Hazmat History

Where did this stuff come from?

California Emergency Management Agency (CalEMA)
California Specialized Training Institute (CSTI)
Hazardous Materials Section

Hazmat History

Hazmat response is a complex field governed by numerous regulations, consensus standards such as NFPA 472 and workplace-specific standard procedures. We think it's important to understand where these came from. It's also important to remember the sacrifices others made and their dedication in bringing about significant changes to benefit responders to this day.

The following case studies contain information on past incidents that had a significant effect on hazmat response procedures, equipment, consensus standards or regulations. These are each one page long and identify the source(s) of the information. If you plan to discuss one or more of these incidents in a class you're teaching please take the time to read the reference(s) listed. This document provides a summary of each incident. It doesn't cover all of the complexities of these incidents.

We've written these for hazmat instructors to help broaden their scope of knowledge about the hazmat response field. We hope this will help instructors to understand why we do what we do in hazmat response. If you have suggestions for other case studies please contact us. We're always eager to add to the knowledge base.

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Where Did Hazcat™ Come From?

San Francisco/Oakland Bay Bridge Closure – 1980

At 1538 on 25 June 1980 a 50-pound of an unknown material fell off a stake bed truck that was westbound on the San Francisco/Oakland Bay Bridge. A car behind the stake bed truck struck the bag and scattered its contents over several lanes. Other vehicles ran over the material and spread it over all 5 lanes of the roadway. The drivers continued to their destinations without stopping. The driver of the stake bed truck continued to his place of employment and notified his supervisor. They didn't notify the California Highway Patrol (CHP) of this incident.

The CHP responded and established a command post. At 1555 they closed all westbound lanes of the bridge. A toxicologist from CalOSHA arrived at the scene and obtained a sample of the spilled material. He couldn't identify the material. A cleanup contractor arrived at 1900 and tested the material. They were not able to identify the substance or determine if it was hazardous.

The cleanup contractor began cleaning up the spilled material about 2020. Cleanup continued throughout the night. At 0122 on 26 June the CHP opened all westbound lanes.

At 1130 on 26 June 1980 a CalOSHA toxicologist notified the CHP that the material had been identified as magnesium silica oxalate. The CHP later interviewed the driver of the stake bed truck and he stated the material was "Microtalc" which was non-hazardous. The material is used as a paint additive, a food additive and as a personal care product.

Representatives of the agencies involved met and identified several concerns. One concern was the lack of an ability to identify an unknown substance. One of the agencies involved directed one of their employees, Bob Turkington, to come up with a method of rapidly identifying unknown substances in the field. Bob then created what is now known as the HazCat™ system.

Source: California Highway Patrol report dated 18 July 1980. File number: 301-4687.A3798

Where Did Business Plans* Come From?

Fricker Fire, Anaheim, CA, 22-26 June 1985

At 2245 on 22 June 1985 the Orange County Fire Department (OCFD) hazmat response team, at the request of the Anaheim Fire Department, responded to a report of a structure fire in an agricultural chemicals warehouse. The fire started in an office area and spread rapidly to chemical storage areas. The first arriving fire department personnel saw green flames coming from the burning building along with brown, green, yellow, purple and black smoke. At that point company officers halted the fire attack and ordered their crews to withdraw from the building.

The responders had no information about the facility. During the initial phase of the response they saw large amounts of bags that appeared to contain pesticides and fertilizers. They later found the building contained water-reactive substances. These substances reacted with firefighting water to give off toxic vapors.

A toxicologist from a nearby university advised the Incident Commander (IC) that the fire was giving off toxic smoke and if the fire were reduced to a smoldering condition it would produce even more airborne toxic material. This led to the evacuation of over 10,000 people.

Firefighters used high expansion foam to suppress the fires. Although the foam didn't completely extinguish the fire it did reduce vapor production and it gave hazmat responders time to remove the hazardous substances in the building.

