



The National Institute for Occupational Safety and Health (NIOSH)

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# Truck Driver Suffocates After Being Engulfed in Shelled Corn Inside Grain Storage Bin in Ohio

FACE 9112

## SUMMARY

A truck driver (victim) was engulfed in shelled corn inside a grain storage bin and suffocated while trying to clear an obstructed grain auger. The grain bin was 32 feet in diameter, 20 feet high, and contained approximately 8,000 bushels of corn at the time of the incident. The bin had a 36-inch by 20-inch hatch at the top near the edge, another hatch on the side, 2 feet above the bin floor, and steel access ladders anchored to the exterior and interior of the bin wall. The victim and two farm laborers were transferring corn from the bin to a truck, using two augers. One auger, placed horizontally in the bottom of the bin, pushed the corn through a pipe into a small hopper outside the bin. The second auger lifted the corn from the hopper to the truck. When each truck was loaded, the corn was hauled to a commercial grain storage silo. When the third truckload had been loaded, the corn stopped flowing into the hopper. The victim and one of the laborers entered the grain bin through the top hatch and tried to get the grain flowing again. The victim stood on the surface of the corn in the middle of the bin, and probed the corn with a 15-foot-long section of 1-inch-diameter galvanized pipe. The laborer stood on the corn near the ladder at the side of the bin. When the corn began to flow, the victim was quickly engulfed, sank to the bottom of the bin, and suffocated. The laborer hung onto the ladder and escaped injury. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- develop and implement safe work procedures and training for employees who work in, or near, confined spaces containing unstable materials
- provide lifelines and harnesses, and ensure that workers wear them before entering confined spaces containing unstable materials
- consider retrofitting grain storage bins and other similar storage facilities with mechanical leveling/raking devices, or other means to minimize the need for worker entry.

## INTRODUCTION

On January 24, 1991, a 43-year-old male truck driver (victim) died after being engulfed in shelled corn inside a grain storage bin. On February 26, 1991, officials of the Ohio State University Agricultural Department notified the Division of Safety Research (DSR) of the death, and requested technical assistance. On March 26, 1991, a research industrial hygienist from DSR traveled to the incident site and conducted an investigation. The DSR investigator reviewed the incident with the

company owner, the medical examiner, the property owner, the investigating police officer, the county agriculture extension agent, and a representative from the Ohio State University Agriculture Department. Photographs of the incident site were obtained during the investigation.

The employer in this incident, a commercial trucking company, had been in business for 23 years. Most of the work performed by the company had involved hauling agricultural products. At the time of the incident, the company owner employed only one truck driver (the victim), who had worked for the owner for 23 years. The owner had employed as many as four truck drivers at one time. The company did not have a written safety policy, safety program or established safe work procedures. Employees did not receive any type of safety training.

## INVESTIGATION

On the day before the incident, the company owner contacted the victim and asked him to haul approximately 12,000 bushels of shelled corn from a grain bin on a local farm to a nearby commercial grain storage silo.

The grain bin on the farm was 32 feet in diameter, 20 feet high, and was constructed of corrugated galvanized steel (Figure 1). The bin had two access hatches. One hatch was on the side, 2 feet above the bin floor, and measured 30 inches wide by 60 inches high (Figure 2). The other hatch was located on the top near the edge, and had an elliptical shape measuring 36 inches by 20 inches across the center (Figure 3). Posted on the inside of the top hatch door was a 20-inch by 12-inch hazard warning sign in red and black lettering. It stated, "DANGER ... YOU CAN SUFFOCATE UNDER GRAIN IN THIS BIN ... DO NOT ENTER WHEN THIS BIN IS BEING LOADED OR UNLOADED." Also included on the warning sign were safety instructions, and diagrams depicting potential hazards of being engulfed and suffocating in grain (Figure 4). Access to the top of the bin was provided by a galvanized steel ladder anchored to the outside of the bin. A second ladder was anchored to the inside of the grain bin, and extended from the top hatch to the bin floor (Figures 2 & 3). Installed within the concrete floor of the bin was a channel with an auger shaft (Figure 5). The auger was connected to a horizontal, 4-inch-diameter grain discharge pipe which extended to the outside of the grain bin. When the grain was loaded from the bin to a truck for commercial transport, a portable electric motor was mounted to the discharge pipe outside the bin. A drive belt on the electric motor turned the shaft of the horizontal auger, and the grain was drawn from the bottom of the bin, through the discharge pipe, and into a small plastic hopper outside the bin (Figure 6). A mobile grain auger, driven by a tractor power-take-off (PTO) unit lifted the grain from the hopper to the truck (Figure 7).

The victim arrived at the site in the afternoon on the day before the incident. With the help of two farm laborers employed by the property owner, the victim transferred nearly 3,000 bushels of corn from the bin to the truck. When the second truckload was nearly loaded, the victim and farm laborers noticed that some of the corn appeared to be "out of condition," i.e., to have a high moisture content. This caused the grain to agglutinate, and obstructed its flow. Since it was late in the afternoon, the victim decided to transport the second load, and complete loading and transporting the rest of the corn the following day.

