



The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces
through safety and health research



Three Fire Fighters Killed Fighting Silo Fire – Ohio



Death in the Line of Duty...A summary of a NIOSH fire fighter fatality investigation

F85-49 Date Released: September 27, 1985

Introduction:

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), is currently conducting the Fatal Accident Circumstances and Epidemiology (FACE) Project, which is focusing primarily upon selected electrical-related and confined space-related fatalities. By scientifically collecting data from a sample of fatal accidents, it will be possible to identify and rank factors that influence the risk of fatal injuries for selected employees.

On August 27, 1985, three fire fighters were killed when a burning silo exploded. The fire fighters were spraying water onto the fire from the top of the silo at the time of the explosion.

Contacts/Activities:

Officials of the Industrial Commission of Ohio notified DSR concerning these fatalities and requested technical assistance. This case has been included in the FACE Project. On September 18, 1985, the DSR research team (a safety engineer, a safety specialist, and a fire protection engineer) conducted a site visit, met with the fire chief, officials of the Industrial Commission of Ohio, and officials of the Sheriff's Department, and photographed the accident site.

Overview of Employer's Safety Program:

The victims were members of a volunteer fire department. On the day of the incident, the volunteer fire department had 22 members on the roster. The fire chief is responsible for training and periodically conducts training sessions concerning fire fighting techniques and equipment. The Ohio Fire Service Training Manual is used as a training resource. No training was received concerning fires in oxygen-limiting silos.

Synopsis of Events:

On August 27, 1985, the fire department arrived at the scene of the silo fire at approximately 7:00 p.m. The fire had been noticed earlier in the day when the owner was “wispy” smoke coming from the top hatch of the silo. Three fire fighters climbed to the top of the 76 foot high silo using the access ladder on the outside of the silo. On top of the silo, they noticed that one of the hatches was open. After opening a second hatch on the elevator, they began the application of water onto the fire using a 1 ½ inch line and a straight stream nozzle. In approximately 30 minutes 3000 gallons of water (the capacity of two water tank trucks) were applied to the fire. At this point the water supply was depleted and the three fire fighters retreated from the top of the silo.

After a delay of approximately fifteen to twenty minutes, the water supply was replenished. Three fire fighters once again positioned themselves at the top of the silo and continued fighting the fire while two other fire fighters were at ground level applying water to the bottom hatch area. At approximately 8:00 p.m. an explosion occurred that lifted the concrete roof of the silo approximately four feet in the air. As the roof began to break apart in large chunks, victims #1 and #2 fell off of the silo and victim #3 fell into the silo. A fourth fire fighter at ground level sustained a broken leg when he was hit by a piece of the concrete roof. Victim #3, who fell into the silo, was removed from the silo through a hole that was cut, 28 feet above ground. All casualties were treated at the scene and transported to local hospitals. Two different coroners were involved in this accident due to victims being transported to different hospital districts. One coroner ruled that victim #1, who fell from the silo roof and landed on the ground the closest to the silo, died due to injuries caused by the fall. The other coroner ruled that victim #2 and #3 died due to injuries caused by the explosion. No autopsies were performed.

This silo was an oxygen-limiting type which means that the openings are sealed to limit oxygen from entering. This design was concrete, slipped-form construction (76' in height, 20' in diameter) with five rubber gasket sealed hatches (two on the roof, one at the side loading portal near the top, and two at the unloading portal at ground level). At the time of the incident, silage was stored to approximately 12' from the base with silage extending at a steep angle to approximately 40' up on the sides of the silo in a cone shape configuration. (After the explosion, the silage collapsed to the 28' level.) The initial indication of cause of ignition was spontaneous heating of the silage. Witnesses state that the bottom and the top doors of the silo were open when the fire department arrived. This would allow sufficient oxygen for spontaneous heating to occur and the silage was sufficiently dry for this action to take place.

The explosion was due to either a build up of combustible gases from incomplete combustion or a dust explosion, or a combination of the two. In either case, directing water into the top of the silo would have been an improper method for fighting this type of silo fire. In this incident, nothing should have been done to increase the level of oxygen inside the silo. Both opening the top hatches to apply water to the fire and entrained air within the water stream increased the level of oxygen and put the gases and/or dust into the explosive range. Additionally, water spray can place the dust into suspension, thereby increasing the risk of explosion.

