards. |
| * Communicate, coordinate and collaborate with all design disciplines and design stakeholders, throughout the design process. | * Work in silo’s with no regular collaboration with other design disciplines or design stakeholders. |
| * Communicate all DRA’s to the Project/Design Manager. | * Retain DRA’s without sharing to the Project/Design Manager. |
| * Generate bespoke DRA’s for each project. | * Use generic or one-size-fits-all DRA’s. |
| * Utilize available historical data, site information and lessons learned. | * Ignore past incidents or industry best practices. |
| * Consult with operations and maintenance personnel | * Disregard the input of operations and maintenance personnel. |
| * Establish a process of peer review and action tracking of design changes against DRA’s. | * Complete DRA’s in isolation without any peer reviews or action tracking. |
| * Identify, record and mitigate all potential design hazards. | * Assume that someone else will identify, record and mitigate the design hazard. |
| * Consider the health and safety of construction workers and end users as part of the DRA. | * Ignore the health and safety of construction workers and end users. |
| * Use contemporary guidance, peer-recognized good or best practice design approaches to provide positive design outcomes. | * Assess design hazards using outdated information. |
| * Consider the impact of the design on the local environment, climate and sustainability. | * Design in isolation of any potential impact on the local environment, climate or sustainability. |
| * Consider the impact of the design on the asset’s entire lifecycle, from construction to operation and final demolition. | * Focus only on the construction phase. |
| * Maintain contemporary records of findings, assumptions, and mitigation strategies and update regularly. | * Neglect documenting the DRA process. |

Table 1 Do’s and Don’ts

# Definitions

In order to establish design risk management requirements, the following definitions are required:

1. **As Low As Reasonably Practicable (ALARP):** That level of risk which can be further lowered only by an increase in resource expenditure that is disproportionate in relation to the resulting decrease in risk.
2. **Avoidance:** New hazards/risks are intentionally avoided in new designs, as well as in redesigns, additions and modifications to existing systems and workplaces. Example: In a new facility, design all walking and working surfaces at the same level to avoid falls from heights.
3. **Cause:** Circumstances, conditions, actions, or inactions that can expose a hazard or initiate a hazardous event.
4. **Design:** The process of converting an idea or market need into the detailed information from which a product, process, or technical system can be produced.
5. **Design Discipline:** Persons who have specialized in a certain area of the built environment who produce drawings, specifications, models etc for the purpose of constructing, altering, refurbishing, decommissioning or demolishing a built environment asset.
6. **Design Risk Assessment:** A process that commences with hazard identification and analysis, through which the probable severity of harm or damage is established, followed by an estimate of the likelihood of the incident or exposure occurring, and concluding with a statement of risk.
7. **Design Safety Review:** An important management process tool for integrating safety and health into the design process. This includes designs related to new facilities, processes, or operations, and for changes in existing operations. Design safety reviews are most effective when performed at an early stage when design objectives are being discussed. To be consistently and effectively applied, top management should establish policies and processes for conducting design safety reviews.
8. **Elimination:** Existing hazards/risks are eliminated or removed from systems/workplaces through redesign. Example: Eliminate a hazardous chemical process from the workplace by redesigning the process or remove it from the workplace and isolate it away from workers.
9. **Exposure:** People (employees, the public), processes, property, equipment, the environment and other things of value that have a potential to be damaged or affected by the risk.
10. **Exposure Assessment:** For occupational health and environmental purposes, exposure assessment is the multi-disciplinary field that identifies and characterizes workplace exposures, develops estimates of exposure-response, and makes risk assessment studies, and evaluates the significance of exposures and effectiveness of intervention strategies.
11. **Failure Mode:** Condition or state where a system or component within the system fails to perform as expected or deviates from its design tolerances resulting in a potential for harm or a hazardous event.
12. **Hazard:** The potential for harm to people (employees, the public), processes, property, equipment and the environment. Note: Hazards include all aspects of technology and activity that produce risk. Hazards include the characteristics of things (e.g., equipment, technology, processes, dusts, fibers, gases, materials, and chemicals) and the actions or inactions of people.
13. **Hierarchy of Risk Treatments:** A systematic approach to selecting and treating risk considering steps in a ranked and sequential order, beginning with avoidance, elimination, substitution, minimization, and simplification. Residual risks are controlled using engineering (passive and active) controls, warning systems, administrative controls and personal protective equipment.
14. **Lifecycle:** The phases of design, construction, operation, maintenance, end of service and disposal of a facility, equipment, process and material.
15. **Likelihood:** An estimate of the possibility of an incident or exposure occurring that could result in harm or damage for a selected unit of time, events, population, items, or activity being considered
16. **Prevention through Design (PtD):** Addressing occupational safety and health needs in the design and redesign process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, retrofitting, and disposal of facilities, processes, materials, and equipment.
17. **Project Design Review Manager:** Responsible for developing and updating the design hazard assessment process and scheduling and facilitating Design Safety Reviews. Shall report to the project manager, or an executive with oversight responsibilities for the project design specifications and documents.
18. **Redesign:** A design activity that includes all retrofitting and altering activities affecting existing facilities, equipment, technologies, materials, and processes, and the work methods.
19. **Risk:** An estimate of the likelihood of a hazard-related incident or exposure occurring and the severity of harm or damage that could result.
20. **Stakeholder:** Interested party, person or organization that can influence, affect, be affected by, or perceive themselves to be affected by a decision or activity.
21. **Top Management:** The person(s) who has responsibility for, and give direction to, an organization and bears the ultimate authority for defining acceptable risk levels for the organization.

