Using worst case scenarios for identification of hazardous activities on industrial facilities

Definition

- **Worst-case scenario is a situation where everything that could go wrong does**
  - In industrial accident management it is usually used to define low probability-high consequences outcomes with the maximum negative consequences (fatalities, environmental pollution, material loss)
  - The release of the largest quantity of a hazardous substance from a single vessel or process line failure that results in the greatest distance to an endpoint (EPA, Offsite Consequence Analysis Guidance)

Requirements

- The accident scenario has to be:
  - *Realistic - no “invasion from Mars” assumptions*
  - *Based on the quantity and the properties of the substances, on the processes involved and the equipment used*
  - *Developed for each process and/or hazardous substance*
  - *Taking into account the different endpoints*

Background information

- **For each process/substance**
  - Determine the relevant hazardous properties of the substance involved
    - Toxicity, ecotoxicity, flammability, other physical-chemical properties
    - Storage/process conditions
    - Environment factors – topography, climate and meteorology, water bodies, residential areas, vulnerable sites, etc.

Developing worst case scenario

- Select a scenario
  - Define the sequence of the events that lead to the occurrence of an accident
  - Define the largest quantity of the hazardous substance to be released
    - For substances in vessels - release of the largest amount in a single largest vessel
    - For substances in pipes - release of the largest amount in a pipe
    - For substances in bulk (explosives only) – the largest amount in the warehouse
- Determine the release
- Determine the distance to the endpoint

Developing worst case scenario

- Determine the release
  - All of the substance is released
  - Short period of time is assumed (usually 10 mins.)
  - Different type of releases
    - Toxic gases
    - Evaporating toxic liquids
    - Water solutions of hazardous substances
    - Flammable gases and liquids

Example

- LPG storage facility
  - Hazardous substance – LPG – mixture of propane and butane
    - Hazards – extremely flammable, dense gas, liquefied, expands when heated
    - Possible outcomes – UVCE, Jetfire, BLEVE
  - Maximum amount of the LPG in the largest single vessel
    - Take into account possible domino effects
  - Release rate
    - Different models used
    - Based on vapour pressure, temperature, hole diameter, gas density

Example

- LPG storage facility
  - Endpoints
    - For UVCE – thermal radiation
    - For BLEVE – thermal radiation and overpressure
  - Several methods of estimation
    - Modelling/calculation
    - Standard distances tables
    - Assume worst possible conditions
      - Stable weather conditions
      - Unsheltered surroundings
      - No topography mitigation

Example

- Warehouse
  - Hazardous substance – Toxic liquids in vessels
    - Possible outcomes – toxic release
  - Maximum amount of a substance in the largest single vessel
    - If credible, simultaneous damage to more than one vessel should be considered – define the flow of events
    - Example – forklift operator error, resulting in puncture of X drums
  - Release rate
    - Release at ground level
    - Unconfined pool
    - Calculation using different techniques - $QR = 1.4\ Q \times LFA \times DF$

Example

- Warehouse
  - Endpoints
    - Toxic effects – AEGL, ERPG, LC50
  - Several methods of estimation
    - Modelling/calculation
    - Standard distances tables
    - Assume worst possible conditions
      - Stable weather conditions
      - Unsheltered surroundings
      - No topography mitigation