SUBJECT: A utility cleanup worker for a brick manufacturer suffocated in a storage silo.

SUMMARY

A 19-year-old Hispanic utility cleanup worker for a brick manufacturer died on August 5, 2005 from environmental suffocation after becoming entrapped in the ground shale contents of a storage silo. Near the end of the victim's shift, he ascended a stair and catwalk system to the top of a 25-foot tall storage silo to verify that the silo was full. When the silo was not full, employees were required to continue to work beyond the end of their shift to add the necessary amount of material to fill the silo. Although the incident was not witnessed, it is believed that the victim entered the top of the silo while the out-feed conveyor was running at the bottom. As the victim entered the silo to kick the contents on the sensor, the finely ground shale beneath his feet collapsed into a cavity below and he was engulfed by the silo contents. When the victim did not return, coworkers searched for him. Coworkers found the victim in the silo and climbed in to rescue him. Emergency medical services (EMS) were called after unsuccessful attempts to recover the victim were made. The side of the silo had to be cut open and the contents drained in order to recover the victim, who was pronounced dead at the scene by EMS.

Oklahoma Fatality Assessment and Control Evaluation (OKFACE) investigators concluded that to help prevent similar occurrences, employers should:

- Install danger signs and guards to restrict employee access to confined spaces.
- Develop, implement, and enforce comprehensive written safety procedures for working in or around permit-required confined spaces, such as silos.
- Develop, implement, and enforce written hazardous energy control (lockout/tagout) procedures for working around moving machinery and stored energy sources, such as silo contents.

Figure 1. Silo involved in the incident

- Train employees on the company's written safety procedures and the hazards associated with working in and around silos or other confined spaces.

- Ensure that employees do not enter confined spaces unless trained, have written consent, and are monitored by an attendant.

- Train employees on confined space rescue operations.

According to Occupational Safety and Health Administration (OSHA) standards, a confined space is "(1) a space that is large enough and so configured that an employee can bodily enter and perform assigned work; and (2) has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and (3) is not designed for continuous employee occupancy.

INTRODUCTION

On August 5, 2005, a 19-year-old Hispanic utility cleanup worker for a brick manufacturer died from environmental suffocation after he entered the top of a storage silo and became entrapped in the contents. OKFACE investigators were notified of the incident and an interview with company officials was conducted on November 22, 2005. OKFACE investigators also reviewed the death certificate and reports from the local media, Medical Examiner, and the Occupational Safety and Health Administration (OSHA).

