HAZARD ALERT

Dangers of Engulfment and Suffocation in Grain Bins

During the week of June 6, 2011, three workers, one each in Iowa, Michigan and North Dakota, were killed when they were engulfed (buried or trapped) by grain while on the job. In Texas, a fourth worker was also buried in grain, but was rescued and survived. Suffocation from engulfment is a leading cause of death in grain bins, and the number of these deaths continues to rise. In fact, the number of such deaths more than doubled between 2006 and 2010. These fatalities are preventable if employers follow work practices and provide training and equipment as required by OSHA's Grain Handling Facilities standard, 29 CFR 1910.272.

How are workers suffocated or engulfed in grain bins?

Suffocation can occur when a worker enters a bin and is engulfed by grain or when bins develop hazardous atmospheres or do not have enough oxygen. A worker can be engulfed or suffocated if the worker enters the bin and:

- **Stands on moving/flowing grain and the moving grain acts like "quicksand" and buries the worker in seconds**

  Entering a bin while the auger is operating is dangerous. As the auger unloads the bin, grain flows to the outlet and is released, causing the grain above it to flow in and replace the released grain. When a worker stands on flowing grain, their weight forces the grain supporting them to flow to the outlet more quickly, causing them to rapidly sink into the grain. According to one source, at the average flow rate for grain, a 6-foot tall worker can be covered with grain in 11 seconds and would be unable to free him/her self after the first 5 seconds.[1]

- **Stands on or below a "bridging" condition that collapses and buries the worker**

  "Bridging" occurs when grain clumps together, because of moisture or mold, creating an empty space beneath the grain as it is released. Bridged grain resists the downward pull that normally moves loose grain to the bin outlet and rarely becomes hard enough to support a person. If a worker steps onto the bridge, it can cave in under the worker's weight, burying him or her in the empty space. Even if the grain flow is stopped before entering a bin, a worker could still be covered if they step onto a grain bridge and it caves in. As grain cascades down, the victim is covered with an "avalanche" of grain that traps and suffocates him or her. Standing under bridged grain is also hazardous because bridged grain can cave in unexpectedly and bury and suffocate the worker.

A center grain unloading auger draws grain from the top center and the grain forms a cone as the bin is emptied.

- **Tries to loosen a pile of grain and the grain caves in onto the worker, or stands next to a pile of grain on the side of the bin and the grain unexpectedly caves in onto the worker**

  Even though a wall of grain may appear safe, one scoop of grain may weaken support and cause the grain to cave in. If a worker is knocked off balance by the weight of grain, he or she can be covered quickly and suffocate. In some cases, grain can be loosened from outside the bin by bumping it with a pole through an access cover.

[1] The University of Arkansas publication entitled "Suffocation Hazards in Grain Bins" was released in 2010, and is available at http://www.uaex.edu/Other_Areas/publications/PDF/FSA-1010.pdf.

- **The atmospheric conditions inside the bin are at dangerous levels**

  Inside a storage bin, there is a potential for oxygen levels to be at unsafe levels. Also there is a potential for hazardous gases to be present. Because such hazardous atmospheres may be present inside a bin, a worker could quickly suffocate and become a victim.

These hazards are present in all grain handling facilities, regardless of size or number of workers. For detailed information about how workers become trapped by flowing grain, see the University of Arkansas publication entitled *Suffocation Hazards in Grain Bins*.

Who is at risk?

Although most workers at grain handling facilities are at risk of being trapped or buried by grain, young workers are particularly vulnerable and are often victims. Under federal law, workers under the age of 16 are prohibited from entering confined spaces or environments, including grain storage structures. In 2010, there were six documented cases of grain entrapments that involved workers who were under the age of 16. Five of these incidents resulted in death.[2] The number of incidents involving young workers, and the fact that they are often fatal, illustrates the importance of making sure that young workers are informed about the hazards of grain handling.

Incidents in grain bins often result in multiple deaths because other workers attempt to rescue their coworkers and become trapped or overcome as well. Pulling out a worker who is trapped in a grain bin requires a great deal of force, much more than is needed to rescue someone from under water. Water has "buoyancy," which "floats" ships and helps lifeguards rescue victims much larger than themselves. Grain does not have these properties and resists the force a rescuer uses when trying to remove a buried worker. Rescue systems should therefore be designed and built to overcome this resistance. A rescuer's strength alone is not likely to be enough to rescue a trapped worker.