Chemical reactions caused responders to be unexpectedly showered with contaminants. At one point, hazmat response personnel worked in a knee-deep sludge of pesticides mixed with spilled paint and firefighting water. Responders and clean-up crews removed over ten tons of materials from the facility.

In response to this incident the California Legislature passed a law requiring business to disclose the amounts and types of hazardous substances they use and/or store. This law required business to give this information to local government responders.

*The legislation in California requiring business plans actually preceded the federal legislation (SARA) requiring business plans.

Source: Orange County Fire Department Report to the Board of Supervisors, October 1985

Where Did Hazwoper and EPCRA* Come From?

Bhopal Disaster, Bhopal, India, 03 December 1984

At about 0030 on 22 June 1985 a control room operator at the Union Carbide pesticide plant noticed needle on a pressure indicator for Tank E610 pinned to the maximum reading of 55 psi. As the operator was checking the tank he heard a safety valve pop, heard rumbling in tank, and felt heat emanating from it. Soon thereafter a cloud of methyl isocyanate gas escaped from the scrubber stack. The tank leaked about 30 metric tons of the gas. Winds blew it towards the city and through a shantytown that had sprung up around the plant.

The Indian government later concluded that 3787 people were killed. Estimates of the number of injuries vary wildly.

This incident increased the awareness in the United States for the deed for laws requiring industry to inform surrounding communities of hazards present and for all levels of government to collect this information in an organized manner. Governments and industry groups also recognized the need for better planning to cope with similar disasters. This lead to the passage of the Superfund Amendment and Reauthorization Act (SARA).

SARA established requirements for federal, state and local governments, Indian tribes, and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. It created the State Emergency Response Commissions (SERC) and the Local Emergency Planning Committees (LEPC).

This law required OSHA to write regulations to protect workers engaged in hazardous waste site clean-up and emergency response to hazardous substance releases. This regulation came to be called "Hazardous Waste and Emergency Operations" commonly know as Hazwoper.

* Emergency Planning and Community Right-to-Know Act

Source: Case Study—Bhopal Disaster, University of Massachusetts Amherst, http://www.umass.edu/sts/ethics/bhopal.html

Where Did "Shelter-in-Place" Come From?

Anhydrous Ammonia Release, Houston, TX, 11 May 1976

About 1108, on 11 May 1976, a Transport Company of Texas MC 331 tractor-semi trailer transporting 7,509 gallons of anhydrous ammonia struck and penetrated a bridge rail on a ramp connecting I-610 with the Southwest Freeway (U.S. 59) in Houston, Texas. The tractor and trailer left the ramp, struck a support column of an overpass, and fell onto the Southwest Freeway, approximately 15 feet below. The anhydrous ammonia was near-instantaneously released from the damaged tank semi trailer.

Six persons died as a result of the accident, 78 persons were hospitalized, and approximately 100 other persons were treated for injuries.

The National Transportation Safety Board investigation determined that the probable cause of the accident was the excessive speed of the vehicle combined with the lateral surge of liquid in the partially loaded tank truck, which caused it to overturn. The cause of 5 of the 6 fatalities and all of the 178 injuries was the inhalation of anhydrous ammonia.

Findings of a Follow-up Investigation by NTSB

An NTSB Special Investigation Report, *Survival in Hazardous Materials Transportation Accidents* found, "When the motorists got out of their cars, they actually decreased their chances of survival…" This report stated, "The differences in the degree of injury among the exposed victims suggest that alternatives to evacuation…could improve survivability." NTSB recommended identifying "…alternatives to evacuation…" in hazmat incidents. Further government studies and academic research found that in-place protection (commonly called "shelter-in-place") was often the preferred method of protecting the public from airborne threats from hazmat incidents.

Source: NTSB Investigation Reports HAR-77/01 and PB-268251, NTSB Special Investigation Report NTSB-HZM-79-4

Why Do They Odorize Natural Gas?

