IMPORTANCE OF SOP AND HAZOP STUDY

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Association of AMMONIA REFRIGERATION

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- Celebrated annually on June 26th.
- this year's theme focuses on the intersection of advanced technologies, artificial intelligence, and human expertise.
- At its heart, Cool Intelligence is about how we design, install, operate, and maintain cooling and sustainable heating systems intelligently.
  - ✓ Designing for efficiency – smart decisions / choices
  - ✓ Operating responsibly – Leak detection, maintaining performance, safety ..
  - ✓ Protecting our planet – destruction of environment . ..ozone, water, air
- Cooling is essential, but it must be intelligent and responsible.

THEME OF THIS YEAR

"COOL INTELLIGENCE"

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Why Ammonia Refrigeration?

- **Eco-friendly refrigerant**: Zero ozone depletion, negligible global warming potential.
- **High efficiency**: Excellent thermodynamic properties, widely used in industrial cooling.
- **Cost-effective**: Lower operating costs compared to many synthetic refrigerants.
- **Hazardous nature**: Toxic, corrosive, and flammable at certain concentrations — requires strict safety measures.

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Ammonia Exposure Limits (ppm)

Limit Type	Value (ppm)	Duration	Meaning
NIOSH REL – TWA	25 ppm	8-hour workday	Safe average exposure without adverse effects.
NIOSH REL – STEL	35 ppm	15 minutes	Short bursts allowed, but not to be exceeded.
OSHA PEL – TWA	50 ppm	8 hours	Legal permissible limit in U.S. workplaces.
IDLH (Immediately Dangerous to Life or Health)	300 ppm	Instant	Concentration at which escape is essential.
Fatal range	5,000–10,000 ppm	Minutes	Reported lethal exposures in humans/animals.

REL – RECOMMENDED EXPOSURE LIMIT
TWA– TIME WEIGHTED AVERAGE
STEL – SHORT TERM EXPOSURE LIMIT

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Why Time Matters

- **TWA** protects against **chronic exposure** — repeated daily contact.
- **STEL** protects against **acute effects** — irritation, narcosis, or tissue damage from short bursts.
- **IDLH** defines the threshold where **life-threatening effects occur quickly**.

Example: Exposure to **500 ppm for 30 minutes** causes severe irritation and respiratory distress.

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Ammonia Flammability Limits

LEL (Lower Explosive Limit): 15% (~150,000 ppm)

UEL (Upper Explosive Limit): 28% (~280,000 ppm)

Auto-ignition temperature: ~651 °C

Flash point: Not applicable (ammonia is a gas at ambient conditions)

Practical implication: In confined spaces, if ammonia concentration rises into the explosive range and a hot surface or spark ≥651 °C is present, ignition/explosion can occur.

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🔥 Ammonia Flammability Limits

Confined Plant Room @ 25 C, 1 atm

Dimensions = 10 meter × 10 meter × 6 meter

Volume = 600 m^3

Limit	Concentration	Ammonia Required
LEL	15% (~150,000 ppm)	~ 64 kg
UEL	28% (~280,000 ppm)	~119 kg

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"This dual hazard — toxicity at low ppm and flammability at high ppm — makes SOPs and HAZOP essential."

Reminding

Cooling Intelligence

1. Efficiency
2. Responsibility
3. Earth protection

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Top 10 leak points

1. Compressor shaft seal
2. Valve gland packing
3. Flange gasket
4. Oil drain valve
5. Safety valve outlet
6. Pressure gauge connection
7. Liquid level column
8. Purger line
9. Defrost line
10. Ammonia Pump seal

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Importance of SOPs – structured response

Consistency in operations: SOPs ensure every operator follows the same safe steps.

Compliance with regulations: Meets AAR, OSHA, ISO, and local safety standards.

Error reduction: Minimizes mistakes during startup, shutdown, and maintenance.

Training tool: Provides structured guidance for new staff.

Emergency readiness: Clear instructions for leaks, fires, or equipment failure.

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Accident – Ammonia Leak

Tamil Nadu ammonia gas leak: Death toll rises to 9, all women

A chemical leak occurred during routine industrial operations on June 21 at a provate seafood processing and exports unit

Published on: Jun 23, 2026 3:04 PM IST

By S Vijay Karthik , Chennai

The department said the affected individuals presented with symptoms consistent with ammonia inhalation. (PTI)

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SOP Example – Leak Response

Key SOP Steps

Immediate evacuation: All personnel leave the affected area.
Ventilation activation: Start exhaust fans to disperse ammonia.
PPE usage: Trained responders wear respirators and protective suits.
Emergency communication: Notify plant control room and local emergency services.
Isolation of source: Shut valves or compressors to stop release.
Post-incident monitoring: Measure air quality before re-entry.

