



ONSHORE SAFETY ALLIANCE (OSA)
onshoresafetyalliance.org

Risk Assessment User Guide



How to Conduct a Risk Assessment Using the What-If Methodology

Special Notes

OSA publications may be used by anyone desiring to do so. Every effort has been made by the OSA to assure the accuracy and reliability of the data contained in them; however, the OSA makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

OSA publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of OSA publications is not intended in any way to inhibit anyone from using any other practices.

Users of this material should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

Table of Contents

| | |
|--|-----------|
| Introduction | 3 |
| What-If Analysis Methodology..... | 4 |
| What is a What-If Analysis Methodology? | 4 |
| Conducting the Review..... | 4 |
| Developing “What-If” Questions..... | 5 |
| Determining the Answers..... | 6 |
| Assessing the Risk & Making Recommendations..... | 6 |
| Risk Prioritization Matrix..... | 6 |
| <i>OSA Risk Matrix</i> | <i>7</i> |
| Determining Consequence, Probability and Resulting Risk Levels..... | 7 |
| Barrier Definition, Characteristics, Application..... | 7 |
| <i>OSA Barrier Definition.....</i> | <i>8</i> |
| Reporting the Results | 9 |
| Appendix A: OSA Risk Assessment Template..... | 10 |

Introduction

A risk assessment is an analysis of the risks present in a given activity or process. It helps decisionmakers identify things that can go wrong and determine controls to prevent or mitigate the risk. The procedure is designed to help companies and their project development teams manage facility-, activity- and product-related risks logically and consistently across the life cycle of the business. Using this procedure will enable proactive assessment of risks and guide management into determining appropriate risk reduction and assurance activities.

[OSA Participant Action 5: Perform Risk Assessments for Common Process Safety Hazards](#) asks participants to perform risk assessment(s) for potentially high-risk activities associated with drilling, completions, flowback, well service and ongoing production operations. At a minimum, the participant will conduct risk assessments for the following activities, as applicable to their operations:

- Drilling – Loss of Well Control
- Drilling – Loss of Primary Containment
- Drilling – Wellhead/Tree Damage
- Completions/Flowbacks – Loss of Well Control
- Completions/Flowbacks – Loss of Primary Containment

- Completions/Flowbacks – Perforating Gun Failure
- Well Service – Loss of Well Control
- Ongoing Operations/Production – Loss of Primary Containment

There are many ways that risk assessments can be performed. The Onshore Safety Alliance provides flexibility in how a participant meets the objective of this action and does not prescribe or endorse a specific risk assessment approach. To support participants, the OSA provides guidance below for a simplified risk assessment methodology and approach. OSA participants may apply this guidance to its specific operations as appropriate.

What-If Analysis Methodology

There are a variety of methodologies that may be used when conducting a risk assessment (“What-If”, “What-If Checklist”, HAZOP, etc.). Below is an overview on the “What-If” method. This is the risk assessment method that the OSA has selected to use within its guidance materials for learning and education purposes.

What is a What-If Analysis Methodology?

What-If Analysis is a structured risk assessment method of determining the potential consequences of the failures that could occur and judging the likelihood of those consequences. The answers to these questions form the basis of the level of potential risks and aid in determining a recommended course of action to prevent or mitigate them. An experienced risk assessment review team can effectively discern major issues concerning a part of a process or system. Led by a facilitator, each member of the review team participates in assessing what could go wrong based on their past experiences and knowledge of similar situations. Guide words can be used to help facilitate the brainstorming process.

The initial step is to develop a list of potential hazards for the phase of operation, part of the process or step in the procedure being evaluated.

The team reviews the phase or part of the system utilizing a form (What if Template). Team members usually include operating and maintenance personnel, design and/or operations engineers, specific skills as needed (drilling engineer, structural engineer, etc.) and a person familiar with facilitating a risk assessment. At each phase, What-If questions are asked, and answers generated.