The London School Explosion, New London, TX, 18 March 1937

The London School was a large structure of steel and concrete located in New London, TX. The school building served all grades from elementary school to high school. It was built on sloping ground, and there was a large dead-air space beneath the structure. The school board had overridden the original architect's plans for a boiler and steam distribution system, instead opting to install 72 gas heaters throughout the building.

Early in 1937, the school board canceled their natural gas contract and had plumbers install a tap into a residue gas line in order to save money. This practice, while not explicitly authorized by local oil companies, was widespread in the area. The odorless and colorless natural gas extracted with the oil was seen as a waste product and was flared off. As there was no value to the natural gas, the oil companies turned a blind eye.

On March 18 at 3:05 PM In the high school's basement woodshop, a shop teacher unplugged an electric sanding machine. Unknown to him, the area was filled with natural gas. The switch ignited the gas/air mixture. The resulting explosion lifted the building from its foundations causing walls to collapse. The roof fell in and buried victims in a mass of brick, steel, and concrete debris. The explosion was heard four miles away and it hurled a two-ton concrete slab 200 feet away where it crushed a car.

Approximately 600 students and 40 teachers were in the building at the time; only about 130 escaped without serious injury. Most of the bodies were either burned beyond recognition, or blown to pieces so it was difficult to estimate the number of people killed. Estimates range from 296 to 319.

As a result of the disaster the state passed an odorization law, which required that distinctive malodorants be mixed in natural gas for commercial and industrial use so the smell would warn people of any leaks.

Source: *New London School Explosion*, Texas State Historical Association, http://www.tshaonline.org/handbook/online/articles/yqn01

Why Does NFPA Have Standards for Face Pieces?

Anhydrous Dimethylamine Release, Benicia, CA 12 August 1983

At 1500 on 12 August 1983 a worker at A.J. Chemicals in Benicia, CA detected a leak in a railcar on their facility. The leak was located close to the sample line valve near the top of the tank car. The company lacked the equipment and personnel needed to stop the leak so they asked the local fire department for help.

A railroad employee and 3 firefighters climbed up on the tank to apply a specialized clamp to the leaking sample line. They installed the clamp but about 30 minutes later it began to leak. They climbed onto the railcar again and while doing so began to experience problems with the face pieces on their chemical-protective suits. The face pieces began to craze and melt. One face piece shattered while the wearer was climbing down off of the railcar exposing him to the hazardous atmosphere.

The fire department involved had information about the chemical compatibility of their chemical-protective suits and they had used that information to select the proper suits for the dimethylamine. A closer examination of the documentation about the suits showed the suit material was tested for permeability but the seams and face pieces were not tested at all.

Further investigation by the NTSB found several other reports of similar incidents. NTSB also found there were no uniform standards for testing chemical-protective suits. They recommended to the National Fire Protection Association (NFPA) and the American Society for Testing and Materials (ASTM) that they develop such standards, which they did.

Source: NTSB Safety Recommendation I-84-1 through 5
http://www.ntsb.gov/recsletters/DisplayLetters.aspx?FolderYR = 1984

Where Did the “Hot” Marking Come From?

Molten Sulfur Release, Benicia, CA 19 January 1985

At about 1150 on 19 January 1985 a tractor with two tank trailers carrying molten sulfur was southbound on the Benicia-Martinez bridge (I-680). The tractor/trailer struck the concrete median barrier. The trailers overturned onto the northbound lanes. The ensuing fire destroyed one trailer. The other was breached in several places. The molten sulfur splashed onto vehicles in the northbound lanes and the roadway. The sulfur burned for over three hours.

