INTRODUCTION TO MODULE 1: Concepts of risk analysis

The objective of LOPA is to calculate an expected event frequency which may then be compared to the target event frequency to determine if further risk reduction is required.

LOPA is one of the mathematical tools available for decision making in the management of process-related hazards. To understand how and when to use it, we need to know the background issues: what we mean by a hazard, how it relates to risk, and how we measure and control risk. These topics, which are fundamental to a correct application of LOPA, are covered in this module.

Terms and abbreviations used in this module are listed here.

Term	Definition
As Low As Reasonably Practicable (ALARP)	Level of risk where the cost to reduce the risk of a harmful event becomes grossly disproportionate to the amount of risk reduction achieved
Control system hazard and operability study (CHAZOP)	A form of workshop study PHA that systematically examines upsets within a control system that will affect a process
Checklist	A form of PHA more suited for analysing well-defined situations such as facility siting
Consequence	Unwanted result of the harmful event resulting from a hazard
Harm	Undesired negative impact on risk receptors from a hazardous incident – for instance, an injury or fatality
Hazard	Property or action that has the potential to cause harm under certain conditions
Hazard and operability study (HAZOP)	A form of workshop study PHA that examines deviations from normal process conditions and identifies consequences and safeguards
Independent protection layer	A risk reduction method that reduces the probability of a specific harmful event occurring, or reduces the severity of the event
Initiating event	Incident which sets off a chain of events potentially leading to harm
Management of change	A company defined procedure for assessing the impact of any change to equipment or procedures relating to a process
Probability of failure on demand	The probability that a safety function will fail to perform its intended function when required
Risk	Product of the frequency and magnitude of the consequence of a harmful event. Used as a measure to determine how impactful a hazardous event may be.
Risk receptor	Objects that are affected by a harmful event (personnel, financial, environmental, others)
Safety integrity level	Discrete measure of the availability of a safety instrumented function
Tolerable risk	Company defined maximum target risk level for a given harmful event
What-If	A more flexible form of PHA more suited to assessing non-typical systems or situations, such as design changes

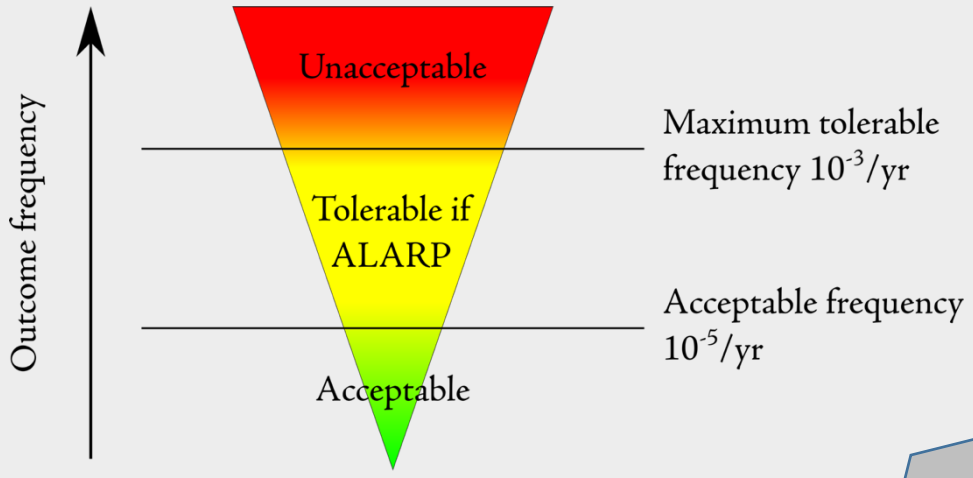
What is ALARP?

When deciding how much risk reduction to apply, we are faced with the question "how much risk reduction is enough?" One way of answering this is to consider "If we apply further risk reduction, is the cost much greater than the benefit?" If we can answer "Yes" to this question, we can argue the risk is As Low As Reasonably Practicable (ALARP). Some companies and countries allow the use of the ALARP concept to justify not providing further risk reduction.

When ALARP is used, tolerable risk is typically expressed as an upper and lower limit, between which the risk is tolerable if it is ALARP. An example is shown below.

Example: Tolerable risk limits using ALARP
For a single hazard leading to a single fatality.
(Values are for illustration only)

Fig. 1.2



Tolerable risk method 2: Single tolerable frequency target

Example 1.1

Suppose a company defines the tolerable frequency for an incident with a PLL of 1.0 (expecting one fatality per incident) to be once in 5,000 years (or 2 x 10^{-4}/year). If we are analyzing an incident with a PLL of 0.1, the tolerable frequency will be (2 x 10^{-4}/year) / 0.1 = 2 x 10^{-3}/year, or once in 500 years.

This method is most commonly applied to the personnel risk receptor. It can also be used for financial risk receptors, although this is uncommon.

In this method, a tolerable frequency is assigned to an outcome with a specific quantitative outcome, such as an expected number of fatalities (known as 'probable loss of life', PLL) or incident cost. This single target is then scaled according to the expected outcome of the event under consideration. See Example 1.1.

What if company expresses risk targets in other ways?

For LOPA, a numerical tolerable frequency value is required. If your company's risk tolerance is expressed in a different way, it may be necessary to try to 'back calculate' the underlying tolerable frequency from the information given. See Example 1.2.

Example 1.2

Some companies specify a relationship between the severity of an incident, and the number of independent protection layers (IPLs) needed to prevent the incident. For instance, a single fatality incident may be required to have 3 IPLs. This could be based on the assumption of an initiating event frequency of 0.1/year and a Probability of Failure on Demand of each IPL of 0.1, giving a tolerable frequency of 0.1/year x $(0.1)^3$ = 10^{-4}/year. (Details of these terms and calculations will be covered in module 2.)

If you base a LOPA on a back-calculation like this, make sure it is clearly documented in the LOPA report, as justification for the conclusions made.

