RISK-BASED DECISION-MAKING GUIDELINES

Volume 3
Procedures for Assessing Risks

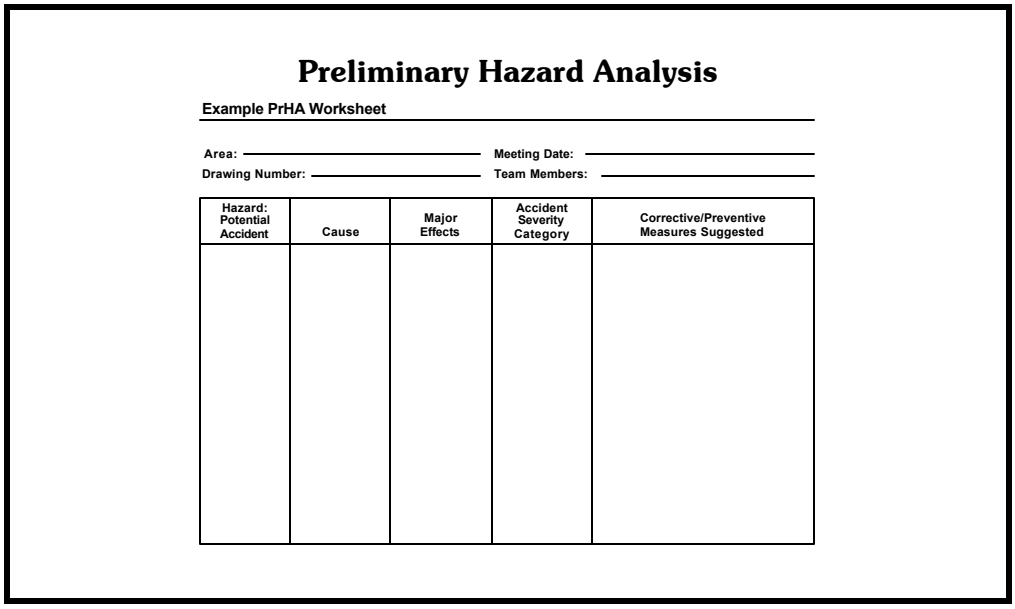
Applying Risk Assessment Tools

Chapter 14 — Preliminary Hazard Analysis (PrHA)

Chapter Contents

This chapter provides a basic overview of the preliminary hazard analysis technique and includes fundamental step-by-step instructions for using this methodology to identify system weaknesses in the early stages of system design. Following are the major topics of this chapter:

See examples of preliminary hazard analyses in Volume 4 in the Preliminary Hazard Analysis directory under Tool-specific Resources.



Preliminary Hazard Analysis

Example PrHA Worksheet

Area: _____ Meeting Date: _____

Drawing Number: _____ Team Members: _____

Hazard: Potential Accident	Cause	Major Effects	Accident Severity Category	Corrective/Preventive Measures Suggested

Summary of Preliminary Hazard Analysis

The preliminary hazard analysis (PrHA) technique is a broad, initial study used in the early stages of system design. It focuses on (1) identifying apparent hazards, (2) assessing the severity of potential accidents that could occur involving the hazards, and (3) identifying safeguards for reducing the risks associated with the hazards. This technique focuses on identifying weaknesses early in the life of a system, thus saving time and money that might be required for major redesign if the hazards were discovered at a later date.

Brief summary of characteristics

- Relies on brainstorming and expert judgment to assess the significance of hazards and assign a ranking to each situation. This helps in prioritizing recommendations for reducing risks.
- Typically performed by one or two people who are knowledgeable about the type of activity in question. They participate in review meetings of documentation and field inspections, if applicable.
- Applicable to any activity or system
- Used as a high-level analysis early in the life of a process
- Generates qualitative descriptions of the hazards related to a process. Provides a qualitative ranking of the hazardous situations; this ranking can be used to prioritize recommendations for reducing or eliminating hazards in subsequent phases of the life cycle.
- Quality of the evaluation depends on the quality and availability of documentation, the training of the review team leader with respect to the various analysis techniques employed, and the experience of the review teams

Most common uses

- Generally applicable for almost any type of risk assessment application, but focuses predominantly on identifying and classifying hazards rather than evaluating them in detail
- Most often conducted early in the development of an activity or system, when there is little detailed information or there are few operating procedures. Often a precursor to further risk assessment.