Key Takeaway: Compliance with ANSI/ASSP Z590.3-2021 will provide guidance for a lifecycle assessment and design model that balances environmental and occupational safety and health goals over the life span of a facility, process or product.

# Design Risk Management Responsibilities

Collaborative design risk management is most effective when there is close communication and cooperation among all design stakeholders including the Client, designers, operations and maintenance personnel and contractors.

Regular communication and design information exchange between all deign stakeholders is crucial to ensuring that design hazards are identified, assessed and mitigated in consideration of the whole asset lifecycle.

The following table summarizes responsibilities for design risk management activities:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Activities | Client | PDRM | Designer | Contractor | O&M |
| Appoint Designer and Contractor | ✓ |  |  |  |  |
| Organize co-operation between designers |  | ✓ |  |  |  |
| Co-operate with Designers and Contractors | ✓ | ✓ | ✓ | ✓ | ✓ |
| Identify design hazards and mitigate design risks | ✓ | ✓ | ✓ | ✓ | ✓ |
| Complete design risk assessments |  |  | ✓ | ✓ | ✓ |
| Review design risk assessments |  | ✓ | ✓ | ✓ | ✓ |
| Attend and input to Design Safety Reviews | ✓ | ✓ | ✓ | ✓ | ✓ |

Table 2 Summary of Design Risk Management Requirements

Key Takeaway: Close collaboration between all design stakeholders is vitally important to ensure that there are no gaps in design knowledge exchange.

# Understanding Hazards and Risks

Design hazards represent potential sources of harm or danger to people or the environment that can arise from the design of built environment projects. Understanding these hazards and how to identify them, is fundamental to effectively managing design risks.

### Difference Between Hazards and Risks

It is important to understand the difference between hazards and risks:

|  |  |
| --- | --- |
| Hazard | Risk |
| A potential source of harm or damage that directly arises from the design of a structure, system, or process | The combination of the probability and the severity of a hazard occurring |

Table 3 Difference Between a Hazard and a Risk

### What is Design Risk Management

Design risk management is the process of identifying, assessing, and controlling design hazards and design risks to ensure that the design can be built, used, maintained and eventually decommissioned or demolished without negatively affecting the health and safety of those involved in the construction process, the end user or the environment.

