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

SUBJECT: MN FACE Investigation 96MN08601
Farmer Dies After Being Engulfed In Corn Inside A Steel Grain Bin

SUMMARY

A 38-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 that was installed below the raised steel floor of the bin. It was also equipped with a ventilation fan that was not turned on at the time of the incident. The bin had an access hatch located near the edge of the roof that was accessible by an exterior ladder attached to the side of the bin. The steel bin contained approximately 5,900 bushels of corn at the time of the incident. The victim was home alone and used a feed grinder to grind corn that was stored in the bin for his livestock. While grinding on the day of the incident, the flow of corn from the bin apparently stopped. He stopped the bin unloading auger before he climbed to the roof of the bin to determine why the flow of grain had stopped. He apparently found that a frozen crust had developed on the surface of the stored grain. The victim entered the bin through the roof hatch with a long steel pipe to break apart the crusted grain. After he entered the bin the crusted grain collapsed and he was engulfed.

The victim's wife arrived home from work later that afternoon. Shortly after she arrived home, she went outside to help her husband with the evening chores. She noticed the tractor and grinder near the bin but could not locate her husband. She called for him several times and then became concerned that he might be trapped inside the bin. She ran to the house and called emergency medical personnel who arrived shortly after being notified. She also notified family members who lived nearby and immediately came to the scene. Rescuers cut holes in the sides of the bin and used a tractor and loader to move the corn as it spilled from the bin.

Approximately one hour after rescue personnel arrived the victim was found, removed from the bin and pronounced dead at the scene. MN FACE investigators concluded that, in order to reduce the likelihood of similar occurrences, the following guidelines should be followed:

- workers should never stand or walk on the unstable surfaces of stored material;
- workers should follow 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 December 10, 1996, MN FACE investigators were notified of a farm work-related fatality that occurred on December 3, 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 a MN FACE investigator on January 10, 1997. 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 used a portable feed grinder to grind corn that was stored in a steel grain bin. The bin was 23.5 feet in diameter and its sides were 18 feet high. It had a storage capacity of approximately 7000 bushels. 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 an access hatch located near the edge of the roof that was accessible by an exterior ladder attached to the side of the bin. A steel ladder was also attached to the inside wall of the bin and was located directly below the roof access hatch. The bin had a side access door that was approximately 3 feet wide by 4 feet high. The door was fitted with a hinged exterior door that opened outward and with interior panels that were bolted in place and prevented stored grain from exerting pressure against the exterior door. The bin was equipped with an eight inch

diameter unloading auger that was installed 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 12 inches square and was not fitted with a steel safety grid.

The steel bin contained approximately 5,900 bushels of corn at the time of the incident. It was filled approximately six weeks before the incident with corn that was grown and harvested during the 1996 growing season. The moisture content of the corn was approximately 22 percent when it was harvested. It was placed directly into the bin without being artificially dried to a lower moisture level. The victim used the bin's ventilation system to circulate outside air through the stored grain. This circulation produced a drying effect that lowered the moisture content of some of the corn. The greatest reduction occurred in the grain that was near the bottom of the bin since the bin was not equipped with a mechanical stirator¹ to agitate the corn as air circulated through it. Several days after the incident, all of the corn was hauled to a local grain elevator. The moisture content of the corn varied from 13.6 percent to 22.9 percent. Eight of the ten truck loads hauled from the scene had moisture levels above 21 percent.

The victim was home alone and used a feed grinder to grind corn for his livestock. During the three or four weeks prior to the incident, he ground corn two or three times per week and had removed approximately 1000 bushels of corn from the bin. While grinding on the day of the incident, the flow of corn from the bin apparently stopped. The victim stopped the tractor's power-take-off but left the engine running. He also stopped the bin unloading auger before he climbed to the roof of the bin to determine why the flow of grain had stopped. He apparently found that a frozen crust had developed on the surface of the stored grain. The victim entered the bin through the roof hatch with a long steel pipe to break apart the crusted grain. After he entered the bin the crusted grain collapsed and he was complete engulfed. Photos of grain that was still in the bin after the victim was found showed large frozen portions of it standing unsupported within the bin. These photos, in conjunction with below freezing temperatures for several weeks before the incident and the moisture content of most of the corn indicate that a frozen crust developed on the corn. The crust concealed a pocket that developed beneath the surface as drier grain was removed from the bin.

¹. Stirator: an auger system installed vertically inside grain bins that enables stored grain to be agitated or mixed to produce uniform drying throughout the bin.

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CAUSE OF DEATH

The cause of death listed on the death certificate was suffocation in corn.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Workers should never stand or walk on the unstable surfaces of stored material.

Discussion: Walking on the unstable surface of stored grain and other materials may expose workers to various hazards. In situations where flowing material is being removed from the bottom of storage bins, a worker walking in the flowing material may become entrapped and pulled below the surface in less than ten to fifteen seconds. A condition known as bridging creates hazardous situations that workers should avoid. Bridging occurs when grain or other loose stored material forms a ridged crust that does not collapse as the grain or material is removed from beneath the crust. A pocket develops beneath the surface that is concealed from workers who enter the storage structure. While standing or walking on the surface of bridged grain or other material, the bridged material may collapse without warning and cause workers to be completely engulfed in the material.

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 that is attached to a fixed external anchor point in a manner that ensures they will remain above the surface of the stored material. 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.

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 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 guidelines 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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