

November 6, 2002

Nebraska FACE Investigation 02NE004

SUBJECT:

Farmer Killed by Propane/Methane Flash Fire

SUMMARY:

A 36-year-old farmer died as a result of severe burns he received after either propane, methane or a combination of both ignited. On January 8, 2002, the victim went to his hog farrowing shed to check on some newly delivered baby pigs. Prior to entering he smelled propane, so opened up some doors to start ventilating the shed. He went around the facility and went to the propane tank located outside the building and shut it off. He went to his house and notified his wife about the gas leak. Together they went back to the shed and turned on two exhaust fans, one for the *north* side of the building, one for the *south*. The victim and his wife removed a broken shut off valve and reconnected the pipe without replacing the valve. His wife went outside to the propane tank and turned the valve on. When the victim attempted to light the *south* heater, his wife saw a flash of light from the eves and roof vent and immediately shut the valve off. The victim ran out of the hog shed with his clothes on fire. His wife was able to get him to the ground and used a coat to pat out the fire. Emergency personnel were called and the victim was life-flighted via helicopter to a nearby hospital burn center where he died five days later.

The Nebraska Workforce Development, Department of Labor's Investigator concluded that to help prevent future similar occurrences, employers should:

- * Install gas/leak detectors
- * Ensure that atmospheric testing equipment is available for use and personnel are trained on its operation.
- * Allow adequate time for accumulated flammable/explosives gases to be ventilated safely outside the facility.
- * Prior to re-lighting, check all joints, valves and associated piping for gas leaks.

PROGRAM OBJECTIVE:

The goal of the Fatality Assessment and Control Evaluation (FACE) workplace investigation is to prevent future work-related deaths or injuries, by a study of the working environment, the worker, the task the worker was performing, the tools the worker was using, and the role of management in controlling how these factors interact.

This report is generated and distributed **solely** for the purpose of providing current, relevant education to employers, their employees and the community on methods to prevent occupational fatalities and injuries.

INTRODUCTION:

On January 8, 2002 a 36-year-old farmer was severely burned by a propane/methane flash fire while trying to ignite a heater in a hog shed. He died five days later on January 13, 2002. The Nebraska Department of Labor was notified of the incident on January 9, 2002, through the local news media and notified of the fatality on January 13, 2002, by the Occupational Safety and Health Administration (OSHA). The Nebraska FACE Investigator met with the investigating OSHA Compliance Officer (COSHA) on January 15, 2002 to determine if OSHA would investigate, which they did not. The Nebraska State Fire Marshal did conduct an investigation which included a site visit and interviews with the victim's family and other pertinent individuals immediately following the accident. The FACE Investigator contacted the building manufacturer on July 31, 2002 and met with the victim's spouse on September 4, 2002.

The victim was a self-employed farmer. He was born and raised on a farm and had been in business raising hogs for several years. At the time of the incident the farm did not employ any other personnel.

INVESTIGATION:

The victim had contracted with a group of farmers to feed and care for their baby pigs. The pigs were to be housed in a separate building called a farrowing shed.

The farrowing shed was contracted for and built during the fall of 1997. It is a single story structure approximately 88 feet long (*north – south*) by 24 feet wide (*east – west*). It has walk-in doors on both the *north* and *south* ends, plus one in the middle on the *east* side. The structure is wood framed covered by metal. In the middle of the building there is an area approximately 6 feet wide with a concrete floor that runs *east/west* that serves as a feed and storage room. This room has a door on the *north* and *south* sides leading to the walkways for the *north* and *south* halves of the building. The *north* and *south* halves of the building are the same size (40 feet long by 24 feet wide) and identically arranged with metal hog pens running along the *east* and *west* walls with a walkway down the middle. The floors are covered with metal grating with a 6 foot deep manure/waste pit underneath. There is no pit under the feed/storage area. The pit had been pumped out prior to the pigs arrival.

Both *north* and *south* pits had a single 16" fan mounted along the *east* wall that pulled clean air down from the roof area sending it through the pit expelling the waste air into the pen area. There were two 20" wall fans mounted in each half on the *east* wall that expelled the pit waste air from the pen area. There were also ventilation fans mounted on the *east* side that helped control the air temperature, drawing air in from outside when necessary. There were roof-mounted vents on both the *north* and *south* halves. There were no smoke or gas detectors installed.