### What is a Design Hazard

Design hazards may be identified as follows:

1. Health in design: The impact of design decisions on how it can positively (or negatively) affect the health of construction workers and end users over the asset’s whole lifecycle:

* Occupational Disease: Work activities or environments which may cause occupational diseases or cancers.
* Mental Health and Wellbeing: Design to benefit the mental health and wellbeing of all persons who will interact with the asset over its design life.

1. Safety in design: The impact of design decisions taken on the selection of materials and equipment, construction sequencing, arrangements and methodologies, which can positively (or negatively) affect the safety of construction workers and end users over asset’s whole lifecycle.
2. Environment in design: Positive (or negative) influence of design on:

* Ensuring compliance with legislative and regulatory requirements as a minimum,
* Protecting and enhancing the local environment and
* Preventing pollution.

### Design Hazards vs Construction Hazards

Designers must understand the differences between design hazards and construction hazards. The focus of design hazard identification should be on what the designer can do to eliminate or mitigate the following:

* Existing site or asset hazards

and/or

* Hazards introduced by the design process that may affect the asset’s whole lifecycle.

|  |  |
| --- | --- |
| Design Hazards | Construction Hazards |
| Conditions, situations, or factors identified during the design of a project, that have the potential to cause harm to people or the environment. | Dangers, circumstances, or activities of construction work that have the potential to cause harm people or the environment |

Table 4 Difference Between Design and Construction Hazards

Key Takeaway: Understanding whole asset lifecycle hazards and how each design stakeholder may have a positive or negative impact on those hazards, is fundamental to design stakeholder collaboration.

# How to Identify Design Hazards

Design hazard identification involves a systematic approach of data gathering, design stakeholder collaboration, peer reviews and the closing of knowledge gaps across the design interface.

Thoroughly understand the project scope. Gather all available project documentation, including plans, specifications, and any relevant site surveys.

1. Project Awareness

Thoroughly understand the design interface, including the interdependencies of design stakeholders and how (and when) other design outputs may impact the design.

2. Design Interface

Plan ahead for successful design delivery. Identify all designers, their responsibilities, scope, key design interfaces, design change control and planned design stakeholder coordination activities before design work commences.

3. Plan

Gain an understanding of local surroundings, topography, existing infrastructure, nearby buildings, roads, utilities, local environmental and end user factors.

4. Site Assessment

Research past incidents or issues related to similar infrastructure projects, or the surrounding area, if available. These can provide valuable insights into potential design hazards that might not be immediately obvious.

5. Historical Data Analysis

Use computer simulations, modelling or virtual/augmented reality tools (where appropriate) to visualize the project and simulate various scenarios. This can help collaborate on potential hazards that might be overlooked in traditional design processes.

6. Simulation or Modelling

Engage in continual collaboration with all design stakeholders to ensure that there are no gaps in design knowledge exchange. Identify and schedule regular engagement between all design stakeholders, including (but not limited to) clients, engineers, architects, permanent and temporary works designers, environmental specialists, operations and maintenance, construction experts, relevant third parties etc.

7. Design Stakeholder Collaboration

Maintain a Design Risk Assessment of design hazards for all design disciplines to guide the design process. Evaluate the identified design hazards in terms of their probability of occurrence and severity. Avoid, eliminate, reduce or control design risks ALARP.

8. Design Risk Assessment

Organize regular, scheduled Design Safety Reviews with the Project Manager, Project Design Safety Review Manager, design discipline leads and design stakeholders (as appropriate) to discuss identified hazards and emerging mitigation measures. Encourage collaboration between all design stakeholders across the design interface.

9. Design Safety Reviews

Encourage ongoing knowledge sharing and training for the project team to stay updated on the latest safety standards, methodologies, technologies, design hazards and best practices for design hazard identification and mitigation.

10. Learning and Training

Key Takeaway: Continuous design stakeholder collaboration is essential to ensure that all potential impacts are considered to benefit construction workers and end users.