The local fire department responded to the incident and began rescue operations. Since the victims appeared to be suffering no respiratory distress the responding firefighters didn’t don their SCBAs. Responders transported 26 people to local hospitals for treatment. Three firefighters were later treated for difficulty breathing. After removing the victims the firefighters donned chemical-protective clothing and SCBAs

The fire department involved initially couldn’t identify the produce. There were no placards visible and the driver was dead. About 1.5 hours into the response firefighters retrieved the shipping papers from the tractor and identified the product as molten sulfur. They had difficulty obtaining information about molten sulfur. The DOT ERG had only limited information.

Two people were killed and 26 were injured.

The NTSB recommended that molten sulfur, and other elevated temperature materials, be classified as a hazardous material. DOT accepted that recommendation. In addition to regulating it as a hazardous material DOT created the “HOT” marking to warn emergency responders of the presence of elevated temperature materials in transportation incidents.

Source: NTSB Safety Recommendation I-85-19 through 20
http://www.ntsb.gov/doclib/recletters/1985/i85_19_20.pdf

US DOT Notice of Proposed Rulemaking HM-198, 11/21/1986
http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Federal%20Register%20Historical%20Files/51fr__1986/51fr-42114.pdf

Where Did the "Superfund" Come From?

Love Canal, Niagara Falls, NY, 1976

In 1894 an entrepreneur named William T. Love sought to develop a planned industrial community in the La Salle area of Niagara Falls, New York. Love planned to dig a canal in the area and route water from the Niagara River around Niagara Falls to produce cheap hydroelectric power for planned residences and industries in the area.

For various reasons, Love was forced to abandon work on the canal after about 1 mile was finished. Over the years the canal became a dumpsite for various entities including the city of Niagara Falls and the U.S. Army.

In 1942, Hooker Chemicals and Plastics Corporation purchased the site. Between 1942 and 1953 Hooker Chemical disposed of about 22,000 tons of mixed chemical wastes into the Love Canal. Shortly after Hooker ceased use of the site, the land was sold to the Niagara Falls School Board for $1.00. Hooker Chemical advised the city (in writing) of the general contents of the dumpsite and recommended they not develop the area. The city ignored these recommendations and built residential neighborhoods and schools in the area.

After unusually heavy rain and snowfalls in the mid-1970s high groundwater levels in the area buried materials started to appear. 55-gallon drums surfaced, ponds and other surface water area became contaminated, basements began to ooze an oily residue, and noxious chemical odors permeated the area.

In 1978 various government agencies, including and FEMA, took steps to remediate the site. However, no government agency had the explicit authority or funding to remediate such sites and Hooker Chemical had long since gone out of business.

Love Canal, and other similar incidents that occurred around the same time, led to the passage of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). CERCLA included funding (commonly known as the "Superfund") to remediate sites such as Love Canal.

Source: Love Canal Archives, University at Buffalo, State University of New York
http://library.buffalo.edu/specialcollections/lovecanal/collections/

Can a BLEVE Occur Without Flame Impingement?

Waverly BLEVE, Waverly, TN, 24 February 1978

About 2225 on 22 February 1978, 23 cars of a Louisville and Nashville Railroad (L&N) train derailed in Waverly, TN. The derailment was not far from the center of town. At 1453 on 24 February 1978 a derailed tank car containing liquefied petroleum gas ruptured. The ensuing BLEVE killed 16 people and injured 43.

The initial responders were the Waverly Police Department and the Waverly Fire Department. In their initial size-up they found LPG tank cars in the wreckage, one actually under other rail cars. They relied on visual observation to decide that there were no leaks since they had no combustible gas indicators.

L&N crews arrived and began clearing the debris and to reopen the tracks. Temperatures had been in the 20s and had not warmed very much during the day. There was about a half inch of snow on the ground. A cable sling was placed around a weakened LPG car under the other cars. It was pulled 12 feet to remove it from the tracks.

On 24 February the temperatures quickly rose to the mid-50s. At approximately 1458, vapor was observed leaking from one of the tank cars. Almost immediately a boiling liquid expanding vapor explosion (BLEVE) occurred.