On the day before the incident a local feed company delivered feed and placed it in the feed/storage room of the hog farrowing shed along the *west* wall. At 8:00 a.m. the day of the incident, 296 baby pigs were delivered and placed in the south half of the farrowing shed. The north half was left empty.

At 12:30 p.m. that same day, a local petroleum company filled the propane tank to 85% full (425 gallons). The propane tank was a Thompson 500-gallon model manufactured in 1997 which sat

approximately 25 feet *west* of the building. The farrowing shed facility used a two-stage system with the first regulator (Fisher) located at the tank, the second (Fisher-Control) outside of the building on the *west* side. Both regulators and associated copper piping between the two were found to be within code. From the second regulator, black steel pipe enters the *west* wall of the building, going upwards directly above the door into the rafters of the feed/storage area. The pipe then runs *east* to about six inches prior to the *east* wall, where it splits off, running both *north* and *south*. At this point each section had a quarter-turn shut off valve. From the shut off valves the pipe was coupled to rubber tubing using brass hose barbs which ran through the *north* and *south* walls of the feed/storage area, into the hog pen areas where they connected to the propane heaters. During the investigation the following day the gauge showed the tank to be 75% full (375 gallons).

The two propane heaters were manufactured by L.B. White and were new at the time of installation. The heater for the *north* side was located in the *south-east* corner of the room, while the heater for the *south* side heater was located in the *northeast* corner of that room. The State Fire Marshal determined that both met code and were not the source of the propane leak.

At approximately 7:15 p.m. the victim went to the shed to check on the baby pigs. Just prior to entering the *east* door of the feed/storage room he smelled propane. He opened up the feed/storage room doors to start ventilating the shed and then went around the facility and shut off the propane at the tank. There were no lights on in the shed and he didn't want to turn any on for fear of an explosion, so went to the house and got his wife. Together they got a flashlight and matches and returned to the shed. The wife stated that just before entering the shed she smelled a very strong odor of propane. They were both concerned that the pigs may have suffered due to either the leaking propane or lack of heat, but upon entering the shed they heard them and they sounded healthy. The victim looked up and saw a break in the metal propane pipe on the shutoff valve for the *south* room. They discussed how to best fix it since they did not have a replacement valve. The victim's wife went to the shop to get some pipe wrenches.

The victim turned the pit exhaust fans for the *north* side on HIGH, but turned the pit exhaust fans for the *south* side on LOW so the baby pigs wouldn't get chilled.

Upon her return they started to disassemble the pipe at the valve. When the pipe was disconnected a "ball" fell out of the pipe, which investigators believe was part of the *south* shut-off valve. The victim removed both halves of the shut-off valve with pipe wrenches and re-connected the pipes without a new shutoff valve since the threads matched perfectly. The shut-off valve parts and wrenches were placed on top of a power washer in the feed/storage area.

While the victim checked the remaining pipe for any other leaks his wife opened the door to the *south* room, turned the light switch on and saw it flicker once, then shut it off. She stated that there was no smell of propane in the room. She exited the building and went to the propane tank to turn the valve on. She stated that she looked at the gauge on top of the propane tank and it read 70%.

The victim went to the *north* side and struck one of the matches, lighting the *north* heater. Seeing that it was operating properly, he went to the *south* side. He struck a match to light the south heater, and saw a big flash come up from the pit area.

The victim's wife saw the flash of light through the eaves of the roof and the vents on top of the shed. She immediately shut off the valve on the propane tank and ran to the east side of the shed. She heard the victim screaming and he ran out of the east door with his clothes on fire. She was

able to get him on the ground and patted the fire out with a coat. She told him to stay there while she ran to the house to summon help.

While on the phone with the 911 operator she heard a noise outside the kitchen door. It was the victim trying to get inside, but he was unable to due to his injuries. Their children brought the victim inside and they laid him on the kitchen floor. Local rescue personnel arrived and determined that the victim should be air lifted to a burn center.

The on-scene fire chief stated that they were concerned about attacking the fire from the inside of the building due to the unknown structural integrity of the steel grating that covered the pits. A neighboring farmer was contacted and brought a tractor with a grappling hook to the scene to pull the roof off the south side of the building.

The victim's prognosis by the doctor was initially listed as "very good", but he passed away five days later due to injuries sustained.

