Emergency Response

CHEN 420 / 597 - Fall 2024

Dr. R. A. Mentzer

Purdue University

Emergency Preparedness

The Oct 10, 2024 chemical leak at the PEMEX Deer Park, Texas refinery that killed two contract workers and resulted in dozens of injuries, prompted an investigation of the petrochemical industry's alert system. Hundreds of petrochemical plants, refinery facilities and other industries stretch for miles in Harris County. The county's lack of zoning laws leaves residents vulnerable to petrochemical leaks and explosions. **Quick response and proper alert systems after a petrochemical disaster can be life-and-death for community members.** In the US, we have many stakeholders associated with chemical processes, and local emergency planning committees gather information about what chemicals are on site.

Similarly, on Feb. 27, 2024 an explosion at Ven Petrochem Pharma Co., Valsad, Gujarat, India, killed at least two workers and injured several others. Firefighters reached the factory quickly but could not start dousing the flames immediately as they were unaware about the type of chemicals which caused the blaze. The firefighters did not find any security personnel to guide them about the chemicals present inside, making their task all the more difficult.

Facility preparedness for emergencies involves understanding hazards, potential consequences, incident pathways, and internal response capabilities – and then communicating that information to the folks who can help.

Nikolai Antoshkin – Obituary, Economist, February 6, 2021

BACKGROUND: *He had been ordered to quench the fire when Chernobyl nuclear power plant reactor #4 exploded exposing the graphite core in 1986. His specialty was helicopter reconnaissance.*

His orders, when he got them, were plain enough. It was up to him to work out how to do it. This was now a total air operation, calling in 600 volunteer pilots from all over the Soviet Union and commandeering 100 helicopters. He also ordered 10,000 brake parachutes, each to be loaded with sand, clay boron and lead and dropped to seal the inferno. He reckoned they might need 5,000 tons of sand.

The task was both delicate and terrifying. The target aperture was only 19 meters across; each pilot had to hoover 200 meters above the core, in thick smoke, while another man held by a harness leaned out to drop the parachute. The air temperature was as much as 200°C. Amid all this neither he, nor they, had adequate protection. He remembered smearing on some nasty cream from Leningrad. They had been exposed to twice the radiation sufficient to kill a man. Overall 4,000 sorties in all, until after two weeks the blaze was out and concrete was poured in to seal the core. Twenty-eight pilots died soon afterwards; 14 more died later, from lingering cancers. He himself spent the next two years in the hospital, eventually dying of coronavirus, years later.

AFTERMATH: Currently 20 km exclusion zone and reactor enclosed in concrete sarcophagus. Chernobyl mini-series is allegedly most viewed of all time.

Deadly DuPont leak exposes safety, response failures

Chemical plant officials slow to react to disaster, minimized risk to fire crews, public in first 911 call

By Lise Olsen and Mark Collette

Five DuPont workers — four of them already dead or dying — had been trapped for an hour by poisonous gases inside a pesticide plant when another worker called 911 to report an emergency at 4:13 a.m.

The accident scene — a multi-story building where DuPont makes a pesticide that is rated highly toxic to human life — typically housed between 50 to 250 tons of highly flammable methyl mercaptan. Nearby, there was a much smaller but unknown amount of one of the most notorious substances in industrial manufacturing: methyl isocyanate, according to public records and former DuPont employees interviewed by the Houston Chronicle.

It is so-called MIC that escaped a Bhopal, India, pesticide plant and formed a toxic cloud in 1984, initially killing more than 2,200 people in the world's worst industrial disaster.

But last Saturday, on Nov. 15, DuPont shift supervisor Jody Knowles gave no details about the chemicals involved and minimized the risk in the 911 call to the La Porte fire department.

"We have a possible casualty five (workers) my medics are telling me," he told a dispatcher.

She immediately asked: "Can you tell me is this any risk to the public? Is it gonna be a possible escaping from your premises?"

"No ma'am, it is not," Knowles responded.

At that time, public records show, no air tests had been conducted outside the plant, and it's unknown whether Knowles — or anyone else at DuPont — knew what the gas levels were beyond the fence line.

The incident is the worst loss of life in an industrial accident at the world's biggest petrochemical complex since 2005, when a refinery explosion killed 15 workers in Texas City.