The increasing temperatures increased the vapor pressure of the LPG. This pressure increase caused the weakened tank, 28,000 gallons of LPG, to rupture. The BLEVE immediately killed six persons and eliminated the on-scene firefighting capability.

The Waverly disaster, and similar incidents, led emergency managers to dramatically redesign training programs for emergency responders to reduce the risks to responders. The Governor of Tennessee ordered the creation of the Tennessee Hazardous Materials Institute. TEMA developed standards and a training program for hazardous materials responders that became a model for the nation.

Source: February 22, 1978 - Waverly, TN Train Derailment, Hazardous Material and Explosion
http://www.tnema.org/events/index.html

The BLEVE We All Learned About

Kingman BLEVE, Kingman, AZ, 05 July 1973

The Kingman BLEVE was a catastrophic boiling liquid expanding vapor explosion (BLEVE) that occurred on July 5, 1973 in Kingman, AZ. The explosion occurred during a propane transfer from a railroad car containing 33,000 gallons of LPG to storage tanks 75 yards away. The initial fire badly burned the two railroad employees present, one later died from his burns. The burning propane gas escaping from the valve connection on the rail car quickly heated the liquid propane inside.

The Kingman Fire Department responded, and began setting up attack lines to cool the propane car. Within minutes of the initial fire, the safety valve on the car opened due to the increased pressure in the tank car. The stream of propane gas blowing out of the safety valve immediately ignited as well. The heat from the streams of burning propane continued to heat the tank, increasing pressure to dangerous levels. The pressure inside the tank car reached the design bursting limit and the tank car exploded.

The boiling liquid propane flashed to gas with the drop in pressure and simultaneously ignited. The resulting explosion produced a shock wave that was heard and felt for over 5 miles, and a fireball over 1,000 feet in diameter. Burning propane rained down on everything in the vicinity, and pieces of the rail car, some weighing over 3 tons, were propelled over a quarter mile. The explosion left a crater 10 feet deep.

The three firefighters closest to the explosion were killed instantly; eight more died from their burns shortly thereafter. Over 90 onlookers gathered on the highway less than 200 yards away from the burning rail car were burned or injured, some severely.

This remains the worst firefighting disaster in Arizona history.

The incident was well documented with both 8mm movie film and still photographs. Because of this, it has been used as a classic BLEVE case study.

Kingman Arizona Historic District, *The Disaster Story*
http://kingmanhistoricdistrict.com/points-of-interest/firefighters-memorial-park/the-disaster-story.htm

The Mother of All Hazmat Evacuations

Mississauga Train Derailment, Mississauga, ON, 10 November 1979

A 106-car train Canadian Pacific Railway was eastbound near Mississauga, Ontario when a wheel bearing on the 33rd car began to overheat due to a lack of lubrication. Shortly before midnight a wheel/axle assembly on the car fell off of that car causing 23 cars to derail. The derailed cars contained a variety of cargo including styrene, toluene, propane, sodium hydroxide and chlorine. Several of these cars, including the car carrying chlorine, ruptured, and spilled their contents. Propane cars exploded and burned. The force of the explosions knocked emergency responders to the ground and hurled one propane car over half a mile.

An hour and a half after the derailment occurred officials ordered an evacuation. Additional evacuations over the next two days caused more than 218,000 of the 248,000 Mississauga residents to leave the area. Firefighters initially concentrated on cooling cars to allow the fire to burn itself out. Six hours after the derailment responders discovered a 3-foot hole in the chlorine tank car. This prompted further evacuations.

After three days the fires were brought under control. Responders found that most of the product in the chlorine car had been released, however, the gas continued to evaporate at the rate of about 35 pounds per hour. Responders spent the next three days removing the remaining 14 tons of chlorine.

There were a total of eight evacuations ordered in the first two days of the response. The evacuees were allowed to return five days later. This response has since become a standard case study in how to conduct large-scale evacuations.

