RWDI
CONSULTING ENGINEERS
& SCIENTISTS

Reputation Resources Results

INDUSTRIAL
TECHNOTES

ISSUE NO. 3

OVERVIEW OF HAZARD ANALYSIS

By Ian Dowsett, R.E.T., Project Director

The production, storage, and transportation of pressurized gases are associated with a number of industrial activities. An accidental release of these gases can result in effects that extend, or are perceived to extend, beyond a facility boundary or right-of-way.

In the event that a release does occur, the immediate focus is to control and minimize the release, and to reduce and mitigate the potential damages. For public safety purposes (when there is a potential for off-site damage), the protection of lives and a reduction in injuries can be addressed explicitly through:

- Emergency response plans;
- Land-use planning and control measures; and
- Public involvement and information programs.

The hazard analysis is a critical part of on- and off-site safety programs. The hazard analysis can be coupled with a risk assessment to address land-use planning issues and public consultation processes. This issue of Technotes outlines the hazard analysis approach. A future issue will address the risk assessment component.

Figure 1: Sour gas well blowout (Lodgepole, Alberta).

Hazard Analysis evaluates the nature (duration, extent and damage) of an accidental release. A screening-level analysis (using conservative, protective assumptions) is used to evaluate the maximum extent of a hazard. It is a recommended means of establishing emergency planning zone distances. A detailed hazard analysis is conducted when additional, specific information, is required about the nature of a release. A hazard analysis is comprised of four steps.

Step 1: Hazard identification considers the inventory of products and storage conditions with a review of potential exposure pathways and effects. This comprehensive evaluation includes:

- The review of published material safety data sheets, exposure guidelines and regulations, and available dose/exposure (probit) information; and
- Selection of the appropriate exposure criteria (heat radiation, overpressure, toxicity, etc.) and the selection of the end-points (fatality, injury, health) to be used for public safety planning. Event tree analysis is often used to assist in this determination.

Step 2: Source characterization determines the physical properties and behaviour of a fluid during an accidental release. This analysis step considers:

- The composition and physical properties of the released fluid (phase behaviour analysis);
- The mass release profile during various failure scenarios (leaks through ruptures); and
- The fluid properties (temperature, liquid mass fraction) at various stages along the release profile (i.e., from storage conditions to atmospheric conditions).

Figure 2 provides an example of the phase envelope and the changes in fluid properties (path shown as a light blue line) followed during the depressurization of a fluid from storage conditions (10000 kPa) to atmospheric conditions (101 kPa). In this example, the fluid expands, produces significant cooling (-115°C) and results in the formation of liquid aerosols (38% mass fraction). At these conditions, the dispersing plume is expected to behave as a dense gas near the source of the release.

Step 3: Dispersion modelling determines ambient concentrations downwind of a release. The concentrations at a specific location are dependent upon the source characterization, terrain, and the meteorological conditions.

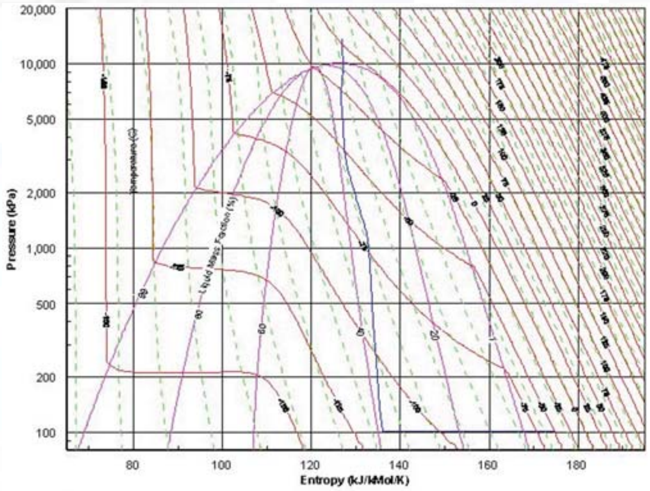

Figure 2: Example of phase behaviour analysis.