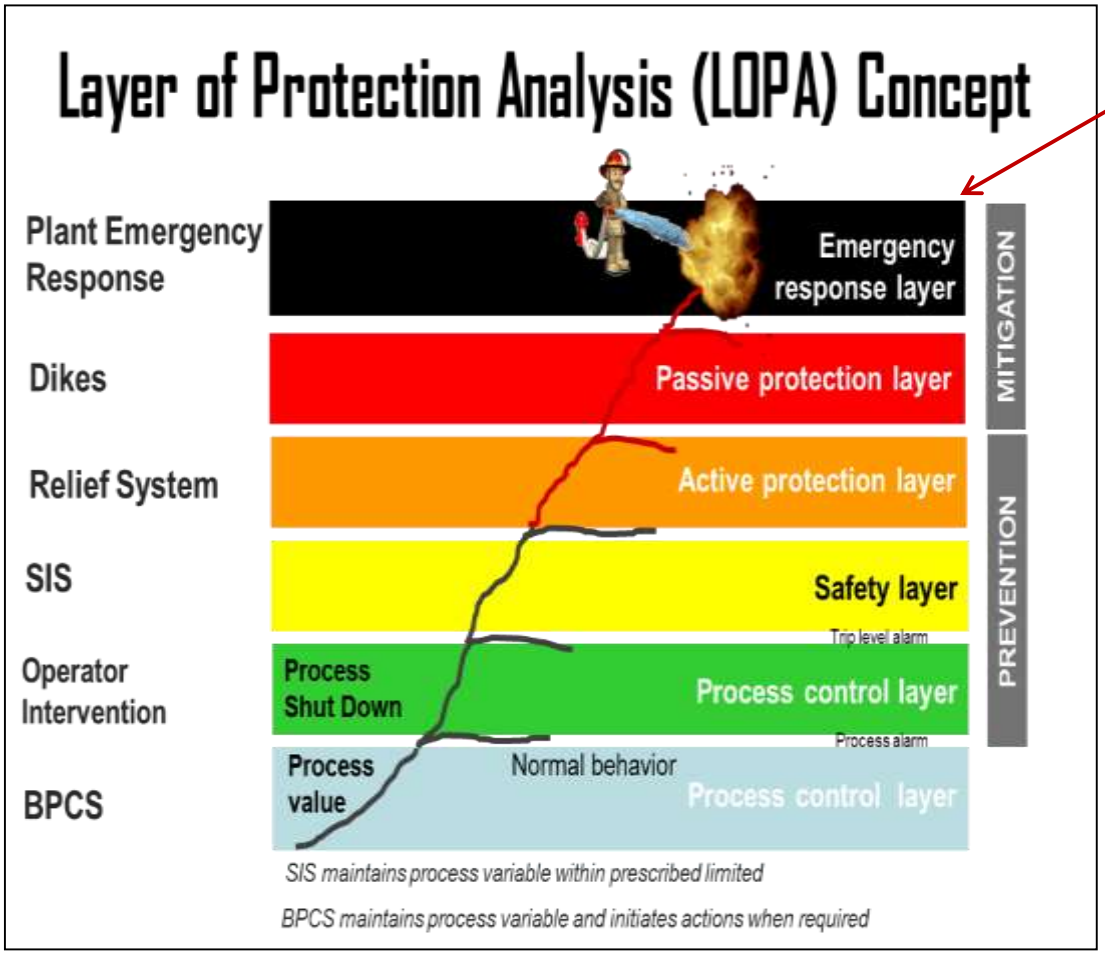
Investigations are ongoing, but already it's clear that the response to the emergency was inadequate and slow, especially given the scope of the disaster, that the accident site had been plagued with recurring

Emergency continues on A13

Questions Addressed

- What types of emergencies might one prepare for?
- What are key steps a company should take to prepare for an emergency?
- What has been the experience of companies that didn't prepare for a catastrophe and to what extent did that contribute to the outcome?