# Design Risk Assessment Process

### Process Overview

The work process for design risk assessments is outlined as follows:

Transfer

Identify

Record

Evaluate

Collaborate

Mitigate

Review

Residual

Figure 1 Design Risk Assessment Process

|  |  |  |
| --- | --- | --- |
| Ref | Stage | Description |
| 1 | Identify | Each design discipline to continuously identify whole lifecycle design hazards which may impact people (employees, the public), processes, property, equipment or the environment throughout the entire design process. |
| 2 | Record | Use a design risk assessment form to continuously record each design hazard as they occur throughout the design process. |
| 3 | Evaluate | Assess each design hazard and evaluate its initial design risk rating in terms of the probability of occurrence against its severity. |
| 4 | Collaborate | Discuss emerging design hazards with design stakeholders (as appropriate) to ensure that there are no gaps in design knowledge exchange. |
| 5 | Mitigate | Designers use the Hierarchy of Risk Treatments to Avoid, Eliminate, Reduce, or Control design risks ALARP. Detail what the designer has done to mitigate the design risk on the design risk assessment form.  Track design changes, mitigation actions and owners for adoption within the design. |
| 6 | Residual | Re-evaluate the probability and severity of the design risk post adoption of the design mitigation measure(s).  Record the residual design risks on the design risk assessment form. |
| 7 | Design Safety Review | Conduct regular Design Safety Reviews throughout the design phase, to ensure continuous communication, coordination and collaboration between all design stakeholders. |
| 8 | Transfer | Collate all residual design risks and communicate design mitigation measures to follow on designers, contractors and end users (where appropriate) for adoption in later project phases. |

Table 5 Design Risk Assessment Process

### Design Risk Rating

A design risk rating is a process used to evaluate and prioritize the potential risk associated with a design hazard. It involves assigning a risk rating based on an assessment of probability of occurrence and potential severity. Design risk rating assessments are subjective and not an absolute or precise determination of a design risk. Refer to the following tables which outlines design risk assessment evaluation.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Design Risk Matrix** | | | | | | |
| Probability of Occurrence | 5 | Medium / High | Medium / High | High | High | High |
| 4 | Medium / Low | Medium / High | Medium / High | High | High |
| 3 | Medium / Low | Medium / Low | Medium / High | Medium / High | High |
| 2 | Low | Low | Medium / Low | Medium / Low | Medium / High |
| 1 | Low | Low | Medium / Low | Medium / Low | Medium / High |
|  |  | 1 | 2 | 3 | 4 | 5 |
|  |  | Severity | | | | |

Table 6 Design Risk Matrix

|  |  |  |
| --- | --- | --- |
| Ref | Probability of Occurrence | Severity |
| 5 | Almost certain to regularly occur. | Catastrophic consequences, immediate and comprehensive action required. |
| 4 | Highly possible, significant chance. | Substantial impact, requires high attention. |
| 3 | Moderate probability, notable to occur. | Notable impact, moderate consequences. |
| 2 | Low likelihood, uncommon occurrence. | Insignificant impact, minimal impact. |
| 1 | Unlikely to occur, minimal chance. | Negligible impact, minor consequences. |

Table 7 Probability and Severity Ratings

|  |  |
| --- | --- |
| Residual Risk Rating | Actions Designers Should Take |
| High | Residual risk resulting from design mitigation is unacceptably high. Revise design to reduce residual risk to an acceptable and manageable level.  In exceptional circumstances, consult with the Client, designers, contractors and operations (where appropriate) to confirm if the residual design risk and identified design mitigation measures must be accepted due to other factors.  Document all decisions. |
| Medium / High | Following consultation between design stakeholders and the Client, residual design risk may be permitted with appropriate design mitigation measures adopted, which shall be communicated to follow on designers, contractors and end users (where appropriate). |
| Medium / Low | Residual design risk is permitted with appropriate design mitigation measures adopted, which shall be communicated to follow on designers, contractors and end users (where appropriate). |
| Low | Residual design risk is permitted, subject to the adoption and communication of identified design mitigation measures, to follow on designers, contractors and end users (where appropriate). |

Table 8 Residual Design Risk Rating Designer Actions

### Hierarchy of Risk Treatments

To mitigate design hazards, designers shall consider the Hierarchy of Risk Treatments. Refer to Section 11 of ANSI/ASSP Z590.3-2021 for further information.