Physical or numerical models can be used and the selection depends on the nature of the release and the environment. Numerical models often considered for public safety decisions involving dense, neutrally-buoyant, and buoyant gases, include for example, the SLAB and GASCON2 models.

For screening-level purposes, a range of possible atmospheric conditions (unstable, neutral and stable) are considered over a representative range of wind speeds. More detailed, site-specific data can be used for detailed hazard assessments.

Figure 3 provides a bird's-eye view of maximum concentrations of hydrogen sulphide (H_2S) resulting from a catastrophic failure of 1600 metres of a 170 mm pipeline, operating at 9300 kPa and transporting 56% H_2S. The failure event lasts approximately 5 minutes.

Step 4: Consequence analysis determines the effects of exposure to a pollutant. The effects of exposure can range from minor irritation to fatality, depending on the concentration and duration of exposure. This relationship can be mathematically evaluated using the "probit" method, which relates the exposure time and exposure concentrations to an expected response.

Hazard analysis techniques provide a reliable and consistent basis for developing emergency planning zones. Results of hazard analysis are used to assist regulators, industry, the public, and emergency responders in gaining an understanding of:

- Relationships between design and operation of a facility (e.g., inventory, storage conditions, control equipment) and the extent of a hazard;
- Appropriate emergency planning and awareness areas; and
- Effectiveness of emergency response procedures (e.g., evacuation, indoor sheltering, response times).

Results obtained from suitably-conducted hazard analyses are a useful, almost mandatory, first step in the public safety assessment process. The results provide an input into additional risk analyses (used for land-use planning) and public involvement programs. The use of these techniques, combined with meaningful public involvement and consultation programs, has resulted in speedy regulatory decisions and approvals, and in building public trust and confidence in the process.

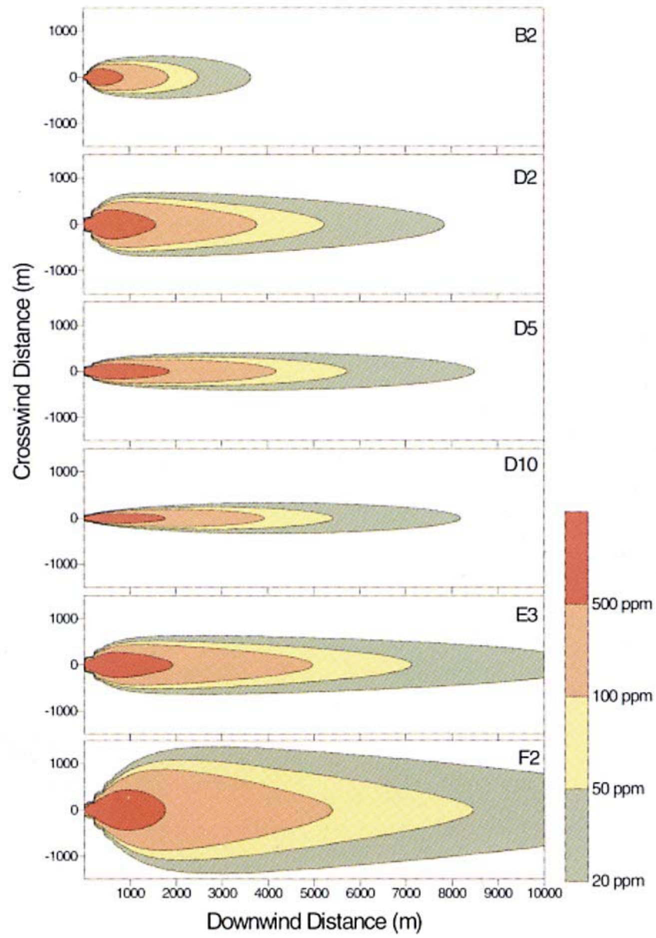

Figure 3: Example, maximum downwind concentrations of H_2S following a pipeline failure, displayed for different meteorological conditions.