Emergency Response – *last layer of response*



Emergency Response

- Very few incidents require Emergency Response << 1%
- Emergency response always precedes incident management & investigation
  - investigation team may be formed for catastrophic incident while response is on-going
- Pre-defined team that is trained to respond to serious incidents - fires, explosions, oil or chemical spills, hurricanes, tornado, breaches of security, etc
  - EX, hurricanes happen every year in Gulf of Mexico; severity and location is random
  - Multi-disciplinary team / roles – leader, process facilitator, engineering / technical representative, operations representative, safety & health … and perhaps Procurement, Accounting, Law, Public Affairs, Human Resources, etc
  - Team makeup dependent on complexity of business & incident, etc

Emergency Response - 2

- Focus is to protect **P**eople, **E**nvironment, **A**ssets and company **R**eputation ('PEAR') in that order
- ER Plan generally includes:
  - written procedures
  - pre-defined team with clear roles
  - internal and external notifications, by & to whom (management, company president, local regulator)
  - training / drills, and annual schedule
- Plan should include necessary resources
  - Resources may include firefighting equipment, chemical spill containment supplies, dispersants for oil spills, personal protective equipment, etc
  - Consideration should also be given to location / staging of equipment, as well as maintenance and periodic testing.

Emergency Response - 3

- Cos. may have documented process / mgmt system OR implicit ER management system with expectations of roles, procedures … even if not documented

- Team conducts various training drills, perhaps annually
  - Drills are based on realistic scenarios, such as spill, hurricane, etc
  - May include external parties such as local law enforcement, regulators, etc - building relationships & expectations is important
  - Issues and information evolve per timeline; initially may only know of 'spill' without size, 'fire' without extent of damage, 'injured' personnel before no. & extent of injuries is confirmed, etc
  - Drills may last up to full day & involve deployment of equipment (e.g., oil spill booms, communication systems)

Emergency Response - 4

- Often 'nested' ER teams within a business, each with unique defined roles, depending on the complexity of the business and magnitude of incident
  - Local operations ER team (EG, at refinery) … focusing on the site – containment, fire fighting, cleanup, etc
  - Regional team (e.g., Midwest, European) providing add'l technical support and whatever resources might be necessary … assists operations team, enabling them to focus on physical site
  - Corporate team, if incident has broader impact / exposure, international, press
- Drills and actual events enable one to learn and upgrade process
  - Cell phones unreliable with massive demand during hurricane Ike
  - Difficult for timely response by Public Affairs to press inquiries
- Key to effective ER is following the agreed to & practiced process

Community Role in Emergency Response

- Needs to be clear understanding of facility hazards and role / expectations of plant personnel vs. local responders in emergency

- Local Emergency Planning Committee (LEPC)
  - Assist in preparing for emergencies, particularly related to hazardous substances; required by law
  - Members: elected officials, police, firemen, environmental, hospital officials, community groups, media & facility representatives
  - Role: make certain responders and communities are aware of hazards; plan & train for emergencies; emergency community notifications & evacuation procedures
- Community Responders
  - Key issues per CSB video *Emergency Preparedness*: training, effective emergency communication & community planning

Ohio Train Derailment – Scope of ER

A - INCIDENT

- On Feb. 3, 2023 – 38 rail cars derailed in East Palestine, Ohio. The train had 20 cars containing hazardous material, 11 of which derailed. There were no reported fatalities or injuries.
- Reportedly, one wheel bearing's temperature prompted an audible alarm, bystanders saw flames by the wheel, and the train's engineer applied the brakes, prior to the derailment.
- Cars contained:
  - **Vinyl chloride (VC):** a colorless gas that is used to make polyvinyl chloride (PVC) plastics, is highly flammable and decomposes to form toxic fumes.
  - **Butyl acrylate:** liquid used for making paints, sealants and adhesives. It is flammable and can cause skin, eye and respiratory irritation.
  - **Ethylhexyl acrylate:** liquid used to make paints and plastics. It can cause skin and respiratory irritation and, under moderate heat, can produce hazardous vapor.
  - **Ethylene glycol monobutyl:** solvent for paint and inks, and drycleaning solutions. Acutely toxic, able to cause serious or permanent injury, and highly flammable.
- Five of the derailed train cars contained 115,580 gallons of vinyl chloride – of most concern.
- As the wreckage burned for days, thousands were forced to evacuate their homes out of fear of a possible explosion and hazardous materials released into the air.
- Involved agencies train for this – BUT, incidents are unique!

