



The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces
through safety and health research



Grain Elevator Leadman Suffocates After Being Engulfed in Shelled Corn Inside Silo

FACE 8933

Introduction

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to prevent fatal work injuries in the future by studying the working environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact.

On April 5, 1989, a 54-year-old male grain elevator leadman died when he was engulfed in corn stored inside a 76-foot-high, 33-foot-diameter grain silo. The victim was using a pneumatic conveyor to clean the inside of the grain silo.

Contacts/Activities

State officials notified DSR of this fatality and requested technical assistance. On May 18, 1989, two safety specialists conducted the investigation, photographed the site, and discussed the incident with the plant manager, the local police, and the county coroner.

Overview of Employer's Safety Program

The victim was employed as an elevator leadman at a grain processing facility that has been in operation for 47 years. The facility employs a total of 80 workers, and has no written safety policy or safety program. Workers receive on-the-job training. Since the incident, the facility has instituted a comprehensive confined space entry program.

Synopsis of Events

On the afternoon prior to the incident, the victim and a co-worker were assigned the task of removing the remaining grain (shelled corn) from a concrete silo. Most of the grain had been removed by a 16-inch-wide gravity-fed auger-transfer unit incorporated into the floor of the silo. When the grain had reached a level approximately 6 feet above floor level, it would no longer feed into the conveyor. An estimated 10,000 bushels of corn remained in the silo. Until 6 months previous to this incident, procedures called for the remaining grain to be shoveled from the silo by hand. However, the employer purchased

a pneumatic conveyor which was powered by the power take-off system of a tractor. Using this device, the remaining grain could be transferred from the silo into a truck by means of a 5-inch diameter suction hose. This pneumatic conveyor had the capacity to transfer between 2500 and 3000 bushels of corn per hour.

On the day prior to the incident, the victim and his co-worker positioned the pneumatic conveyor outside the silo. The victim and the facility manager entered the silo by means of a door (16 inches by 18 inches) located on the side of the silo. The bottom of the door was 6 feet above the floor level of the silo. The shelled corn that remained in the silo was level with the bottom of the door. The two men inspected the surface of the grain at that time and felt confident that the surface was not crusted and that no bridging (crusted surface covering a hollow space) was present in the remaining grain. The men then exited the silo. The victim re-entered the silo later with the suction hose of the pneumatic conveyor and began transferring the grain to a truck outside. A co-worker remained outside the silo to operate the tractor and the pneumatic conveyor. After enough corn was removed to determine the machinery was working properly, the two men then shut off the equipment and left it in position for the following day.

The following morning the men resumed the transfer operation. At 10:00 a.m., the co-worker heard the victim yell from inside the tank to turn the pneumatic conveyor off. After not seeing or hearing from the victim for a few moments, the co-worker looked through the door into the silo. When the co-worker did not see the victim inside the silo, he assumed that the victim had exited the silo and gone inside the office building. Discovering that the victim had not been seen in the area, he called the facility manager. A decision was made to begin cutting holes around the perimeter of the silo in order to remove the grain. In addition, the pneumatic conveyor was restarted and the facility manager entered the silo to operate the suction hose. At 2:00 p.m., after some of the grain had been removed, the victim was found lying on his back on the floor of the silo. He was removed from the silo by facility personnel and was pronounced dead at the scene by the county coroner.

The rapid removal of the grain by the pneumatic conveyor may have created a quicksand-like effect at the feet of the victim causing him to be engulfed by the shelled corn before he could exit the silo.

Cause of Death

The county coroner ruled suffocation as the cause of death.

Recommendations/Discussion

Recommendation #1: Employers should develop a comprehensive safety program that clearly documents procedures for safe entry into confined spaces such as those contained in the NIOSH criteria document on "Working in Confined Spaces" (NIOSH Publication 80-106) and "A Guide to Safety in Confined Spaces" (NIOSH Publication 87-113).

Discussion: All employees who work in or around confined spaces should be aware of potential hazards, possible emergencies, and specific procedures to be followed prior to working in a confined space. These procedures should include, but not be limited to:

1. testing air quality to determine adequate oxygen level and the presence of flammable and/or toxic gas/vapors
2. ventilating the space to remove air contaminants
3. monitoring the space to determine a safe oxygen level is maintained
4. training employees in confined space entry, testing, and use of personal protective equipment, safety harnesses, respirators, clothing, etc.
5. stationing a standby person(s) outside the space for communication and visual monitoring
6. providing for emergency rescue procedures
7. identifying and controlling of the hazards associated with unstable surfaces.