This is the largest evacuation for a hazmat incident. There were no fatalities.

The Mississauga Evacuation, Final Report, Ministry of the Solicitor General, 1981
http://cidbimena.desastres.hn/docum/crid/Diciembre2004/pdf/eng/doc4131/doc4131.htm
Derailment, the Mississauga Miracle, Mary Clare Havey, Allan Dickie, and David Allen, Government of Ontario, 1980
Mississauga Train Derailment, Mississauga Heritage Foundation 2009
http://www.heritagemississauga.com/page/Mississauga-Train-Derailment

Why Does OSHA Require Retention of Placards?

ANFO Explosion, Kansas City, MO, 29 November 1988

At 0340 on 29 November 1988, the Kansas City, MO Fire Department received an alarm indicating there was a fire at a highway construction project. The dispatcher directed Pumper 41 to respond to the truck fire. He added: "Pumper 41, use caution on your call. There's information there may be explosives. It's in a construction area…" Pumper 41 arrived at 0346 and found two separate fires, one involving a pickup truck and the other involving a trailer. There was another trailer parked less than 100 feet away.

Pumper 41 requested another pumper. The second pumper arrived at 0352 and began to fight the fire involving the trailer. The first company extinguished the fire in the pickup truck and proceeded to the other fire to assist the second company.

At 0408 a catastrophic explosion occurred. All six firefighters assigned to both companies were killed.

Approximately 40 minutes later, a second explosion occurred, followed by several minor explosions. The explosions broke windows far from the site and were heard through a wide area.

There were two large craters found where the two trailers had been. The first trailer explosion created a swimming pool-like crater, with a "deep part" 80 feet in diameter and eight feet deep connected to a smaller crater 20 feet in diameter and six feet deep. The second trailer explosion created a crater approximately 100 feet in diameter and eight feet deep.

The trailers contained over 20,000 pounds of ammonium nitrate/fuel oil (ANFO) mixture. There were no DOT placards visible nor were there any other markings on the trailers.

In 1994 OSHA issued a regulation requiring employers who receive a shipment of hazardous materials that is required to be placarded to retain all required DOT markings including placards.

Six Firefighter Fatalities in Construction Site Explosion Kansas City, Missouri U.S. Fire Administration/Technical Report USFA-TR-024/November 1988

Is Anhydrous Ammonia a "Non-Flammable Gas"?

Cold Storage Warehouse Fire, Shreveport, LA, 17 September 1984

On Monday, 9/17/1984 at about 1600 an explosion occurred in a cold storage warehouse near Shreveport, LA. The explosion occurred while two members of the Shreveport Fire Department's Hazardous Material Unit were attempting to stop a leak of anhydrous ammonia in the warehouse's refrigeration system. The two firefighters were wearing encapsulated chemical protective clothing and oxygen re-breathers. As they tried to repair the leak the ammonia continued to leak and the concentration reached the lower explosive limit (16%). The gas found an ignition source and an explosion and fire occurred.

The force of the explosion raised the building's roof/ceiling assembly approximately one foot and severely damaged interior wall assemblies. The fire resulting from the explosion severely burned the two firefighters. One died within 36 hours and the other was permanently disabled.

The fire department used the DOT Emergency Response Guidebook (ERG) as a reference source. DOT classifies anhydrous ammonia as a non-flammable gas and the ERG information reflected that. Both the ERG and NFPA 704 indicated that ammonia could be flammable under certain conditions. Both, however, lacked detailed information about the flammability hazards of anhydrous ammonia. In addition, the workers at the cold storage warehouse didn't have the knowledge and training to understand the risks of high concentrations of anhydrous ammonia in an enclosed space.

Although there had been similar incidents prior to this one, this incident caused the fire service to modify hazmat training programs to prevent similar tragedies.

Cold Storage Warehouse, Shreveport, Louisiana, September 17, 1984, National Fire Protection Association Fire Investigation