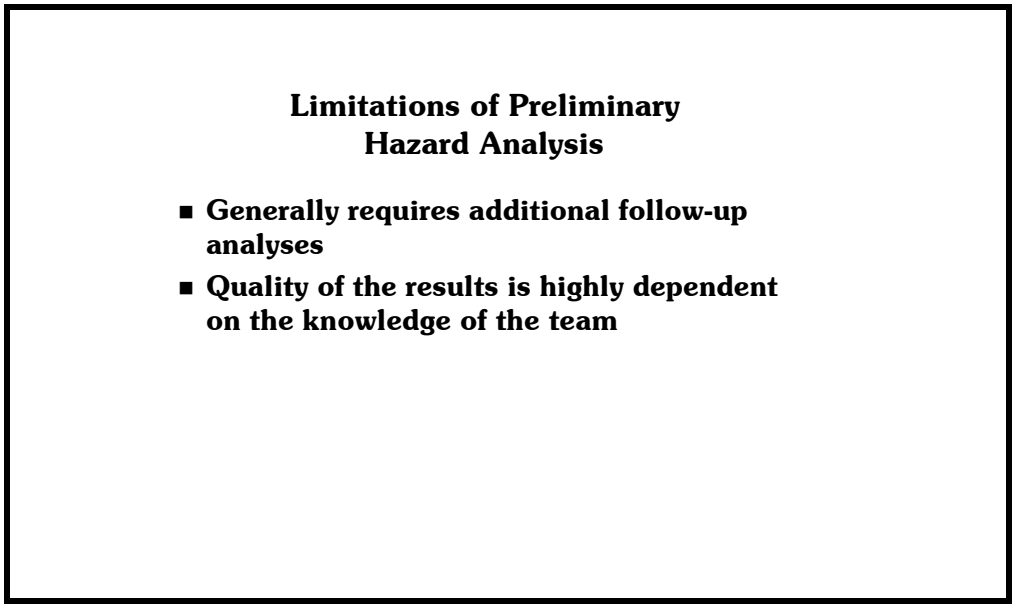
Example PrHA Worksheet

Area: _____ **Meeting Date:** _____

Drawing Number: _____ **Team Members:** _____

Hazard: Potential Accident	Cause	Major Effects	Accident Severity* Category	Corrective or Preventive Measures Suggested
Fuel oil: spill	Ship motion away from the transfer terminal during bunkering	Release of fuel oil into the waterway, resulting in significant environmental impact	2	Consider installing mooring tension meters with alarms to indicate ship motion during bunkering
Liquefied natural gas (LNG): fire or explosion	Loss of ventilation in the compressor room	Potential for explosion and large fire with fatalities	1	Consider providing an alarm that indicates when the ventilation fan in the compressor room shuts down

* See page 14-11 for the definition of these accident severity categories.