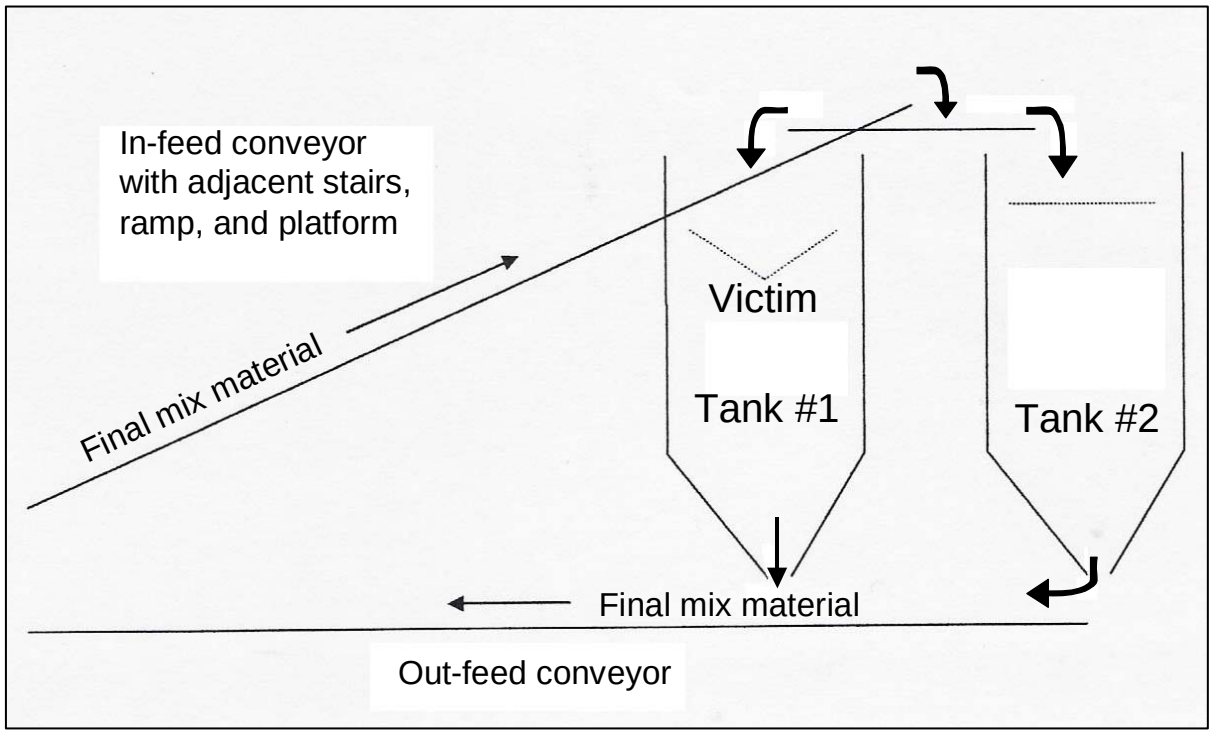

Figure 2. Sketch of silos, in-feed conveyor, and out-feed conveyor

Employer: The victim was employed by a privately owned brick manufacturing company. At the time of the incident, the company had been in business for 30 years and employed 160 full-time employees. The company had a written safety and health program, which included task-specific written work procedures. The company did not have a safety professional on

staff. Not all required regulatory programs were covered comprehensively in the written safety and health program, nor were the regulatory requirements of programs, such as lockout/tagout, fully implemented. Safety training was delegated to department heads and was conducted inconsistently between departments. The company had two safety and health committees in place; the first was composed of company managers and the second was composed of company labor and managers.

Victim: The 19-year-old Hispanic male victim had worked for the brick company for eight months. He was part of the utility crew and was operating a final mix storage silo that contained finely ground shale used to make brick. He had worked with this operation during his entire eight months of employment, and the task was a regular part of his job duties. His primary language was Spanish; it was unknown how well he could read and speak English. The primary language of the victim's coworkers was Spanish. All supervisors were bilingual and served as translators during English-based training.

Training: The company conducted weekly safety meetings and had additional meetings as safety concerns would arise. Company officials and a consultant conducted task-specific training. Machine-specific training was provided to all operators using classroom teaching, videos, manuals, and on-the-job, hands-on training. Machine operators' proficiency was measured by on-the-job demonstration, testing, and evaluations. Documentation of safety training and meetings was not kept on file with the company. Witness statements indicated that the victim's on-the-job training was limited to an explanation of the emergency stop cables on the conveyor system. The victim did not receive confined space entry training.

Incident Scene: The incident involved a storage silo located in the grinding room of a manufacturing facility. There were two 25-foot tall, 60-ton capacity vertical storage silos sitting side-by-side with in and out-feed conveyors. Because of the nature of the material, the entire room and equipment were covered with a thin film of shale dust. The incident occurred at 8:45 p.m., 15 minutes prior to the end of the shift.

Weather Conditions: On the day of the incident, there had been thunderstorms in the area and it was very humid inside the storage silo room. According to the employer, the finely ground shale particles clung together during high humidity, which, when the out-feed conveyor was running, increased the chances of a cavity forming in the silo and a false floor of material forming at the top.