The review team then makes judgments regarding the potential consequence and likelihood of the “What-If” answers. The OSA Risk Matrix should be reviewed for risk level and recommendations are made to eliminate or mitigate identified risks. The completed risk assessment is then summarized and prioritized, and responsibilities and completion dates are assigned.

Conducting the Review

The facilitator shares the description of the step, process or system, its design intent and related documentation with the team. The Team reviews the information package and prepares to conduct the

risk assessment. Generally, an experienced risk assessment facilitator will lead the group through a series of “What-If” questions. As hazards are identified and assessed, they are recorded in the risk assessment template.

Developing “What-If” Questions

Using the documents available and knowledge of the review team, “What-If” questions can be formulated around human errors, process upsets, and equipment failures. These errors and failures can be considered during normal production operations, during construction, during maintenance activities, as well as during drilling, well servicing and completion operations. The questions could address any of the following situations:

- Failure to follow procedures or procedures followed incorrectly
- Procedures incorrect or latest procedures not used
- Operator not trained
- Procedures modified due to upset
- Process conditions upsets
- Equipment failure
- Instrumentation mis-calibrated
- Utility failures such as loss of power, steam, gas, etc.
- External influences such as weather, vandalism, fire

The assessment team generates “What-If” questions based on their experience of the related operations and systems. Questions describing an initiating cause can generally be loaded directly into the risk assessment worksheet

- What if the control valve fails open?
- What if the operator performs step 2 before step 1?

Questions describing consequences/concerns need to be explored further and restated for risk assessment

- What if the line ruptures?
- What if the vessel is empty?
- What if there is a fire?

As the “What-If” questions are being generated, the facilitator should ensure that each member of the team has an opportunity to input potential errors or failures. Determining the answer to each question as it is generated creates the danger of closing too soon on all possible upsets. The facilitator needs to assess if the team has really looked at all the possibilities before going to the next step of answering the questions. Break up the risk assessment into smaller pieces if there is danger of just developing questions and not gaining the value of having them fresh in mind to answer those questions.

Checklists may be applied before or after the brainstorming of potential What-if scenarios are complete. However, if checklists are applied first, the facilitator should assure that the creativity of the review team is not restricted during the What-if brainstorming. As with the What-If brainstorming, issues identified by checklists should be broken down to potential initiating causes so that related scenarios can be fully developed.

Determining the Answers

After being assured that the review team has exhausted the potential “What-If” scenarios, the facilitator then has the team answer the question, what would be the result of that situation occurring? What are the potential causes that could lead to the consequence scenario? What are the conditions that allow the failure to occur?

If done correctly, reviewing the potential equipment failures and human errors can point out the potentials for not only safety and health improvements but also the opportunity to minimize operating and quality problems. Including the operators and trades personnel in the review can bring a practical reality to the conclusions that will be reached.

Assessing the Risk & Making Recommendations

The potential worst consequence is developed and recorded, without credit for safeguards or protective barriers. Having considered the answers to the “What-If” questions, the next task is to make judgments regarding the likelihood and consequence of that scenario to determine related risk level. The review team needs to make judgments regarding the level of risk using a risk prioritization matrix. Consequence is considered without safeguards or barriers, and likelihood is determined considering the existence of effective (appropriate, available, and functioning) barriers.

Risk Prioritization Matrix

A Risk Prioritization Matrix is a tool to improve consistency in the qualitative assessment of workforce safety & health, public health & safety, environmental and asset and business & reputation risks. The purpose of the matrix is to provide a single tool for qualitative assessment of risks. It is designed to help asset management teams and project development teams identify, prioritize, and manage risks of existing facilities, activities and projects logically and consistently.

There is wide variance in risk matrices designs based on operational and business complexities. Matrices size may range from 5x5 up to 8x8 depending on how granular a company wants to define its likelihoods and consequences. Individual companies must decide on an appropriate scale for each of the consequence levels (incidental, minor, moderate, major and severe) and also decide whether to distinguish consequences between workforce health and safety, public health and safety, the environment and business asset impacts.