Properties of VC are as follows:
Boiling point: -13.4 deg. C (7.9 deg. F)
Flash point temperature: -78 deg. C (-108.4 deg. F)
Lower flammable limit: 3.8 vol. %
Upper flammable limit: 29.3 vol. %
Threshold limit value (TLV): 1 ppm

Ohio Train Derailment

B – THE PROBLEM

- VC vapor is 2.2 times heavier than air so vapor escaping a tank rail car will stay on the ground.
- The low TLV is a major problem.
- With connections on top of tank cars, those on their side can only be drained of about half of capacity.
- VC is maintained in the liquid state by its own vapor pressure. However, if a hole is drilled in the side of the tank car (a common emergency response procedure) the pressure will be relieved and the VC will begin to boil, producing lots of escaping vapor.
- Burning the VC will result in CO2, likely HCl, maybe a small amount of phosgene.

C – CONSIDERATIONS

- If the VC liquid is released it will boil and vaporize and form a toxic, possibly combustible cloud on the ground.
- If the liquid is burnt, the fire cannot be in the vicinity of the rail car which might cause a BLEVE. It will certainly open the relief valve and spew burning vapor.
- Pumping out each rail car is not an option if the cars are on their sides or upside down. Even if this could be done, it would take 7 or so tank trucks to empty one railcar.
- Any leaking rail cars after the accident this would create an immediate problem and change the emergency response dramatically. This did not appear to be the case.

Ohio Train Derailment (3)*

D - SITE Management

- Dispersion modeling yielded the figure to right, where red area denotes death if inhaled & orange represents severe injury to lungs and skin burns. Officials were concerned about the possibility of an explosion and release of VC.
- Trenches were dug underneath the 5 railcars on their side containing VC. Charged explosives were placed under the cars to make 2.5 - 3 inch holes in the bottom of the tanks. The vapor pressure of the vinyl chloride pushed the liquid out of the rail car tanks.
- VC liquid flowed thru trenches to a pool area on the side of the track away from the tank cars. The pool area was lined with flares to ensure the VC immediately ignited. One year er

E - AFTERMATH

- 4,832 cubic yards of contaminated soil and 1.7 million gallons of contaminated water were removed (~1 M gal were injected in deep wells in TX). The railroad tracks were also removed so the contaminated soil could be removed.
- Soil & water were transported to licensed hazardous waste facilities in Ohio, Michigan, Indiana and Texas before protests stalled disposal.
- Over 30 lawsuits have been filed related to the derailment from nearby homeowners, including shareholders of Norfolk Southern Railway, the Department of Justice (for pollution of the waterway), and a class action lawsuit.
- Also, some waterways in the area were contaminated after the derailment – reportedly killing +40,000 fish. Ohio authorities said air quality and municipal water tests in East Palestine showed no dangerous levels of chemicals.

**Special thanks to Prof Dan Crowl for his insights*

Train Transport Incidents

And as all too often happens, similar incidents to the recent train derailment in Ohio have happened, EG:

- In 2009, in Viareggio, Italy, a train carrying LPG derailed due to failure in the axle of a train car. This incident killed 32 people.
- In 2013, in Lac-Mégantic, Quebec, Canada, a train's braking system failed to engage, causing derailment and killing 47.

While the source of each of these derailments differed, some similarities exist in the consequences and the cause. Issues with the axle and wheel assemblies were implicated.

The age-old question: ***why do similar incidents continue to happen?***

What to Know – *Emergency Response*

- Importance of preparing for an emergency, teams, individual responsibilities & drills
- Types of emergencies to prepare for
- What does PEAR represent?
- Who should be on response team and what parties engaged in drills?
- What is a LEPC and what is their role in this?

Homework #13 (not assigned)

1. What are key steps a company should take to prepare for an emergency?
2. If you were responsible for the Emergency Response management system, provide two leading indicator metrics that would help you judge the 'health or readiness' of your system?
3. A key aspect of emergency response is planning for various potential scenarios and conducting drills. Name five potential emergency response scenarios.
4. For each of the scenarios noted above, list which external parties or organizations you would invite to participate?
5. Why do accident investigation recommendations include improvements to the ER management system?