INVESTIGATION

The incident involved one of two storage silos used to hold a final mix of ground shale (Figure 1). The silos were built in 1998 and maintained in good condition, but manufacturer instructions and warning devices were not present. An in-feed conveyor was used to fill the silos and an out-feed conveyor operated below the silos to carry ground shale to the next step in the manufacturing process (Figure 2). A utility crew was present on each of three shifts as the manufacturing facility operated 24 hours a day. The victim was a member of the crew whose shift was scheduled to end at 9:00 p.m. At the end of each shift, a cleanup crewmember was required to check a full silo indicator light and also ascend a stair and catwalk system (Figure 3) to the top of the silos to verify visually that the silos were full. It was standard practice to verify the contents of the silo by the use of the indicator light and a visual inspection. The safety policy prohibited employees from entering a restricted area while

machines were in operation; however, the top of the silo area was not marked as restricted. The opening from the observation and work platform leading into the top of the storage silo was unguarded and signs were not posted to restrict access. If the silos were not full, employees would have to continue to work beyond the end of their shift to fill the silo and cover a sensor that was located inside the top edge of the silo. Each shift was supposed to leave full silos for the incoming shift of workers.

Figure 3. Catwalk system used to access the top of storage silos

At 8:45 p.m., the victim went up the platform to visually check the silo contents of tank #1. Tank #2 had been filled, but tank #1 was releasing product via the out-feed conveyor. The in-feed conveyors were not operating. The observation and work platform (Figure 4) spanned the full opening of the top of the silo; guardrails were present around the outer edges, but the opening in the center of platform leading into the tank was unguarded. It was reported that employees were known to kick silo contents on the sensor to avoid restarting the system to add a few inches of material. Considering the small size of the entry hole through the grid floor of the observation platform, it is unlikely that the victim could have fallen into the tank without suffering bruising or cuts, which were not apparent on his body. Although the incident was not witnessed, it is believed that the victim entered the top of the silo through an unguarded opening, while the out-feed conveyor was running. Although the victim was not following written standard operating procedures, witness statements indicate that training was not always fully performed and the victim may not have been aware of the standard operating procedures. As the victim entered the silo, the ground shale beneath his feet collapsed into a cavity that had formed as a result of particles sticking together while the out-feed conveyor was running.

The victim was working with four other employees in the grinding room when the incident occurred. These coworkers began looking for him when he did not return after 15 minutes. The victim was found shortly thereafter engulfed in the silo's contents. Coworkers went into the silo to dig out the decedent, but their attempts were unsuccessful. EMS was called and, ultimately, the side of the silo had to be cut open and the contents drained in order to rescue the victim.

CAUSE OF DEATH

The Medical Examiner's report listed the cause of death as environmental suffocation.