A diagram of a risk management

Description automatically generatedThe most effective form design hazard mitigation method is hazard avoidance. The least effective being the provision of personal protective equipment (PPE).

Figure 2 Hierarchy of Risk Treatments (Source: ANSI/ASSP Z590.3-2021)

Key Takeaway: The design risk assessment shall be a live document which is continuously maintained as a means to guide the design process, not completed as an afterthought when the design process is completed.

# Risk Assessor Competency

### Overview

Section 9.2 of ANSI/ASSP Z590.3-2021 notes that risk assessors should possess the technical expertise and interpersonal skills necessary for the context and understand how to apply the risk criteria established by the organization in the PtD risk management process.

Risk assessor competency risk is a combination of skills, knowledge and experience that enables an individual to perform a task or an activity successfully within a given context.

### Who are Risk Assessors?

The greatest opportunity to either eliminate or reduce hazards or risks to people (employees, the public), processes, property, equipment and the environment, over the whole lifecycle of the asset, lies with the designer.  The choices that designers make, both implicit and explicit, can influence how assets are built, operated, maintained, decommissioned and demolished over the asset's whole lifecycle.

Therefore, all designers are considered risk assessors.

In addition to design discipline knowledge, it is important that designers have an understanding of:

1. Any applicable legislation, codes of practice/guidance and other regulatory requirements applicable to that design discipline.
2. The Hierarchy of Risk Treatments.
3. How the asset being designed can be safely constructed, operated, maintained, refurbished, decommissioned and demolished.
4. The potential impact of the design on people (employees, the public), processes, property, equipment and the environment over the asset’s whole lifecycle.

### Establishing Risk Assessor Competency

Competencies  are observable which can be measured and evaluated to determine the appropriate resources for design tasks. Demonstrating competency may include sample evidence such as curriculum vitae, professional accreditation, appropriate training records or examples of working on similar projects.

The following table provides an example matrix to establish competency and, importantly, any competency gaps requiring either additional training or sourcing of other expert resources.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Name | Proposed Role | Professional Accreditation and Qualifications | Design Scope for Intended Project Role | Previous Relevant Technical Project Experience | Relevant Training for Role | CV Received Yes/No | Identified Competency  Gaps |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

Table 9 Risk Assessor Competency Matrix

Key Takeaway: All designers are risk assessors. Designs should be completed so that associated hazards and risks are avoided, eliminated, reduced or controlled ALARP, so that they can be constructed, operated, maintained, refurbished, decommissioned and demolished without risk to the health and safety of people (employees, the public), processes, property, equipment and the environment.

# Knowledge Enhancement

CPWR encourages the continuous development of design professionals and engagement in lifelong learning to stay updated on the latest PtD practices. The following are encouraged to be adopted by all design stakeholders:

1. Industry-specific training: Seek out training programs (internal or external) that address the unique challenges of the water industry.
2. Interdisciplinary knowledge: Encourage cross-training between different disciplines within design teams to enhance understanding and collaboration.
3. Knowledge sharing: Foster an environment where design professionals share their expertise, experiences and lessons learned to promote a holistic understanding of design risks.

# Further reference

Refer to the following additional reference documents for further information:

* [CPWR Prevention through Design Resources](https://www.cpwr.com/research/prevention-through-design-resources/).
* [NIOSH Hierarchy of Risk Treatments](https://www.cdc.gov/niosh/hierarchy-of-controls/about/index.html).
* [NIOSH Directory of Engineering Controls](https://www.cdc.gov/niosh/engcontrols/).

# Appendices

## 

## Appendix 1