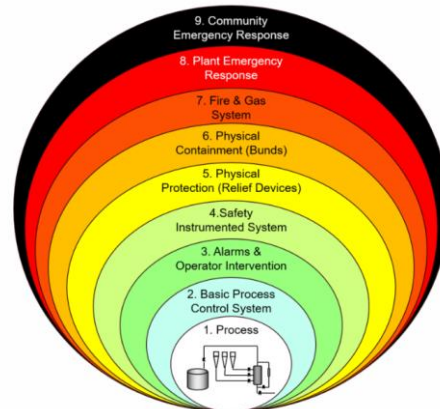


Layers of Protection Analysis (LOPA)

What is Layers of Protection Analysis (LOPA)?

Layers of Protection Analysis (LOPA) is a semi-quantitative risk assessment technique that evaluates the adequacy of existing safeguards for a specific hazardous scenario. It considers the initiating event, potential consequence, and the effectiveness of safeguards before determining whether further risk reduction is required. LOPA is conducted to ensure that risks are effectively mitigated to a tolerable level.

LOPA is widely used in process industries (e.g. chemical, oil & gas, petrochemical, pharmaceutical). LOPA provides a structured approach to risk management and can support organizations in risk-based decision-making process.



Layers of Protection Example Illustration. Courtesy:
<https://safeche.engin.umich.edu/tutorials/lopa-tutorial/>



Key LOPA Concepts – How does LOPA work?

- 1) Select Hazardous Scenario: Start with a scenario (“What can go wrong?”) identified from a process safety study (e.g. HAZOP or PHA).
- 2) Identify Initiating Event: Determine the event that starts the hazardous scenario, such as equipment failure or instrumentation failure.
- 3) Consequence Analysis: Assess the potential impact of the hazardous scenario.
- 4) Identify Independent Protection Layers (IPLs): IPLs are safeguards that are independent of one another and the Initiating Event. IPLs also need to be effective and auditable.
- 5) Risk Assessment: Assess the risk of the scenario considering the existing IPLs, to determine the risk frequency and potential consequence.
- 6) Determine Risk Tolerability & Risk Reduction Measures: Determine whether the risk is tolerable, or whether further risk reduction is needed.

Tips / Guidance on conducting LOPA:

- A multidisciplinary team is recommended to verify whether safeguards meet the criteria of IPL.
- Where possible, use site validated data, which is more representative of the site operating conditions, than industry data.
- Avoid double-counting safeguards that share a common cause of failure or rely on the same human response, equipment or logic path.
- Revalidate the LOPA when there are changes to the process conditions, operating envelope, safeguard design, or equipment.

References:

1. <https://safeche.engin.umich.edu/tutorials/lopa-tutorial/>
2. <https://inspectioneering.com/blog/2025-01-17/11404/enhancing-process-safety-through-layers-of-protection-analysis>
3. <https://www.icheme.org/media/9906/xviii-paper-23.pdf>