Cause of Death:

The cause of death for victims #2 and #3 was due to “injuries caused by explosion” and for victim #1, “injuries caused by fall from silo.”

Recommendations/Discussion

Recommendation #1: During fire fighting operations, water should not be directed onto the fire through the top hatches of an oxygen-limiting silo.

Discussion: A fire in an oxygen-limiting silo can be potentially very hazardous since explosive gases can be contained. Any increase in oxygen may place the gases into their explosive range. One method of fighting this type of fire that has met with success in the past involves the injection of liquid nitrogen or carbon dioxide into the silo to extinguish the fire.

Manufacturers of the silos normally have instructions on putting out fires in their silos. Further information can be obtained from the bulletin: “Extinguishing Silo Fires” which is published by the Northeast Regional Agricultural Engineering Service,

NIOSH Alert: "Request for Assistance in Preventing Hazards in the Use of Water Spray (FOG) Streams to Prevent or Control Ignition of Flammable Atmospheres," No. 85-112, and the NIOSH report: Occupational Safety in Grain Elevators and Feed Mills, No. 83-126.

Recommendation #2: When not being filled or emptied, the silo hatches should be kept closed, and proper maintenance on the silo should be performed to ensure the integrity of the oxygen-limiting features.

Discussion: If an oxygen limiting silo is properly sealed, there is very little likelihood of a fire occurring by spontaneous heating since there is usually insufficient oxygen to support a fire. The manufacturer of the silo should be contacted for proper operating and maintenance procedures for the silo. Additionally, further information on minimizing the possibility of a silo fire can be obtained from the bulletin, "Extinguishing Silo Fires," referenced in Recommendation #1.

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Was this page helpful?

Yes

Partly

No

FACE: 85-49
DATE: September 27, 1985
CAUSE: Fire
SUBJECT: Three Fire Fighters Killed Fighting Silo Fire in Ohio

On August 27, 1985, three firefighters were killed when a burning oxygen-limiting silo exploded. The firefighters were spraying water into the silo from its top at the time of the explosion. A male firefighter on the ground was also injured.

After observing "wispy" smoke coming from the top hatch of a silo, the owner summoned the Fire Department. Firefighters arrived at the silo at about 7:00 P.M. Three firefighters climbed to the top of the 76-foot-high silo and applied water onto the fire. In 30 minutes they exhausted the capacity of two 1,500-gallon water trucks. They retreated for 15-20 minutes, and returned when the water was replenished. At about 8:00 P.M., as the three firefighters applied water from the top and two fighters applied water to the bottom hatch area, there was an explosion that lifted the concrete silo roof about four feet in the air. Two firefighters fell to the ground and a third fell into the silo. A firefighter on the ground suffered a broken leg when struck by a piece of concrete from the roof. The victim inside the silo was removed by a hole cut into the silo 28 feet above ground. At the time of the incident, the silo was filled with silage to about 12 feet from the ground in the center, and about 40 feet around the inside rim. The silo was 20 feet in diameter. Cause of the ignition was spontaneous heating of the silage. When properly sealed, fire due to spontaneous heating in an oxygen-limiting silo is unlikely because there is usually not enough oxygen to feed a fire. Witnesses state, however, that the bottom and top doors of the silo were open when firefighters arrived, which would allow sufficient oxygen for spontaneous heating. The explosion was due either to a buildup of combustible gases from incomplete combustion, a dust explosion, or a combination of the two. Directing water into the top of a silo is an improper method of fighting such a fire, because opening the hatches to apply water admits more oxygen. Air in the water also introduces oxygen. Water spray can place dust into suspension, increasing the risk of explosion. Recommendations:

- o During fire fighting operations, water should not be directed onto a fire through the top hatches of an oxygen-limiting silo. Use of liquid nitrogen or carbon dioxide has met with success. See "Extinguishing Silo Fires," Northeast Regional Agricultural Engineering Service; NIOSH Alert No. 85-112; and NIOSH Report No. 83-126.
- o When not being filled or emptied, the silo hatches should be kept closed, and proper maintenance on the silo should be performed to ensure the integrity of the oxygen-limiting features.