Risk Ranking

Clint Guymon, PhD PE

Brigham Young University

1st Jan, 2025

created in Curvenote

Keywords Spiritual Safety, Process Safety, Chemical Engineering, Risk Assessment

Learning Outcomes

- Differentiate between voluntary and involuntary risks and how they influence risk tolerance.
- Apply the MIL-STD-882E Risk Matrix to categorize hazards based on severity (Catastrophic to Negligible) and probability (Frequent to Improbable).
- Assign alphanumeric risk rankings (e.g., 1A, 3C) to prioritize safety hazards for mitigation.

Reading

- Foundations of Spiritual and Physical Safety: with Chemical Processes; Chapter 4, Sections 1-2

1 Criticality of Process Safety

Hopefully in the last discussion we began to establish that process safety is a critical part of manufacturing. But when and how do we systematically go about responsibly managing risks and preventing accidents? We need tools to estimate risks for specific scenarios or actions, and we need tools to reduce those risks.

2 Risk Tolerance

Our tolerance for risk varies widely between individuals and organizations. How do we determine what is an acceptable risk? How do we determine what is an unacceptable risk? How do we determine what is a tolerable risk? How do we determine what is a negligible risk?

What risks do you voluntarily accept everyday?

- Getting struck by lightning?
- Getting hit by a meteorite?
- Getting in a car accident?

- Slipping on ice?
- Getting skin cancer?
- Getting the flu?

What involuntary risks do you accept frequently?

- Eating lead in your food?
- Eating salmonella in your food?
- Breathing in particulate matter?
- Getting drafted into the military?

What spiritual risks do you accept?

- Being exposed to damaging images?
- Being exposed to damaging philosophies?
- Consuming content that is not edifying?

How does your risk tolerance outside of work compare to your risk tolerance at work?

Note
As an industry consultant who performed many hazards analyses on explosive operations, we typically estimated the risks for a given hazard subjectively using the risk matrix shown below. About 1% of the time, for the most consequential hazards, we would quantify the risks using a more rigorous method. That more rigorous method is called Quantitative Risk Assessment (QRA). QRA is a topic to be disussed later in the course.

3 Risk Matrix

Risk is estimated by both the severity and its event probabilty or frequency. Usually the severity is listed first and the event probability is listed second. For example, getting hit by lightning would be catastrophic (death or a 1) but that event probability is very low (improbably, E), so that hazard rank would be 1E for most locations you're in. What ranking would you give the following physical events?

- Getting in a car accident driving to and from work over a 35 mile commute in a city?
- Getting in a car accident driving to and from work over a 35 mile commute in a rural area?
- Breaking your arm while playing frisbee?
- Getting burned by your stove while cooking?
- Getting burned eating hot pizza?
- Getting killed as an arborist cutting down 50 foot trees with a chain saw while being secured with a plastic rope?

RISK ASSESSMENT MATRIX				
SEVERITY / PROBABILITY	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

Figure 1: Qualitative Risk Matrix

3.0.1 Spritual Risk Rankings

What about a risk rating for \textbf{spiritual events}? Physical injury is straightforward like scratches and scrapes to broken bones or loss of sight to death. Spiritual injury is not as straight forward and it's difficult to recognize sometimes. For that reason, we'll primarily focus on physical risks. However, we can define spiritual harm as being separated from God if we fail to keep His commandments. Some activities are not edifying and participating in those may not immediately lead to committing a mistake or sin. However, small acts of setting aside God can result in spiritual or emotional trauma. In that light, could you ranking the following events?

- Not reading your scriptures for a day? (What emotional or spiritual harm would result, corresponding to a severity, and instead of a frequency, how probable is it that you would be harmed to that severity)
- Not reading your scriptures for a week?
- Viewing pornography?
- Lying to your spouse?
- Lying to your boss?

Important
The overall risk assessment based on the severity and frequency are ranked from eliminated, to low, medium, serious, and high. That overall risk is labeled by a color as well in the risk matrix above.

The risk acceptance level in the defense or energetics manufacturing industry was acceptable in the medium range (marked yellow and roughly equivalent to an employee getting injured in driving to and from work). If risks are in the serious range (colored orange), recommendations (engineering or administrative controls) were given to reduce the event probability or the event severity. If risks were in the red or high category, operations could not be performed without mitigating steps to substantially lower that risk (such as a remote operation or redesign).

4 OSHA 29 CFR PSM Elements

Compliance to the standard is required for those operations meeting the Threshold Quantities values for different listed chemicals but theses principles are applied in other scenarios to reduce risks.

Figure 2: OSHA PSM Elements

- Employee Participation
- **Process Safety Information**
- **Process Hazards Analysis**
- Operating Procedures
- Training
- Contractors
- Pre-Startup Safety Review
- Mechanical Integrity
- Hot Work Permits
- Management of Change
- Incident Investigation
- Emergency Planning and Response
- Audits
- Trade Secrets

Action Items

1. Use the Qualitative Risk Matrix to rank the risk of five everyday events: getting burned while cooking, getting in a car accident during your commute, breaking an arm playing sports, getting a cold, and viewing non-edifying content.
2. Rank each of these events by assigning both a severity (1-4) and a probability (A-E), then color-code them according to the MIL-STD-882E standard.
3. Reflect on your risk tolerance for involuntary risks at work and outside of work. For example, you could be exposed to a harmful chemical at work involuntarily for instance in the air or water. Contrast that risk tolerance to a similar involuntary risk outside of work such as being exposed to lead in your food. Rank both scenarios using the risk matrix and give your comments on why they are the same or different.

4.1