On the day of the incident, the victim returned to the site at 1:00 p.m., and worked with the farm laborers to fill the third truckload. When the truck was nearly full, the corn stopped flowing out of the bin discharge pipe. The victim transported that load, and returned at approximately 5:00 p.m. The victim told the farm laborers that he would enter the grain bin and probe the corn with a pole or rod to get the corn flowing again. He found a 15-foot-long, 1-inch-diameter section of galvanized pipe to use for this purpose. He climbed the ladder to the top of the grain bin, and one of the laborers (first laborer) handed him the pipe. The victim opened the top hatch, inserted the pipe, and entered the bin with the grain bin auger still running. There was approximately 12 feet of corn remaining inside the bin. The first laborer entered the bin and stood on the corn near the ladder to help the victim probe the corn. The victim stood on the corn near the center of the bin and pushed the pipe to the bottom of the bin in several places, but the corn still would not flow.

Suddenly, the corn began to flow, pulling the victim down with it. Almost instantly the victim was buried up to his knees, and continued to sink into the corn. The victim immediately yelled to the first laborer, "Turn off the auger!" The first laborer hurriedly climbed up the ladder, stuck his head out the top hatch, and shouted to the laborer who was on the ground near the hopper (second laborer) to turn off the grain bin auger. The second laborer immediately pulled the electric power cord

to the auger motor, and the first laborer climbed back down into the bin in an attempt to rescue the victim. The first laborer could not see very well because of the dust in the air, so he yelled the victim's name several times, but could not hear any response. The first laborer climbed back up the ladder inside the bin, and told the second laborer to "Get help!"

After calling the emergency medical service (EMS) from a phone at a nearby residence, the second laborer climbed to the top of the grain bin, and the two laborers entered the bin to look for the victim. The grain had stopped flowing but the dust in the air restricted the laborers' visibility to only a few feet. The laborers searched for the victim for approximately 10 minutes. They walked across the surface of the corn several times, thrusting their hands into the corn in various places, and calling out the victim's name. However, they were unsuccessful in locating the victim, and did not hear any response from him.

Two police officers, followed by several local volunteer firefighters, arrived at the scene approximately 10 to 15 minutes after receiving the emergency call. They opened the side hatch on the bin, and began shoveling corn away from the bin. Firefighters cut several openings in the side of the bin with the bucket on a front end loader and a metal-cutting power saw (Figures 8 & 9). Other emergency responders shoveled corn away from all the openings in the bin. The victim was found on the bottom of the bin after having been engulfed for approximately 90 minutes. The victim received cardiopulmonary resuscitation (CPR) at the scene and en route to a local hospital where the attending physician pronounced him dead on arrival.

## CAUSE OF DEATH

The medical examiner listed the cause of death as mechanical asphyxiation due to inhumation in corn.

## RECOMMENDATIONS/DISCUSSION

**Recommendation #1: Employers should develop and implement safe work procedures and training for employees who work in, or near confined spaces containing unstable materials.**

Discussion: Farm workers, truck drivers, and other employees who work with agricultural products are regularly exposed to confined space hazards. Employers should ensure that they and their workers are familiar with the hazards of grain bins, silos, manure pits, and other farm-related confined spaces. Additionally, they should be aware of possible emergencies, and specific procedures to follow, prior to working in confined spaces. Grain storage bins, by their design, meet the NIOSH criteria for the definition of a confined space. Entrance into these bins should be in accordance with the guidelines in NIOSH Publication 80-106 ("Criteria for a Recommended Standard ... Working in Confined Spaces"). Four other publications, designed to increase worker awareness of confined space hazards, and to provide specific recommendations for safe work procedures are available: (1) A grain bin hazard alert, developed and published by the Ohio State University Cooperative Extension Service, "Suffocation Hazards in Grain Bins," (2) NIOSH Publication 88-102 (NIOSH Alert, "Request for Assistance in Preventing Entrapment and Suffocation Caused by the Unstable Surfaces of Stored Grain and Other Materials"), (3) NIOSH Publication 86-110 ("Request for Assistance in Preventing Occupational Fatalities in Confined Spaces"), and (4) NIOSH Publication 87-113 ("A Guide to Safety in Confined Spaces"). During the on-site investigation, the NIOSH/DSR investigator gave a copy of each NIOSH publication to the employer, the farm owner, and the agriculture extension agent. The publications do not address all safety concerns and recommendations for every situation. However, they do provide useful information in developing safety training and safe work procedures specific to the engulfment hazards associated with storing and transporting grain. Some of these issues which should be addressed are included in the appendix of this report.