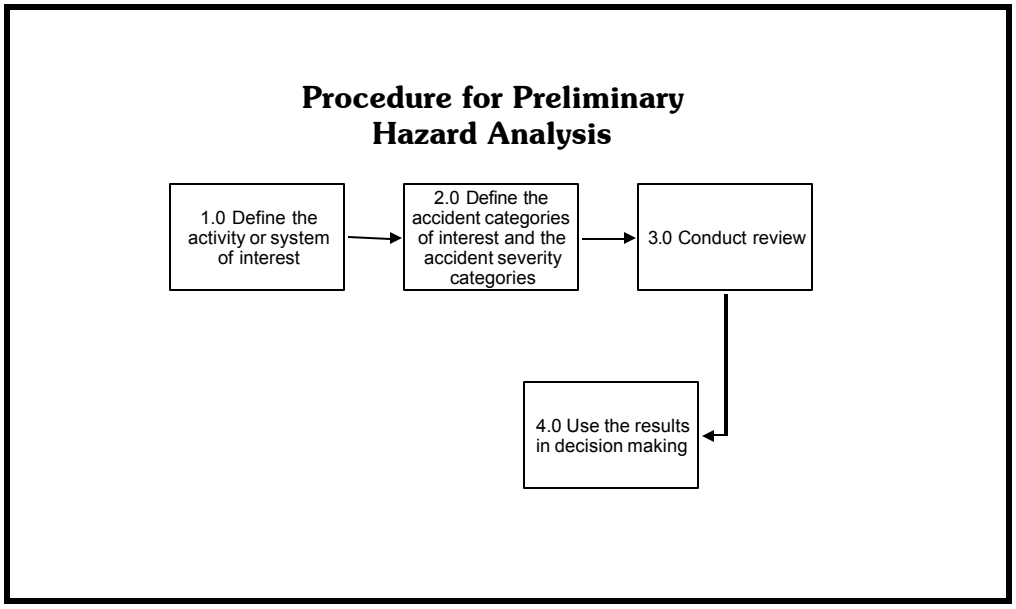


Limitations of Preliminary Hazard Analysis

Because the preliminary hazard analysis technique is typically conducted early in the process, before other analysis techniques are practical, this methodology has two primary limitations:

Generally requires additional follow-up analyses. Because the PrHA is conducted early in the process and uses preliminary design information, additional analyses are generally required to more fully understand and evaluate hazards and potential accidents identified by the PrHA team.

Quality of the results is highly dependent on the knowledge of the team. At the time of a PrHA, there are few or no fully developed system specifications and little or no detailed design information. Therefore, the risk assessment relies heavily on the knowledge of subject matter experts. If these experts do not participate in the risk assessment, or if the system is a new technology having little or no early operational history, the results of the PrHA will reflect the uncertainty of the team in many of its assessments and assumptions.



Procedure for Preliminary Hazard Analysis

The procedure for conducting a preliminary hazard analysis consists of the following steps. Each step is further explained on the following pages.

1.0 Define the activity or system of interest. Specify and clearly define the boundaries of the activity or system for which preliminary hazard information is needed.

2.0 Define the accident categories of interest and the accident severity categories. Specify the problems of interest that the risk assessment will address (e.g., health and safety concerns, environmental issues). Specify the accident severity categories that will be used to prioritize resources for risk reduction efforts.

3.0 Conduct review. Identify the major hazards and associated accidents that could result in undesirable consequences. Also, identify design criteria or alternatives that could eliminate or reduce the hazards.

4.0 Use the results in decision making. Evaluate the risk assessment recommendations and the benefits they are intended to achieve (e.g., improved safety and environmental performance, cost savings). Determine implementation criteria and plans.

1.0 Define the activity or system of interest

- **Intended functions**
- **Boundaries**

1.0 Define the activity or system of interest

Intended functions. Because all risk assessments are concerned with ways in which a system can fail to perform an intended function, clearly defining these intended functions is an important first step in any risk assessment. This step does not have to be formally documented for most preliminary risk assessments.

Boundaries. Few activities or systems operate in isolation. Most interact with or are connected to other activities or systems. By clearly defining the boundaries of an activity or system, especially boundaries with support systems such as electric power and compressed air, the analysis can avoid (1) overlooking key elements of an activity or system at interfaces and (2) penalizing an activity or system by associating other equipment with the subject of the study.

Example:

Functions of interest

- Safe handling and use of fuel oil for an LNG cargo ship
- Safe handling and use of LNG cargo for an LNG cargo ship

Boundaries

- Include only shipboard systems or operations

2.0 Define the accident categories of interest and the accident severity categories

Accident categories

- **Safety problems**
- **Environmental issues**
- **Economic impacts**

Accident severity categories

- **Major**
- **Moderate**
- **Minor**

2.0 Define the accident categories of interest and the accident severity categories

Accident categories

The following paragraphs describe three of the most common types of accidents of interest in a PrHA:

Safety problems. The risk assessment team may look for ways in which improper performance of a marine activity or failures in a hardware system can result in personnel injury. These injuries may be caused by many mechanisms, including the following:

- Person overboard
- Exposure to high temperatures (e.g., through steam leaks)
- Fires or explosions