[2] The Purdue University study entitled "2010 Summary of Grain Entrapments in the United States" was released on February 9, 2011, and is available at http://extension.entm.purdue.edu/grainlab/content/pdf/2010GrainEntrapments.pdf

OSHA requirements: How can employers reduce hazards and protect workers entering grain storage bins?

Under the Occupational Safety and Health Act of 1970, employers are responsible for providing safe and healthful workplaces for their employees.

OSHA's *Grain Handling Facilities* standard sets requirements that employers must follow to protect and train workers exposed to the hazards of grain handling facilities. The standard establishes common-sense safety practices and specific controls that can prevent worker injuries and deaths, and identifies specific controls for engulfment hazards that are covered below. OSHA's standard also covers controls for other common issues at these facilities, including: dust accumulation and explosions, hazardous atmospheres, confined space entry, and emergencies.

States that operate their own occupational safety and health programs approved by Federal OSHA enforce similar standards but may have different or additional requirements. A list of State plans is available at www.osha.gov/dcsp/osp/index.html.

Entering grain storage bins is EXTREMELY DANGEROUS. To reduce the risk of engulfment and suffocation, do not allow workers to enter a grain storage bin unless it is absolutely necessary. If a worker must enter a grain storage bin, these simple hazard control measures must be implemented.

Following these measures can SAVE WORKERS' LIVES:

- De-energize (turn off) and disconnect, lockout and tag, or block off all mechanical, electrical, hydraulic and pneumatic equipment that presents a danger, particularly grain-moving equipment as required by 1910.272(g)(1)(ii). Grain should not be emptied or moved into or out of the bin while workers are inside because it creates a suction that can pull the worker into the grain in seconds.[3]
- Prohibit and prevent workers from walking down grain and similar practices where walking on grain is intended to make it flow, required by 1910.272(g)(1)(iv).
- Prohibit and prevent worker entry onto or below a bridging condition, or where grain is built up on the side of the bin, required by 1910.272(g)(6).

[3] *See* The University of Arkansas's "Suffocation Hazards in Grain Bins."

- Train all workers for the specific hazardous work operations they are to perform when entering and working inside of grain bins, required by 1910.272(e).
- Provide each worker entering a bin from a level at or above stored grain, or when a worker will walk or stand on stored grain, with a body harness. The body harness should have a lifeline that is positioned and is of sufficient length to prevent a worker from sinking further than waist-deep in grain, required by 1910.272(g)(2).
- Provide workers with rescue equipment, such as winch systems, that are specifically suited for rescue from the bin, required by 1910.272(g)(4).
- Station an observer who is equipped to provide assistance and perform rescue operations outside the bin, required by 1910.272(g)(3).
- Ensure that communications (visual, voice or signal line) are maintained between the observer and the workers who entered the bin, as required by 1910.272(g)(3).
- Test the air within a bin for oxygen content and the presence of hazardous gases before entry, required by 1910.272(g)(1)(iii).
- Provide and continue ventilation until any unsafe atmospheric conditions are eliminated. If toxicity or oxygen deficiency cannot be eliminated, workers must wear appropriate respirators, required by 1910.272(g)(1)(iii)A and B.
- Issue a permit each time a worker enters a bin, unless the employer is present during the entire entry operation. The permit must certify that the above precautions have been implemented before workers enter the bin, required by 1910.272(g)(1)(i).

What has OSHA done to address the hazards?

In 2010, OSHA conducted nearly 300 grain handling inspections of various grain operations, an increase of more than 100 such inspections since 2008. This increase was a direct result of the Local Emphasis Programs that OSHA has implemented in several regions to focus on significant hazards associated with grain handling.

OSHA found that employer negligence, noncompliance with OSHA standards, and/or poor safety and health practices are significant factors in causing grain engulfments. About three-fourths of the nearly 300 worksites inspected were in violation of OSHA standards, and nearly 20 of the inspections resulted in willful or repeat citations. Violations covered hazards associated with grain engulfment, machine guarding, lockout/tagout of dangerous equipment to prevent accidental energization start-up, electricity, falls, employee training and combustible dust hazards.