Since the incident the employer has implemented a comprehensive confined space entry program.

Recommendation #2: Confined spaces containing unstable material should be equipped with life lines and harnesses at their entrance point(s), and workers should be trained in their usage.

Discussion: Life lines and harnesses should be present at the entrance(s) of confined spaces containing unstable materials and should be utilized by all persons entering the confined spaces. If these are not incorporated into the design of the silo by the manufacturer, they should be installed by the user prior to worker entry into the confined space. Workers should then be trained in the proper use of this equipment.

Recommendation #3: When work is being performed in a confined space containing unstable material, a standby person should be utilized in a manner such that constant communication with the worker inside the confined space can be maintained.

Discussion: A standby person e.g., stationed outside of confined spaces containing unstable material (i.e., shelled corn) should maintain constant communication with the worker inside the area. If visual contact cannot be maintained, the standby person should at least maintain constant voice contact. In this instance, although there was a person outside the silo, he was not a designated standby person and did not maintain constant contact with the person inside. The co-worker outside the silo was operating noisy machinery that made it difficult to hear a worker inside the silo. Although the co-worker heard the victim yell to turn the pneumatic conveyor off, he may have not have heard other calls from the victim. If a designated standby person had been stationed at the door of the silo, quicker action may have been taken that may have prevented the fatality.

Recommendation #4: Employers should perform a hazard analysis on each new piece of equipment or machinery and associated tasks to determine if potential hazards exist.

Discussion: A proper hazard analysis involves three distinct steps:

- (1) outline each step of a task or activity that involves the equipment or machinery
- (2) identify all potential hazards presented by the equipment or machinery during each step
- (3) develop measures for controlling each hazard.

Had such an analysis been performed, the employer may have identified the danger associated with rapidly transferring unstable material when someone is standing on the surface of that material.

Recommendation #5: Employers should instruct workers to enter confined spaces only when absolutely necessary and to strictly adhere to established confined space entry procedures.

Discussion: In this instance it was not absolutely necessary for the worker to enter the silo when the job began. A significant amount of the corn could have been removed while a worker maneuvered the 5-inch flexible hose from outside the silo. Enough corn could have been transferred in this manner to allow the victim to stand on the floor of the silo to complete the job. This would have eliminated the hazard of performing work while standing on an unstable surface.

Recommendation #6: Employers should not allow workers to stand on or work from the surface of loose, granular materials, even when the surface appears to be stable.

Discussion: Employers should not only prohibit workers from standing on unstable surfaces while performing their assigned tasks, but should also require employees to wear safety harnesses or safety belts attached to lifelines when working in the vicinity of unstable surfaces. Workers should be made aware of the hazards, such as engulfment, bridging, and crusting, associated with unstable surfaces. Workers should be instructed in the identification of these hazards and appropriate methods needed to avoid them.

Recommendation #7: Equipment manufacturers should recognize potential hazards inherent in the operation of their products, and provide appropriate warnings and safety information in product advertising and packaging.

Discussion: At the time of the investigation, advertising literature for two manufacturers of pneumatic conveyor systems was obtained. Neither pamphlet contained any warning of the hazards associated with entering confined spaces or the hazards associated with unstable surfaces such as stored grain. A photograph in one pamphlet actually shows a worker inside a silo standing on shelled corn while performing his task. No safety devices or stand-by persons are visible in the photograph.

Both manufacturers were apprised of the situation and alerted to the hazard presented by standing on grain while using the pneumatic conveyor system. The manufacturers are considering including a warning in the advertising literature that addresses the hazards associated with confined spaces and unstable surfaces. Additionally, copies of NIOSH publications 87-113 (A Guide to Safety in Confined Spaces) and 88-102 (Preventing Entrapment and Suffocation Caused by the Unstable Surfaces of Stored Grain and Other Materials) were sent to the manufacturers for consideration as supplementary information to be included with advertising literature. Responsible advertising could contribute to the prevention of these fatalities.

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