DATE: July 15, 1996

FROM: Minnesota Fatality Assessment and Control Evaluation (MN FACE) Program Minnesota Department of Health

SUBJECT: MN FACE Investigation 96MN02301
Farmer Dies After Being Engulfed In Corn Inside A Steel Grain Bin

SUMMARY

A 66-year-old male farmer (victim) suffocated after he was engulfed in corn inside a steel grain bin. The bin was equipped with an unloading auger mounted between a raised steel floor and the concrete base that supported the bin. It was also equipped with a ventilation fan designed to aerate the stored grain by circulating air through it. The fan was not turned on at the time of the incident. The victim and a semi-truck driver removed corn from the bin when they noticed that the flow of corn from the unloading auger was decreasing. They thought the reduced flow was caused by clumps of frozen grain blocking the auger intake in the bin floor. The victim climbed a ladder to an access opening in the bin roof. He entered the bin with a steel pipe to push through the corn to the auger intake. Apparently after he pushed the pipe into the corn, he broke the frozen grain blocking the auger intake. The flow of corn into the auger suddenly increased and he was quickly engulfed in the flowing grain. Approximately fifteen minutes after the victim entered the bin, the driver placed a call to emergency personnel who arrived shortly after being notified. Approximately ninety minutes after they arrived, rescue personnel removed the victim from the bin and transported him to a local hospital where he was pronounced dead. MN FACE investigators concluded that, in order to reduce the likelihood of similar occurrences, the following guidelines should be followed:

- all equipment used to fill or empty a grain bin should be stopped, and the power source locked out, before workers enter the bin;

- workers should follow established confined space entry procedures when entering grain bins;

- grain bins should be identified as confined spaces and posted with hazard

warning signs at all entrances; and

- grain bin ventilation fans should be turned on and operating properly before workers enter bins which are either full or partially full.

INTRODUCTION

On May 28, 1996, MN FACE investigators were notified of a farm work-related fatality that occurred on March 12, 1996. The county sheriff's department was contacted and a releasable copy of their report of the incident was obtained. A site investigation was conducted by two MN FACE investigators and a National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) safety specialist on June 11, 1996. During MN FACE investigations, incident information is obtained from a variety of sources such as law enforcement agencies, county coroners and medical examiners, employers, coworkers and family members.

INVESTIGATION

On the day of the incident, the victim and a semi-truck driver removed corn from a steel grain bin. The twelve to fifteen year old bin was 27 feet in diameter and 18 feet high. It had a storage capacity of 8,000 bushels and contained approximately 6,000 bushels of corn at the time of the incident. The corn was grown and harvested during the 1995 growing season. The bin was equipped with a ventilation system that consisted of a fan and a raised grated steel floor. The ventilation fan, when operated, aerated the stored grain by forcing outside air into the space between the concrete bin foundation and the raised steel floor. The air was forced upward through the stored grain and escaped through seams in the bin roof. The ventilation fan was not turned on at the time of the incident. The bin had eight access hatches located near the edge of the roof and evenly spaced around the perimeter of the roof. It also had a side access door that was approximately 3 feet wide by 4 feet high. The bottom of the side door was approximately 18 inches above the bin floor. The door was fitted with a hinged exterior door that opened outward and with 6-8 overlapping panels that slid into slots along the sides of the door. Each panel was 3 feet long and approximately 6-7 inches wide and when in place, prevented stored grain from exerting pressure against the hinged exterior door. Grain could be emptied from the bin by sliding the individual panels upward.

The bin was equipped with a 6 inch diameter unloading auger mounted horizontally below the

raised steel floor of the bin. It extended from one side of the bin to the center of the bin floor where a square auger intake opening was located. The intake opening was fitted with a steel safety grid. The grid allowed grain to pass through it but prevented workers from being directly exposed to the auger located below the bin floor.

The victim and the truck driver were outside the bin as the unloading auger filled a semi-truck with corn from the bin. They noticed the flow of corn from the auger was gradually decreasing. They thought the reduced flow was caused by clumps of frozen grain that had flowed to and blocked the auger intake in the bin floor. The clumps of frozen grain were caused by snow that had apparently blown into the bin during a snowstorm several months before the incident. The snow was blown through a small seam that existed between the sides of the bin and the bin roof. This seam is normal on steel bins and enables air that is forced through the grain by the ventilation fan to escape from the bin. Generally, snow and rain will not be blown into bins through the seam between the sides and the bin roof. In this case, the snow partially melted during mild weather and later refroze causing a frozen surface crust to develop on a portion of the stored grain. While grain was emptied from the bin, the frozen crust broke into clumps that flowed to the center of the bin and down through the grain to the auger intake.

