Screening Atmospheric Relief Devices for Unacceptable Risks

• Relief Devices Routed to Atmosphere
• Implementing a Work Process

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We all recognize the need for a screening process. But, defining a detailed work process isn’t easy.

API 521:
- Contains specific guidance for flammability risks.
- Specific guidance for toxics is lacking.

The Dow Chemical Company (Dow) has developed a detailed work process for screening flammability and toxicity hazards.
General Principals

Containment is Typically Required When:

1. Liquid or partially liquid at valve inlet.
2. Normally vapor service, but where flammable, corrosive or hazardous liquid carryover could occur.
3. Toxic service where acceptable levels can be exceeded in any working or otherwise unrestricted area.
4. Flammable vapor where concentrations at grade or frequently accessed platform/equipment could be in the flammable range.
Dow Work Process

Key Steps

A. Does the effluent stream contain reactive, toxic, or flammable components?

B. Is the relief effluent liquid or 2-phase?

C. Tier-1 toxic vapor screening test.

D. Tier-1 flammable vapor screening test.
Dow Work Process

Key Steps conti.

E. If either test fails, then re-evaluate the relief design. Can the design be modified in such a way that results in passing these tests?

F. Tier-2 rigorous analysis using gas dispersion modeling and/or Layers of Protection Analysis (LOPA).
Key Steps in More Detail

A. Does the effluent stream contain reactive, toxic, or flammable components?

• Multiple sources available for classifying chemical hazards.
• Dow chose the EU Dangerous Substances Directive (67/548/EEC).
• The EU Dangerous Substances Directive has a strong focus on toxicity and flammability.
Key Steps in More Detail

B. Is the relief effluent liquid or 2-phase?

- Rarely can hazardous liquids be safely routed to the atmosphere.
- Relief devices sized for an all-vapor will often have one or more liquid scenarios too.
- If such a device is routed to the atmosphere, the liquid scenario(s) must be mitigated, even if the design scenario (vapor) is screened and found to be safe for atmospheric discharge.
Key Steps in More Detail

B. Is the relief effluent liquid or 2-phase? (conti.)

Relief device designed for an all-vapor scenario, but liquid scenarios are also present.

✓ Route to containment, or…..

✓ Use LOPA, or other risk assessment, to determine the protection layers needed to minimize the probability of the liquid scenario occurring.

*Risk assessment must satisfy corporate risk criteria!*
Key Steps in More Detail

C. Tier-1 toxic vapor screening test.

• This initial screening test is based on Chemical Exposure Index (CEI) calculation.

• Calculating the hazard distance based on airborne quantity and the acute emergency response value (ER-3).

• Must satisfy limits for on-site and off-site exposure.

• Off-site exposure limit is based on ER-3 value.

• On-site limit is based on multiple of ER-3 value.
C. Tier-1 toxic vapor screening test. (conti.)

Using a multiple of the ER-3 value for on-site exposures, consistent with corporate risk tolerance criteria.

- Short-term exposure.
- Vapor cloud must be easily escapable via an unobstructed escape route.
- Personnel are trained in emergency response.
D. Tier-1 flammable vapor screening test.

Three acceptance criteria for this flammability test.

1. Exit velocity > 500 ft/sec (152 m/sec).

2. Reynolds number exceeds the minimum requirement as defined by API 521, 5th edition, paragraph 6.3.2.2.

3. The calculated 0.5xLFL (Lower Flammability Limit) vapor cloud does not enter any unrestricted personnel areas. *(Using the simple but conservative Fire & Explosion Index (F&EI) tool.)*
**Key Steps in More Detail**

E. If either test fails, then re-evaluate the relief design. Can the design be modified in such a way that results in passing the failed test(s)?

Are there any practical options for passing the test by changing the design?

**Example:**

The initial sizing calculations might have been overly simplified, with excessive conservatism in calculating the required relief flowrate.
**Key Steps in More Detail**

F. Tier-2 rigorous analysis using gas dispersion modeling and/or Layers of Protection Analysis (LOPA).

- The application failed the simpler Tier-1 test. Therefore, more detailed analysis is required.
- The user can choose to go directly to a LOPA analysis, or try gas dispersion modeling first.
- The PHAST tool is used for gas dispersion modeling.
- PHAST results are often needed for LOPA.
Key Steps in More Detail

Step F (conti.)

Using PHAST to analyze toxic vapor releases

Relief designs that are routed to the atmosphere can be found to be acceptable if:

a) the resulting fence-line concentration is no higher than 1xER3 at an elevation where off-site personnel could be exposed, and...

b) the resulting concentration is no higher than the corporate risk criteria (a multiple of ER3) in unrestricted work areas and an individual in that area can easily escape the vapor cloud by moving 20m or less.
Key Steps in More Detail

Step F (conti.)

Using PHAST to analyze **flammable vapor** releases

If....

the relief device discharge stream is < 50% LFL in a process and / or unrestricted personnel area,

then....

the scenario passes the flammability screening test.
Key Steps in More Detail

Step F (conti.)

Using LOPA to analyze toxic, or flammable vapors.

Acceptance criteria:

• Relief designs that are routed to the atmosphere can be found to be acceptable if the LOPA gaps can be closed, meeting corporate risk tolerance criteria.

• For the LOPA analysis, no credit is taken for the relief valve. Credits are taken for the layers of protection that minimize the probability of a release.
Documentation

✓ Documentation is critical for future reference.
  • “Which components were analyzed?”
  • “What exposure value was used for benzene?”
  • “Did the designer screen for flammability and toxicity or just flammability?”

✓ Standardizing the documentation is very important.
  • *Documentation is of limited value if it’s not consistent from one relief device to another.*
Documentation

Dow uses an Excel based tool to simplify this work process for the user and to standardize the output documentation.

- **Header info**
- **Text field** for explanations, when necessary.
- **Automatic documentation**, based on user input.
Questions?