**Recommendation #2: Employers should provide lifelines and harnesses, and ensure that workers wear them before entering confined spaces containing unstable materials.**

Discussion: OSHA construction safety standard 29 CFR 1926.250(b)(2), General Requirements for Storage, requires workers to use safety belts while working on stored materials in silos, grain bins, or other similar storage areas. The Mine Safety and Health Administration (MSHA) has requirements for storage of materials in the mining industry (30 CFR 56). These requirements address the storage of loose, unconsolidated materials, safe access, and the use of safety belts and

lines. Although OSHA and MSHA have no jurisdiction in this incident, their standards serve as appropriate guidelines in this instance. Life lines and harnesses should be present at the entrances of confined spaces containing unstable materials, and should be used by all workers (including rescuers) entering confined spaces. A standby person should tend the lifeline when silos, bins, tanks, or other confined spaces are entered. If the manufacturer does not incorporate lifelines and harnesses into the design of the storage bin or silo, then the employer should provide the equipment. The use of this equipment should be mandatory, and workers should be properly trained in how to use it. Some lifelines, harnesses, and human hoisting devices designed for confined space entry are also rated for fall protection (Appendix item #1).

**Recommendation #3: Employers should consider retrofitting grain storage bins and other similar storage facilities with mechanical leveling/raking devices, or other means to minimize the need for workers to enter grain storage bins.**

Discussion: Grain bins, silos, hoppers, tanks, transport vehicles, and surge piles where loose materials are stored, handled, or transferred should be equipped with mechanical leveling/raking devices or other means for remotely handling materials. Such devices would minimize the need for workers to enter such storage facilities. Usually cone-shaped piles of loose material can be leveled, and bridging of material prevented, by mechanical agitation or vibration of stored materials.

## REFERENCES

National Institute for Occupational Safety and Health, Criteria for a Recommended Standard ... Working in Confined Spaces, DHHS (NIOSH) Publication Number 80-106, December 1979.

Ohio State University Cooperative Extension Service, Suffocation Hazards in Grain Bins, August 1975.

National Institute for Occupational Safety and Health, Request for Assistance in Preventing Entrapment and Suffocation Caused by the Unstable Surfaces of Stored Grain and Other Materials, DHHS (NIOSH) Publication Number 88-102, December 1987.

National Institute for Occupational Safety and Health, Request for Assistance in Preventing Occupational Fatalities in Confined Spaces, DHHS (NIOSH) Publication Number 86-110, January 1986.

National Institute for Occupational Safety and Health, A Guide to Safety in Confined Spaces, DHHS (NIOSH) Publication Number 87-113, July 1987.

National Institute for Occupational Safety and Health, Guidelines for Controlling Hazardous Energy During Maintenance and Servicing, DHHS (NIOSH) Publication Number 83-125, September 1983.

Office of the Federal Register, Code of Federal Regulations, Labor, 29 CFR 1926.250(b)(2), U.S. Department of Labor, Occupational Safety and Health Administration, Washington, D.C., July 1989.

Office of the Federal Register, Code of Federal Regulations, Labor, 39 CFR 56.16002, 39 CFR 56.11001, and 39 CFR 56.15005, U.S. Department of Labor, Mine Safety and Health Administration, Washington, D.C., July 1989.

## APPENDIX

### Space Safety Checklist for Grain Storage Bins:

1. Is entry necessary? Can the assigned task be accomplished from the outside? Under certain conditions, a worker could use a non-conductive pole (such as fiberglass or wood) of sufficient length to probe the grain in a bin from immediately above the top hatch, without entering. However, to prevent electrical injury, workers should first verify that there are no overhead electric powerlines near the grain bin that a pole might contact. Also, for fall protection, workers should wear a harness with a lifeline tied off to a secure anchorage point on top of the bin.

Employers should address the following items (beginning with # 2) only if entry into a grain bin has been determined necessary:

2. Are grain bins and other confined spaces posted with warning signs where workers will notice them? In this incident, a warning sign was posted on the top hatch where the victim entered.
3. Has the grain bin auger been de-energized and locked out/tagged out prior to entry?
4. Has consideration been given to testing the air quality to determine an adequate oxygen level and the presence of flammable and/or toxic dust, gas, or vapor?
5. Is ventilation equipment of explosion-proof design available and used before and during entry? Some grain storage bins, like the one in this incident, have an electric fan built into the side of the bin at the bottom. The fan can be operated to pull air from the top of the bin and out the bottom. In this incident, the fan was not used (Figure 10).
6. Do workers know how and when to use the following personal protective equipment?:
- (a) Respirators (air-supplying and air-purifying)
  - (b) Lifelines/harnesses
  - (c) Emergency rescue equipment (SCBA, human hoist, etc.)
  - (d) Protective clothing
  - (e) Eye protection
  - (f) Hard hats
  - (g) Gloves
7. Can workers recognize confined spaces (grain bins, tanks, silos, etc.), and are they aware of their hazards?
8. Do workers discuss confined space safe work practices with employers and co-workers before attempting entry?
9. Is there a confined space rescue plan, and do workers know how to respond safely in an emergency?

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