Environmental issues. The risk assessment team may look for ways in which the conduct of a particular activity or the failure of a system can damage the environment. These environmental issues may be caused by many mechanisms, including the following:

- Discharge of material into the water, either intentional or unintentional
- Equipment failures (e.g., seal failures) that result in a material spill
- Disruption of the ecosystem through overutilization of a marine area

Economic impacts. The risk assessment team may look for ways in which the improper conduct of a particular activity or the failure of a system can have undesirable economic impacts. These economic risks may be categorized in many ways, including the following:

- Business risks such as contractual penalties, lost revenue, etc.
- Environmental restoration costs
- Replacement costs for damaged equipment

Some risk assessments may focus only on events above a certain threshold of concern in one or more of these categories.

Accident severity categories

During a PrHA, a team assesses the severity of the various accidents that can occur with each of the hazards. Establishing severity categories with definitive boundaries allows the team to assess each accident against a consistent measure of severity. It thus provides the framework for prioritizing recommendations for risk reduction alternatives.

Example

The following table is an example of three accident severity categories for four different accident categories.

Accident Severity Category	Accident Categories			
	Safety Impact	Environmental Impact	Economic Impact	Mission Impact
Major (1)	One or more deaths or permanent disabilities	Releases that result in long-term disruption of the ecosystem or long-term exposure to chronic health risks	> $3M	> $3M
Moderate (2)	Injury that requires hospitalization or lost work days	Releases that result in short-term disruption of the ecosystem	> $10K and ≤$3M	> $10K and ≤$3M
Minor (3)	Injury that requires first aid	Pollution with minimal acute environmental or public health impact	> $100 and ≤$10K	> $100 and ≤$10K

3.0 Conduct review

- **Identify major hazards and accident scenarios**
- **Identify design criteria or alternatives that could eliminate or reduce hazards**

3.0 Conduct review

Performing a PrHA identifies major hazards and accident situations that could result in losses. However, the PrHA should also identify design criteria or alternatives that could eliminate or reduce those hazards. Obviously, some experience is required in making such judgments. The team performing the PrHA should consider the following factors:

- Hazardous vessel equipment and materials, such as fuels, highly reactive chemicals, toxic substances, explosives, high pressure systems, and other energy storage systems
- Safety-related interfaces between equipment and materials, such as material interactions, fire or explosion initiation and propagation, and control or shutdown systems
- Environmental factors that may influence the vessel or facility equipment and materials, such as vibration, flooding, extreme temperatures, electro-static discharge, and humidity
- Operating, testing, maintenance, and emergency procedures, such as human error potential, crew functions to be accomplished, equipment layout and accessibility, and personnel safety protection
- Vessel support, such as storage, equipment testing, training, and utilities
- Safety-related equipment, such as mitigating systems, redundancy, fire suppression, and personal protective equipment

The next page is an example of a completed PrHA table documenting the findings of an analysis team.

Example PrHA Worksheet

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Drawing Number: _____ **Team Members:** _____

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4.0 Use the results in decision making

- **Judge acceptability**
- **Identify improvement opportunities**
- **Make recommendations for improvements**
- **Justify allocation of resources for improvements**
- **Recommend additional risk assessments**

4.0 Use the results in decision making

Judge acceptability. Decide whether the estimated performance for the activity or system meets an established goal or requirement.

Identify improvement opportunities. Identify the elements of the activity or system that are most likely to contribute to future problems. These are the items with the largest percentage contributions to the identified risks.

Make recommendations for improvements. Develop specific suggestions for improving future activity or system performance, including any of the following:

- Equipment modifications
- Procedural changes
- Administrative policy changes, such as planned maintenance tasks or personnel training

Justify allocation of resources for improvements. Estimate how implementation of expensive or controversial recommendations for improvement will affect future performance. Compare the economic benefits of these improvements to the total life-cycle costs of implementing each recommendation.

Recommend additional risk assessments. As suggested by the name, preliminary hazard analysis is conducted in an early phase of a project. Additional risk assessments will likely be needed to investigate certain issues in more detail. The insights gained from the PrHA will help determine what, if any, additional risk assessments should be conducted.