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Introduction to HAZOP

Definition: Hazard and Operability Study — a structured, systematic technique to identify risks in processes. It doesn't wait for accidents to happen.

Methodology: Uses guide words (No Flow, More Pressure, Less Temperature) to explore deviations. Helps to uncover hidden hazards and operability issues.

Team approach: Engineers, operators, and safety experts collaborate.

Outcome: Identifies causes, consequences, and safeguards for each deviation.

Application: Prevents catastrophic incidents like compressor failure or ammonia release.

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Example – More Pressure in HPR

Guide Word = MORE PRESSURE

Node: High Pressure Receiver

Causes:
Condenser fan failure
Water supply failure

Consequences:
Relief valve lifting
Ammonia release

Safeguards:
HP cutout
Relief valve

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Example – Liquid Carryover

Deviation identified: *Liquid carryover into compressor suction*

Cause: Faulty separator or operator error during startup.

Consequence: Compressor damage, sudden ammonia release, potential fire/explosion, production downtime, worker safety hazard, environmental impact, financial loss, damage to company reputation

Risk / Matrix Index : Identify likelihood (rare > frequent) and severity (Minor > catastrophic)

Safeguards:
Installation of liquid separators.
SOP for startup sequence.
Pressure/level monitoring alarms.

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Risk – Matrix Chart – Visual Representation of Risk

Likelihood \ Impact	Negligible	Minor	Moderate	Significant	Severe
Very Likely	Low Med	Medium	Med Hi	High	High
Likely	Low	Low Med	Medium	Med Hi	High
Possible	Low	Low Med	Medium	Med Hi	Med Hi
Unlikely	Low	Low Med	Low Med	Medium	Med Hi
Very Unlikely	Low	Low	Low Med	Medium	Medium

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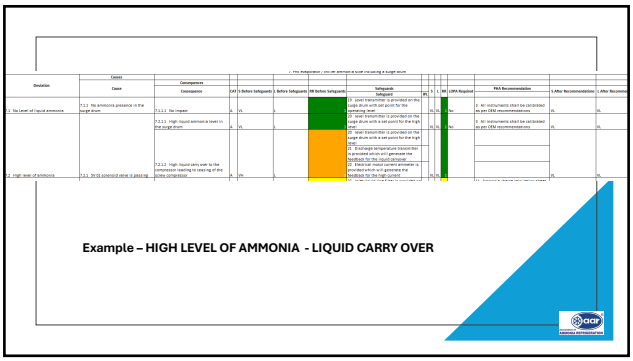

Example – HIGH LEVEL OF AMMONIA - LIQUID CARRY OVER

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SOP + HAZOP Integration

SOP discipline: Provides structured, repeatable steps for safe operation.

HAZOP foresight: Identifies hidden hazards and operability issues before incidents occur.

Combined strength: Together, they form a robust **Process Safety Management** system.

Continuous improvement: SOPs evolve with lessons learned from HAZOP studies.

Culture of safety: Integration fosters awareness, accountability, and resilience.

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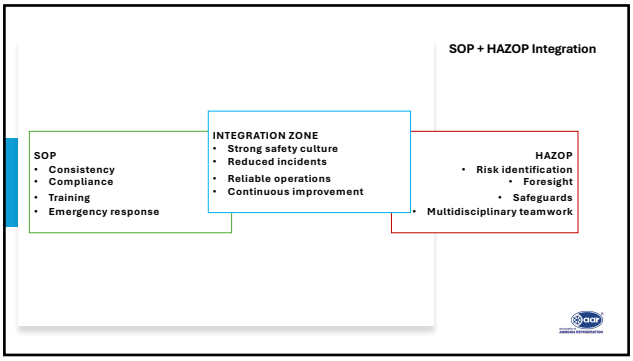
SOP + HAZOP Integration



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Real Incidents & Lessons Learned

Case Highlights

- **Cold storage leak**: Ammonia release led to mass evacuation and worker hospitalizations.
- **Compressor failure**: Lack of SOP adherence caused liquid carryover, damaging equipment.
- **Confined space explosion**: High concentration + ignition source resulted in fire/explosion.

Lessons Learned

- **Strict SOP compliance** prevents operator errors.
- **HAZOP foresight** identifies hidden risks before incidents.
- **Emergency preparedness** saves lives during leaks.
- **Continuous training** ensures staff readiness.

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Key Takeaways

SAFETY GOLDEN RULES

- Respect ammonia.
- Never bypass safety devices.
- Follow SOP every time.
- Report abnormalities immediately.
- HAZOP findings must be acted upon.
- Everyone is responsible for safety.

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