

Determining and Managing Safe Operating Limits in Major Hazard Installations

Why Safe Operating Limits Matter

Safe Operating Limits (SOLs) define the **minimum and maximum values of Critical Operating Parameters (COPs)** within which a process can operate safely. In Major Hazard Installations (MHIs), unclear or poorly managed SOLs can:

- Reduce operating margins
- Increase escalation risk during transient conditions (start-up, shutdown)
- Lead to loss of containment despite mechanical integrity

Common industry challenges:

- Difficulty identifying credible COPs
- SOLs set too close to NOL (reduced flexibility) or MDL (reduced safety margin)
- Limits documented but not embedded into procedures, alarms, interlocks, and training

Understanding the Difference: NOL vs SOL vs MDL

- **Normal Operating Limit (NOL):** Typical operating envelope. Exceeding NOL triggers alarms for correction.
- **Safe Operating Limit (SOL):** Absolute safe boundary. If approached/exceeded, predefined operator or automatic actions must return the process to a safe state.
- **Mechanical Design Limit (MDL):** Physical containment limit of equipment (e.g., design pressure/temperature).

Operating between SOL and MDL may be mechanically possible — but not necessarily safe.

SOL Exceedance as a Leading indicator

- SOL exceedances should be recorded, investigated, and formally closed out within PSM — and may be tracked as a Tier 3 leading indicator (API RP 754).

How to determine Safe Operating Limits?

A structured **five-step** approach:

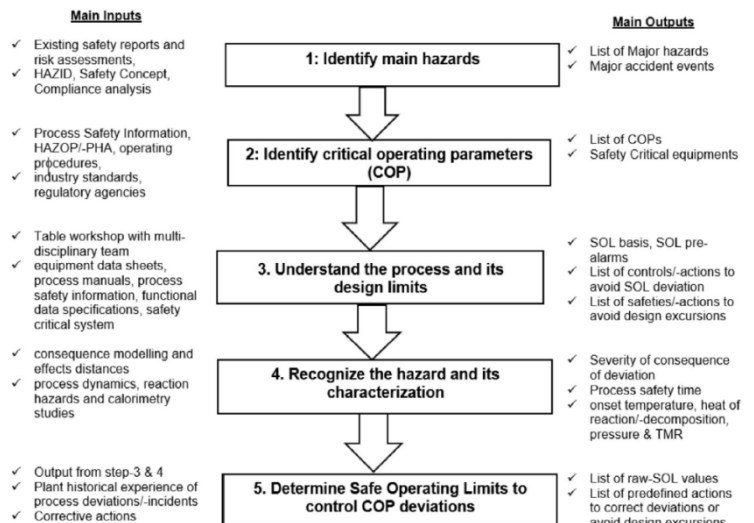
1. Identify major accident hazards
2. Define Critical Operating Parameters (COPs)
3. Establish NOL, SOL basis, and MDL
4. Characterize consequence and quantify Process Safety Time (PST)
5. Set SOLs with clear pre-alarms and response actions

Steps 1–5 establish SOLs at the unit level (e.g., tank, column, reactor), forming the technical basis for safe operation under defined design and credible abnormal conditions

Extending to Plant-Wide SOL Management

Beyond unit-level SOLs, plant-wide integration requires:

- Validation under realistic plant variability
- Coupling across shared utilities and process connectivity
- Lifecycle revalidation through MOC, inspection, audits, and operating experience



Ref: Senthilvelan K. et al., PSP, 2025

Key Takeaways



Operational Perspective

- SOLs define the boundary of safe operation — not merely alarm settings.
- PST must provide realistic intervention time.
- Define SOLs for all operating modes (start-up, standby, abnormal)



Management & Lifecycle Perspective

- Treat exceedances as learning: record → investigate → correct → verify.
- Revalidate SOLs through MOC, inspection, audits, and operating experience.

References:

1. Senthilvelan, K., Shaik, S.M., Wong, W.C., Sugiman, D., From Theory to Practice: Implementing Safe Operating Limits in Major Hazard Facilities, Process Safety Progress (2025)
2. Stauffer T., Chastain-Knight D. Do not let your safe operating limits leave you S-O-L (out of luck). Process Safety Progress (2020), e12163
3. OSHA. 29 CFR 1910.119 – Process Safety Management of Highly Hazardous Chemicals (2015)
4. API RP 754. Process Safety Indicators for the Refining and Petrochemical Industries (2021).