ANALYSIS/SYNOPSIS: The State Fire Marshal's office investigators were able to find all pieces of the shut off valve that had been removed. Upon re-assembly it was noted that there was a crack near the base of the valve threads at the point of attachment to the black steel pipe. It was concluded that when the shut off valve broke, it began leaking propane through the crack into the feed/storage area, where the propane pooled on the floor and entered a drain that was directly below the valve. This drain ran only to the *south* side. The propane also traveled under the *south* door of the feed/storage area and into the *south* half of the hog shed. The propane then settled to the bottom of the pit in the *south* half of the building, due to the fact that propane is heavier than air, mixing with the existing methane gas. The pit fans in this south pit were only on LOW so the baby pigs would not become chilled, so the methane and propane mixture was not fully expelled when the victim attempted to ignite the heater, causing the flash fire. It is not known if the exhaust fans located in the pen area were operating at the time of the incident.

Olfactory fatigue - From the time the victim initially smelled propane until he attempted to re-light the south heater, approximately 30-45 minutes had passed. Both the victim and his wife smelled propane prior to entering the shed. After completing the pipe repair, the victim's wife opened the door to the south side of the shed and did not smell propane.

Propane - In its natural state, propane is odorless and colorless. A chemical odorant is added to give a distinct smell to the propane. The normal additive used in this region is **mercaptan**. The purpose of the odorant is to help people detect the presence of propane. Under certain conditions, a person may be prevented from smelling the odorant, such as:

1. Colds, allergies, congestion, or other similar medical conditions
2. Use of tobacco, alcohol, and/or drugs
3. Decline in a person's sense of smell
4. Being exposed to the odorant for a period of time
5. Odor masking where strong odors can overpower the smell of the odorant

Methane - Bio-gas from livestock waste usually contains about 60 to 70 percent methane, 30 to 40 percent carbon dioxide, and other gases, including ammonia, hydrogen sulfide, **mercaptans** and other noxious gases. It is relatively odorless and detection may be difficult. Methane in a concentration of 6 to 15 percent with air is an explosive mixture. It is lighter than air and will collect in rooftops and other enclosed areas.

It is possible that both the victim and his wife suffered from olfactory fatigue and were not able to smell either the methane or propane gas at the time the victim attempted to light the south heater.

CAUSE OF DEATH:

According to the death certificate, the cause of death was: Cardiac arrest due to acute inhalation burns due to burns to 75% of body surface area.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Install gas/leak detectors.

Discussion: Persons working in this type of environment may eventually become unable to smell the distinctive odor of either propane or methane gasses. For this reason, another method of detection may be necessary. There are electronic gas alarms available to supplement a person's ability to detect a gas leak by sounding a warning when it detects the presence of unburned propane.

Recommendation #2: Ensure that atmospheric testing equipment is available for use and personnel are trained on its operation.

Discussion: No atmospheric testing was done prior to the incident. At a minimum, the area should be tested for possible oxygen deficiency (levels less than 19.5%), toxic gases, and flammability (less than 10% of the lower explosive level). These tests are precautionary and essential.

Recommendation #3: Allow adequate time for accumulated flammable/explosive gasses to be ventilated safely outside the facility.

Discussion: Although 30-45 minutes had elapsed since the victim had shut off the propane gas and turned on the south pit exhaust fan, there was still ample gasses accumulated in the south side pen area to cause the flash fire. Prior to reentry into a facility where a gas leak has occurred, ample ventilation should be provided and the atmosphere should be tested for potential hazardous gases.

Recommendation #4: Prior to re-lighting, check all joints, valves and associated piping for gas leaks.

Discussion: The entire gas pipe system, where accessible, should be checked prior to re-lighting to ensure that no other leaks are present. The use of a simple soap/water solution that bubbles when applied over a leak is sufficient. This should be applied to all fittings to include shut-off valves, elbows, extensions, etc.

REFERENCES:

- * Methane Generation From Livestock Wastes, R.W. Hansen, Colorado State University Cooperative Extension, May 2001.

- * Propane Education & Research Council, October 1996
- * National Institute for Occupational Safety and Health, Worker Deaths in Confined Spaces, January 1994
- * North Carolina Propane Gas Association, www.ncpga.org, Safety, October 2002

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