As a result of the increased number of inspections, OSHA imposed substantial multi-million dollar fines on several employers for preventable grain handling fatalities and injuries. For example, in 2011[4] OSHA fined Haasbach LLC in Mount Carroll and Hillsdale Elevator Co. in Geneseo and Annawan, Illinois following the deaths of three workers, including two teenagers. The employers were cited for failing to lockout/tagout dangerous equipment prior to bin entry, entering grain bins under bridging (engulfment) conditions, and failing to post an observer outside the bin during an entry. The workers were killed when the grain engulfed and suffocated them. The fines to both companies total $1,352,125.

Additionally, OSHA has:

- sent notification letters to over 13,000 worksites reminding employers of basic safeguards they must use
- published a new grain handling fact sheet
- updated its Grain Handling Safety & Health Topics Web page
- developed a Grain Bin Entry wallet card.

OSHA Area Offices conduct local outreach efforts, including outreach to high school and college students, and outreach to small cooperative grain handling operations. OSHA Area Offices also coordinate with State Plan states on their enforcement and hazard prevention efforts.

[4]The Haasbach and Hillsdale citations were issued on January 24, 2011, and are available at http://www.osha.gov/ooc/citations/haasbach-hillsdale-citations.html.

How can OSHA help employers?

OSHA provides free, On-Site Consultation for small businesses with fewer than 250 workers at a site (and no more than 500 employees nationwide). This program provides free on-site compliance assistance to help employers identify and correct job hazards as well as improve injury and illness prevention programs. On-site consultation services are separate from enforcement and do not result in penalties or citations. To locate the OSHA Consultation Office nearest you, visit www.osha.gov or call 1-800-321-OSHA (6742).

OSHA also has **Compliance Assistance Specialists** throughout the nation who can provide general information about OSHA standards and compliance assistance resources. Contact your local OSHA office for more information by calling 1-800-321-OSHA (6742) or visit OSHA's website at www.osha.gov.

What rights do workers have?

Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary they understand) about workplace hazards, methods to prevent them, and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- Get copies of test results that find and measure hazards.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules. When requested, OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation or discrimination.

For questions or to get information or advice, to reach OSHA consultation, to report an emergency, a fatality or catastrophe, to order products or to file a complaint, contact your nearest OSHA office, visit www.osha.gov or call OSHA at 1-800-321-OSHA (6742), TTY 1-877-889-5627.

Resources with more information:

- Safety and Health Topics: Grain Handling. This OSHA webpage describes grain handling hazards and OSHA's standard for grain handling facilities. www.osha.gov/SLTC/grainhandling/index.html
- Worker Entry Into Grain Storage Bins. This OSHA Fact Sheet illustrates hazardous conditions and includes a brief list of the precautions employers must use.
- Suffocation Hazards in Grain Bins. This University of Arkansas publication describes in detail why it is easy to get trapped by flowing grain.
- 2010 Summary of Grain Entrapments in the United States. This Purdue University study documents the trend in grain entrapment incidents.
- OSHA Standard 29 CFR 1910.272, *Grain Handling Facilities*. This OSHA standard covers grain handling facilities and includes requirements for controlling the many hazards associated with grain handling operations, including engulfment hazards, grain dust fires and explosions, and certain other safety hazards.
- National Council of Farmer Cooperatives. This website lists member regional and national farmer cooperatives that may be able to provide assistance. www.ncfc.org

Page 1 illustration: John A. Kramer, *Safety Measures in Handling Stored Grain*, Kansas State University, February 1989.

Disclaimer

This Hazard Alert is not a standard or regulation, and it creates no new legal obligations. It contains recommendations as well as descriptions of mandatory safety and health standards [and other regulatory requirements]. The recommendations are advisory in nature, informational in content, and are intended to assist employers in providing a safe and healthful workplace. The Occupational Safety and Health Act requires employers to comply with safety and health standards and regulations promulgated by OSHA or by a state with an OSHA-approved state plan. In addition, the Act's General Duty Clause, Section 5(a)(1), requires employers to provide their employees with a workplace free from recognized hazards likely to cause death or serious physical harm.

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