The victim climbed an exterior bin ladder to one of the access openings in the roof of the bin. He entered the bin with a steel pipe to push through the corn to the blocked auger intake. After he pushed the pipe down into the corn, he broke the frozen grain blocking the auger intake. The flow of corn into the auger suddenly increased and he was quickly engulfed in the flowing grain.

Approximately fifteen minutes after the victim entered the bin, the truck driver realized that he had not exited the bin. The driver placed a call to emergency medical personnel who arrived at the scene shortly after they were notified. They used a portable auger to remove four semi-truck loads of corn through the bin's side door. Approximately ninety minutes after rescue personnel arrived, the victim was found at the bottom of the bin. They removed him from the bin through the side entry door and transported him to a local hospital where he was pronounced dead.

CAUSE OF DEATH

The cause of death listed on the death certificate was asphyxia due to immersion in shelled corn.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: All equipment used to fill or empty a grain bin should be stopped, and the power source locked out, before workers enter the bin.

Discussion: Workers are exposed to various hazards if they enter or work inside a grain bin while the bin is being filled or emptied. The lack of adequate ventilation inside a bin usually results in high concentrations of dusts as a bin is being filled. Workers not wearing adequate dust masks or respirators will be exposed to these dusts. Exposure to these dusts may have both short- and long-term hazardous health effects. In addition, a worker inside a bin that is being filled is at risk of being buried alive by the incoming grain. Even greater dangers may exist when a bin is being emptied. When grain flows from the bottom of a bin, a worker inside the bin may be quickly engulfed and buried by the flowing grain. Flowing grain acts similarly to quicksand and may create forces so great that after a worker is waist deep in the grain, he or she will not be able to escape, even with the aid of a safety rope. Typical auger unloading rates are high enough that a worker will be pulled below the surface of the grain in less than thirty seconds. Because of these hazards, workers should never enter or work inside a bin when it is being filled or emptied. Also, all power sources should be locked out to ensure that the loading and/or unloading equipment cannot start accidentally or be started inadvertently by someone else. This may require locking out all electrical circuits that operate electric motors, removing ignition keys from tractors or removing spark plug wires from gasoline engines. If the auger system involved in this incident had been stopped and the electric motor circuits had been locked out, this fatality might have been prevented.

Recommendation #2: Workers should follow established confined space entry procedures when entering grain bins.

Discussion: If entrance into a grain bin is necessary, workers should follow established confined space entry procedures such as those described in NIOSH Publication No. 80-106. Anyone entering a bin should wear a safety belt or harness and a lifeline which is attached to a fixed external anchor point. In addition, a standby person should be stationed outside the bin whenever a worker enters a bin. Visual contact and/or audible communication should be maintained between the worker in the bin and the standby person at all times. Details of a rescue must be discussed and understood by the worker and the standby person before entry into a bin occurs. If established confined space entry procedures had been followed in this case, this fatality might have been prevented.

Recommendation #3: Grain bins should be identified as confined spaces and posted with hazard warning signs at all entrances.

Discussion: Grain bins meet the NIOSH definition of a confined space. A space is considered "confined" if it has any one of the following characteristics: (1) limited openings for entry and exit; (2) unfavorable natural ventilation; or (3) is not designed for continuous worker occupancy. Entrance into confined spaces are addressed in NIOSH Publication No. 80-106 (Working in Confined Spaces). Warning signs to alert farm workers of the hazards associated with grain bins should be posted at all entrances. In some areas, signs should be printed in more than one language for workers who might not be able to read and understand English.

Recommendation #4: Grain bin ventilation fans should be turned on and operating properly before workers enter bins which are either full or partially full.

Discussion: Older grain bins typically were not equipped with ventilation fans but many grain bins built in recent years are equipped with electric ventilation fans. These fans are used primarily to circulate unheated air through the stored grain. Ventilation fans force outside air into a space between the concrete bin foundation and a raised steel floor containing small holes. The air is forced upward through the grain and escapes through seams in the bin roof. When ventilation fans are operating, they are capable of providing a continuous flow of air through the stored grain. Although this flow of air is small, it may prevent a buried worker from suffocating if the worker is located within a short time after being buried in the grain. The presence and use of ventilation fans does not lessen or eliminate the confined space hazards of steel bins nor does their use reduce the need for workers to follow the guideline provided in Recommendations 1, 2, and 3. However, grain bin ventilation fans should be turned on and operating properly before workers enter bins which are either full or partially full.

REFERENCES

1. NIOSH (April 28, 1993). NIOSH Update: NIOSH Warns Farmers of Deadly Risk of Grain Suffocation. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 93-116.

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