OSA Risk Matrix

For the purposes of this guidance document and other OSA guidance materials, the OSA has selected the below simplified 5x5 risk matrix to use in its guidance for learning educational purposes. OSA participants should select a risk matrix appropriate for its specific operations.

Figure 1 – A Simplified 5x5 Risk Matrix

| Likelihood Qualitative Descriptions | # of Barriers | | Risk Level (Likelihood with confirmed Barriers and Consequence without Barriers) | | | | | |
|--|--|----------------------|--|--|---|--|---|----|
| Expect to occur - Likely | 0 | 5 | <div>Decreasing Likelihood</div> | 6 | 7 | 8 | 9 | 10 |
| Conditions may allow to occur - Occasional | 1 | 4 | | 5 | 6 | 7 | 8 | 9 |
| Exceptional conditions may allow to occur - Seldom | 2 | 3 | | 5 | 5 | 6 | 7 | 8 |
| Reasonable to expect will not occur - Unlikely | 3 | 2 | | 3 | 4 | 5 | 6 | 7 |
| Has occurred once in the industry - Remote | ≥4 | 1 | | 2 | 3 | 4 | 5 | 6 |
| | Consequence Descriptions and Index (without Barriers) | | <div>Decreasing Consequence</div> | | | | | |
| | | Consequence Category | 1 | 2 | 3 | 4 | 5 | |
| | | | Incidental | Minor | Moderate | Major | Severe | |
| | | Health and Safety | One injury or illness requiring treatment but not life altering | More and than one injury or illness requiring treatment but not life altering | One or more injuries or illnesses with potential life altering effects | One or more life altering injuries or illnesses | One or more fatalities | |
| | | Environment | Limited on pad spill, temporary impact, remediation efforts require less than 1 week cleanup | Localized spill on pad or immediate surrounding areas, remediation efforts require between 1 week to 6 months to cleanup | Localized spill on pad and or surrounding areas, remediation efforts take between 6 months to 1 year to cleanup | Long-term, widespread impact, remediation requires 1 to 5 years to cleanup | Long-term, widespread impact, restoration is greater than 5 years | |
| | | | | | | | | |

Determining Consequence, Probability and Resulting Risk Levels

Once the team has identified the worst consequence scenario and selected an appropriate risk matrix, the next step is to identify the consequence, probability and resulting risk levels. First, the team will determine the consequence level without barriers using the risk matrix and appropriate consequence categories.

Once the consequence is recorded without credit for safeguards or protective barriers, the team will then identify all potential barriers – physical and/or operational elements – that could be implemented to prevent, control, or significantly mitigate an event scenario likelihood or consequence.

Barrier Definition, Characteristics, Application

Barriers or safeguards are equipment or actions that directly prevent or mitigate an incident or impact. Prevention barriers/safeguards reduce the chance that an unintended event will occur. Mitigation safeguards reduce the ultimate consequence of an event or restore conditions after the event has occurred.

Common safeguards include facility design elements, mechanical devices, engineered systems, protective equipment, execution of procedures and other human actions.

Safeguards may vary in their effectiveness over time and in the work environment in which they are placed.

During qualitative risk assessment, teams with appropriate expertise apply knowledge of both the presence and functionality of safeguards to determine if the safeguard is effective. In making this determination, teams shall answer two questions:

- Does the safeguard have a direct role in preventing the scenario or reducing the ultimate potential consequences i.e., Is it a device, system or action that would likely interrupt the chain of events?
- Based on available documentation, knowledge and expertise of the team members, will the safeguard work if needed, i.e., is the supporting management system in place and functioning?

If the answer to either of these two questions is “no”, then the safeguard cannot be effective and shall not be claimed in the risk assessment.

OSA Barrier Definition

Note: For the purposes of this guidance document and other OSA guidance materials, the OSA has selected to use the term Barrier along with the below definition. The term “safeguard” may also be used. OSA participants should select a term and definition appropriate for its specific operations.