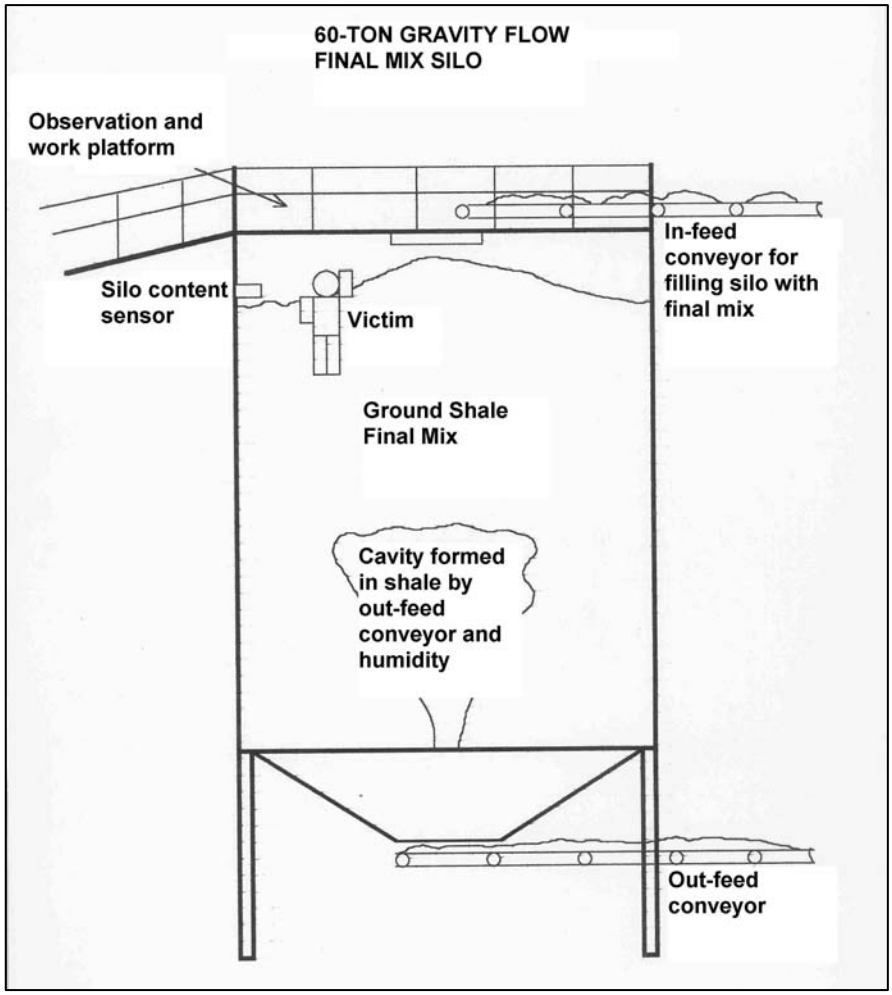

Figure 4. Sketch of silo involved in the incident

RECOMMENDATIONS

<u>Recommendation #1:</u> Employers should install danger signs and guards to restrict employee access to confined spaces.

<u>Discussion:</u> According to OSHA regulations, danger signs reading "DANGER – PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" or signs using similar language should be posted at the entrance of confined spaces. All posted signs should be appropriate for the language and literacy level of all employees in the area. In addition to signs, guards in the form of railing, doors, chains, or other physical barriers should be installed to restrict voluntary or involuntary (i.e., falling) employee access to confined spaces. Danger signs and physical barriers can be useful in reinforcing written procedures and safety training to restrict unauthorized employee entrance of confined spaces. Posting signs, however, does not negate the need for a comprehensive confined space entry program and effective training.

Figure 5. Example of a warning sign in English and Spanish

<u>Recommendation #2:</u> Employers should develop, implement, and enforce comprehensive written safety procedures for working in or around permit-required confined spaces, such as silos.

<u>Discussion:</u> OSHA regulations require workplaces to be evaluated to identify permit-required confined spaces. These areas are defined by OSHA as "a confined space that has one or more of the following characteristics: (1) contains or has a potential to contain a hazardous atmosphere; (2) contains a material that has the potential for engulfing an entrant; (3) has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a small cross-section; or (4) contains any other recognized serious safety or health hazard." Written procedures should be developed and implemented in areas where employees work in or around silos and other areas that are determined to be confined spaces. The written procedures should become a part of the company's standard operating procedures with adequate supervision in place to ensure that written procedures are followed. Written procedures should include a provision for at least one attendant to remain with the entrant for the duration of the confined space entry and a policy against workers standing on or working from surfaces of loose, granular materials, even if the surface appears stable. Written procedures should also include provisions that meet OSHA requirements related to the control of hazardous energy (lockout/tagout) during confined space entry tasks.

The victim was required to make a visual inspection of the silo contents; entering the silo was not necessary to perform this task. The entrance from the observation platform into the silo was not marked as a permit-required confined space and access was not restricted by the use of chains, guardrails, or other barriers. During this incident, the victim entered the confined space without an attendant while the out-feed conveyor was removing ground shale from the bottom of the silo. Written procedures should be enforced to prevent confined space entry without an attendant and also require lockout/tagout procedures to be performed on conveyor systems before entry is permitted. In this case, the cavity within the ground shale may not have been present if the out-feed conveyor was not in operation just before and during entry by the victim.

<u>Recommendation #3:</u> Employers should develop, implement, and enforce written hazardous energy control (lockout/tagout) procedures for working around moving machinery and stored energy sources, such as silo contents.

