ioMosaic®

Minimizing risk. Maximizing potential.®

Risk Ranking For PHA, LOPA and Facility Siting

An ioMosaic White Paper

Introduction

Risk ranking is a common methodology for making risk based decisions without conducting quantitative risk analysis. The basis for risk ranking is the risk matrix that has both a consequence and frequency axis. The product of consequence and frequency provides a measure of risk. Each consequence/frequency pair on the risk matrix is assigned a risk ranking that includes risk levels that are tolerable and others that are intolerable. The intolerable risk levels may be further divided into higher and lower risks to prioritize mitigation actions.

Developing a Risk Matrix

The process for developing a risk matrix is to start with the ranges of consequences of concern and then to determine the tolerability level for each. Generally, the most severe consequence range includes one or more fatalities. However, some companies like to define multiple fatality events as the most severe range and a less severe range that typically is limited to a single fatality. Some companies also treat offsite or public impacts as more severe than onsite impacts. One argument for the latter approach is that onsite employees are more prepared and protected against an incident than the public and therefore have a lower chance of realizing the impact given an exposure event. Another argument is that offsite impacts have more far reaching implications in terms of the Business Case for Process Safety and the License to Operate.

Analyzing Fatality Risk Tolerability Data

There is considerable data on fatality risk tolerability for individuals. [1] We have also benchmarked data from other chemical/petrochemical companies and the results depend on whether they are expressed as impact criteria or event criteria. An impact scenario considers all events that need to occur in order to realize an undesired impact such as an injury. An impact scenario will consist of an initiating event and any number of enabling events, conditional events (probability of ignition, probability of personnel in affected area, probability of realizing undesired consequences) and safeguards. An event scenario considers only those events necessary to have a release or condition with the potential for an injury. An event scenario will consist of the initiating event and any safeguards. Event scenarios are typically used for PHAs whereas impact scenarios are typically used for LOPA and facility siting.

Tolerable impact criteria for events with the potential for one or more fatalities range from 10-5 to 10-6 per year, whereas comparable tolerable event criteria range from 10-4 to 10-5 per year. This implies that typically tolerable event criteria are set an order of magnitude higher than the equivalent impact criteria. This seems reasonable and conservative given all of the additional conditional probabilities that need to be included in determining the frequency of impacts from scenarios.

Historical Injury

Therefore, if a company wants to be in the norm regarding their risk tolerability they would choose a tolerable fatality event frequency of 10-4 per year or a tolerable fatality impact frequency of 10-5 per year. Once the most severe consequence category has been determined and its risk tolerability defined, the same process is used for each of the other consequence categories. A review of recent API data [2] is summarized in Table 1. This data shows that there is a gap between lost workday injuries and fatalities. We have assumed that this intermediate category would be a disabling injury.

Table 1: Historical Injury Data

Consequences	API Annual Injury Rate (1994-1998 avg)	Annual Impact Frequency Range
Recordable injury	2x10-2	10-1 to 10-2
Lost workday injury	5x10-3	10-2 to 10-3
Disabling injury	Not reported	10-3 to 10-4
Fatality	5x10-5	< 10-4

Consequence Ranges

Since all industries strive to continuously reduce incident rates, it seems reasonable to set the target event frequency ranges at the historical incident rate ranges. Given a factor of 10 between event and impact frequencies, this would set the company target event frequency ten times lower than the historical frequency. Thus, a set of four consequence ranges and their tolerable event frequencies would be as follows:

Table 2: Consequence Ranges

Events That Have Potential for the Following Consequences	Tolerable Event Annual Frequency
Recordable injury (R)	10-1 to 10-2
Lost workday injury (L)	10-2 to 10-3
Disabling injury (D)	10-3 to 10-4
Fatality (F)	< 10-4

References

1. *Layer of Protection Analysis,* American Institute of Chemical Engineers, Center for Chemical Process Safety, New York, NY, 2001.
2. API Publication 2377, *Summary of U.S. Occupational Injuries, Illnesses, and Fatalities in the Petroleum Industry,* American Petroleum Institute, Washington, D.C., 1999.

Additional Resources

1. Henry Ozog, 2003