A Barrier is a single or combined group (system) of physical and/or operational elements that prevent, control or significantly mitigate an event scenario likelihood or consequence.

A Barrier generally meets the following characteristics:

- Effective in preventing or reducing the likelihood of a scenario
- Effective in significantly mitigating the consequence of a scenario

Each Barrier can be applied (credited) to one risk reduction level using the risk matrix if it meets the following:

- Independent of any other Barrier that has already been credited
- Failure of one Barrier shall not prevent another Barrier from performing its function
- Auditable to validate level of effectiveness

Human Intervention Barriers:

- Personnel competency and training alone can't be credited as a barrier.
- Personnel competency and training in conjunction with the appropriate human action can be credited as a barrier if it meets the criteria noted above.
- More than one personnel competency and training barrier can be credited for the same scenario only if the appropriate human action is performed by two separate individuals and each action meets the criteria noted above, i.e., must meet the independence criteria.

Next the team will identify the probability/likelihood level with confirmed barriers. The team can then determine the resulting risk level by using the risk matrix and the identified consequence and probability levels.

Notice that the team has not only assessed the risk of each consequence scenario but has also made their recommendation to eliminate or mitigate it. The discussion of each situation leads naturally to the recommendation. The team will then continue the review question by question until the entire process or operation has been analyzed. At this point, the facilitator should have the team step back and review the “big picture” and determine they have inadvertently missed anything.

A risk assessment template is provided in Appendix A.

Reporting the Results

The facilitator will generate a cover memo that details the scope of the review as well as the major findings and recommendations. Actions will then be assigned to individuals to ensure that mitigations are appropriately completed.

Appendix A: OSA Risk Assessment Template

Below is a list of the typical information that is discussed and documented by a risk assessment team when using the What-If methodology approach. This information is often collected within an excel spreadsheet. Figure 2 provides an example of how the template may be set up within an excel spreadsheet.

| Template Field | Explanation |
|---------------------------------|---|
| Activity | <i>Define the activity being assessed.</i> |
| What If Event Scenario | <i>Identify and record all potential event scenarios by using the What-If methodology questions approach.</i> |
| Potential Consequences | <i>For each identified scenario, answer the questions:</i> <ul style="list-style-type: none"> - <i>what would be the result of that situation occurring?</i> - <i>What are the potential causes that could lead to the consequence scenario?</i> - <i>What are the conditions that allow the failure to occur?</i> |
| Consequence Category | <i>Select the appropriate consequence category to consider within the selected risk assessment matrix.</i> |
| Barrier(s) | <i>Identify all potential barriers – physical and/or operational elements – that could be implemented to prevent, control, or significantly mitigate the event scenario likelihood or consequence.</i> |
| Consequence Level (C) | <i>Using the selected risk matrix and its consequence categories, identify the consequence level (C) without barriers.</i> |
| Probability Level (P) | <i>Using the selected risk matrix, identify the probability/likelihood level with confirmed barriers.</i> |
| Resulting Risk Level (R) | <i>Determine the resulting risk level by using the risk matrix, the identified consequence and the identified probability levels.</i> |
| Recommendations | <i>Document recommendations to address any identified gaps in meeting the barriers or controls, recommendations to improve the existing barriers or suggest new barriers/controls that should be considered.</i> |

Figure 2 - Example of a Risk Assessment Template within Excel

| Activity | What If Event Scenario | Potential Consequences | Consequence Category | Barrier(s) | C | P | R | Recommendations |
|-------------------------------|--|--|----------------------|------------------------------------|---|---|---|--|
| Drilling Loss of Well Control | Drilling production hole in target formation and experience an unexpected kick due to high pressure zone resulting in loss of well control | Gas release and fire or explosion potentially impacting personnel on the drilling rig or on location | Health and Safety | (1) Well Design (2) Overbalance | 5 | 3 | 8 | <i>Use this column to document recommendations to address any identified gaps in meeting the barriers or controls, recommendations to improve the existing or suggest new barriers/controls that should be considered.</i> |