<u>Discussion:</u> Employers should develop and implement written hazardous energy control procedures for working around energy sources that may cause injury. According to OSHA regulations, an object is energized if it is connected to an energy source or contains residual or stored energy. As the out-feed conveyor continued to run, the cavity in the silo contents grew larger, increasing the chance of the collapse of the false floor located at the top of the silo. Lockout/tagout procedures should be used when maintenance is performed on machinery or employees enter a confined space where machinery is in operation. In this case, before silo entry was permitted, the out-feed conveyor should have been turned off and a lock or tag should have been placed on the out-feed conveyor controls. The entrant should be the only person with authority to remove the lock or tag placed on machinery or other devices that have been locked/tagged out. All written materials should be appropriate for the language and literacy level of the employees working in the area.

Recommendation #4: Employers should train employees on the company's written safety procedures and the hazards associated with working in and around silos or other confined spaces.

Discussion: All employees working in areas with confined spaces should be trained on the company's written safety procedures and have the ability to identify potential hazards associated with confined spaces, such as engulfment, oxygen deprivation, presence of toxic gases, or mechanical and electrical hazards. Written procedures and training should cover all information necessary to allow employees to safely work in or around silos and should also address OSHA requirements. Confined space training, as well as all other safety training, should be documented and kept on file with the employer. All written and oral training should be appropriate for the language and literacy level of the employees who are being trained. Supervision through random observation should be conducted to prevent unauthorized entry and ensure that employees follow all written safety procedures and training. Corrective action should be taken whenever an employee is observed performing tasks outside of the company's safety procedures. Retraining at regular intervals should also be conducted.

Recommendation #5: Employers should ensure that employees do not enter confined spaces unless trained, have written consent, and are monitored by an attendant.

Discussion: OSHA requires the use of attendants for entry into confined spaces. Entrants should wear harnesses attached to lanyards or other available methods to allow for attendants to remove entrants without making entry into the confined space. An attendant should maintain constant communication with the entrant and may not leave while the entrant is still inside the confined space. Attendants should have knowledge of the hazards involved in the confined space entry and must maintain an accurate count of authorized entrants within the confined space. A policy should exist that prohibits workers from standing on silo contents that are loose or unstable, even when the surface appears stable. Simple mechanical devices, such as vibrators or a chain placed in the middle of materials stored in silos, can be utilized to prevent cavity formation.

Recommendation #6: Employers should train employees on confined space rescue operations.

Discussion: Rescue operation procedures, including summoning emergency services, rescuing entrants, and providing first aid, should be developed and implemented. Employees should be trained on procedures for performing a confined space rescue. If employees are required to perform rescue procedures, they must be trained on the proper techniques, be provided with necessary equipment, and have annual refresher training and practice drills. The employees who attempted the rescue of the victim in this incident could have become additional victims when they entered the silo to help their coworker. Confined space entry should not be conducted without a qualified and equipped rescue team in place to respond in case of an incident.

REFERENCES

- Occupational Safety and Health Administration, 29 CFR 1910.23, *Subpart D, Walking and Working Surfaces: Guarding Floor and Wall Openings and Holes.*
- Occupational Safety and Health Administration, 29 CFR 1910.146, *Permit Required Confined Spaces.*
- Occupational Safety and Health Administration, 29 CFR 1910.147, *The Control of Hazardous Energy (Lockout/Tagout).*
- National Institute for Occupational Safety and Health, A *Guide to Safety in Confined Spaces,* Publication 87-113.
- National Safety Council, *Confined Spaces: Training the Team, Entry Principles,* 1991.
- New York FACE Program, *Feed Mill Worker Dies in Grain Bin,* Case Report No. 02NY012, 2002.
- California FACE Program, *Warehouseman Dies from Asphyxiation in Salt Storage Bin in California*, Case Report No. 94CA009, 1994.

The Oklahoma Fatality Assessment and Control Evaluation (OKFACE) is an occupational fatality surveillance project to determine the epidemiology of all fatal work-related injuries and identify and recommend prevention strategies. FACE is a research program of the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research.

These fatality investigations serve to prevent fatal work-related injuries in the future by studying the work environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in injury, and the role of management in controlling how these factors interact.

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