

NIOSH

ALERT

ALERT

ALERT

ALERT

ALERT

ALERT



Request for Assistance in

**Preventing Entrapment and Suffocation
Caused by the Unstable Surfaces of
Stored Grain and Other Materials**

December 1987

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

DISCLAIMER

Mention of the name of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health

DHHS (NIOSH) Publication No. 88-102

Copies of this and other NIOSH documents are available from

Publications Dissemination, DSDTT
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226
(513) 533-8287

For further information on other occupational
safety and health problems, call
1-800-35-NIOSH

REQUEST FOR ASSISTANCE IN PREVENTING ENTRAPMENT
AND SUFFOCATION CAUSED BY THE UNSTABLE SURFACES OF
STORED GRAIN AND OTHER MATERIALS

WARNING!

THE SURFACES OF STORED GRAIN AND OTHER MATERIALS SUCH AS SAND AND GRAVEL MAY BE UNSTABLE. WORKERS MAY BECOME ENTRAPPED AND SUBSEQUENTLY SUFFOCATE WHILE WORKING ON OR UNDER SUCH STORED MATERIALS.

SUMMARY

Managers, supervisors, and workers are requested to help prevent the accidental entrapment and subsequent suffocation of workers trapped by the unstable surfaces of stored grain and other materials. In several incidents, workers have been entrapped and suffocated by collapsing material while working on or under the unstable surfaces of stored grain or other materials such as sand, gravel, and coal. This Alert recounts seven case reports describing the deaths of 12 workers. In each case, the workers became entrapped in grain or other loose material and were unable to free themselves or be freed by their coworkers. These deaths demonstrate the need to focus on preventing future fatalities.

December 1987

Page 2 - REQUEST FOR ASSISTANCE IN PREVENTING ENTRAPMENT AND SUFFOCATION
CAUSED BY THE UNSTABLE SURFACES OF STORED GRAIN AND OTHER
MATERIALS

BACKGROUND

Entrapment and suffocation are hazards associated with storage bins and hoppers where loose materials such as grain, sand, or gravel are stored, handled, or transferred. The fatalities described in this Alert occurred when suspended materials or crusted surfaces of stored material suddenly broke loose and entrapped the workers. The behavior of such material is unpredictable, and entrapment and burial can occur in a matter of seconds [NIOSH 1983b; Ginnold 1975; Fields and Bailey 1979].

In some cases, material being drawn from the bottom of storage bins can cause the surface to act like quicksand. When a storage bin is emptied from the bottom, the flow of material forms a funnel-shaped path over the outlet. The rate of material flow increases toward the center of the funnel. During a typical unloading operation, the flow rate can become so great that once a worker is drawn into the flow path, escape is virtually impossible [Fields and Bailey 1979].

A condition known as bridging can create hazardous situations. Bridging occurs when grain or other loose material clings to the sides of a silo or bin that is being emptied from below. A bridge of material may collapse without warning, entrapping workers who are standing below or on top of the bridge and who are unaware that the surface is unstable.

Bridging can occur in storage bins, silos, and hoppers that contain ground grains or meal such as soybean meal or other loose materials such as cement, limestone, coal, or sawdust. Unground grains such as barley, oats, and corn are less likely to form bridges, since the individual kernels do not adhere to the sides of the storage bin. Diameter of the storage vessel and moisture content of the stored materials are factors that contribute to bridging [FMEC 1979].

CASE REPORTS OF SEVEN FATAL INCIDENTS

Case #1 - ONE FATALITY

A man was swinging in a boatswain's chair suspended on a 3/8-inch steel rope in a bin containing soybean meal. While attempting to dislodge some of the meal from the side of the bin, the man allowed the chair to swing below the level of the material. The meal suddenly collapsed on him, breaking the steel rope, carrying him to the bottom of the bin, and burying and suffocating him [NSC 1977].

Case #2 - ONE FATALITY

Two men were working outside a bin that was being emptied of grain. Believing that the bin was completely empty, one of the workers entered it through the bottom access door. Once inside, he was buried by material that suddenly broke loose from the sides of the bin. The worker was unable to find the access door, and the other worker could not locate him in time to save him [NSC 1977].

**Page 3 - REQUEST FOR ASSISTANCE IN PREVENTING ENTRAPMENT AND SUFFOCATION
CAUSED BY THE UNSTABLE SURFACES OF STORED GRAIN AND OTHER
MATERIALS**

Case #3 - ONE FATALITY

Two workers were cleaning a wheat storage bin by using an auger to remove the grain. One worker was caught in the flowing grain created by the auger and was not able to free himself, even with the assistance of the other worker in the bin. The second worker was unable to communicate with workers outside the bin or to exit from the bin in time to get help and save the trapped worker [Parent 1976].

Case #4 - ONE FATALITY

A self-employed truck driver pulled his truck underneath an auger that dispensed sawdust. When the driver saw that very little sawdust was coming out of the auger, he turned the auger off and entered the top of the bin to dislodge sawdust from the sides using a long metal pole. While the worker was standing on the bridged sawdust, the surface collapsed beneath him, burying him with sawdust and suffocating him [NIOSH 1986a].

Case #5 - TWO FATALITIES

Two workers were fatally injured after they entered the top of a limestone storage bin in an attempt to dislodge some bridged material with a metal bar. The limestone on which they were standing collapsed and engulfed them, leading to their suffocation [MSHA 1986b].

Case #6 - FIVE FATALITIES

As five workers walked on top of coal contained in a 90- x 225-foot coal bin, the coal suddenly collapsed and engulfed them. The workers had been on the surface of the coal for about 2 minutes to observe the damaged structural component of an overhead conveyor (tripper belt). They were unaware that the coal surface was bridged. The cavity created by the collapsing coal was initially 4 to 6 feet in diameter and expanded to about 10 feet in diameter [Miller et al. 1986].

Case #7 - ONE FATALITY

One worker was fatally injured while trying to free a blockage of sand. The bridged or caked surface of the sandpile on which he was standing collapsed. He was engulfed and suffocated [MSHA 1986a].

REGULATORY STATUS

The OSHA construction safety standards [29 CFR* 1926.250 (b) (2), General Requirements for Storage] require workers to use safety belts while working on stored materials in bins or similar storage areas. However,

* Code of Federal Regulations. See CFR in references.

Page 4 - REQUEST FOR ASSISTANCE IN PREVENTING ENTRAPMENT AND SUFFOCATION
CAUSED BY THE UNSTABLE SURFACES OF STORED GRAIN AND OTHER
MATERIALS

no specific requirements cover similar work on or around grain storage areas. The Mine Safety and Health Administration (MSHA) has requirements for storage of materials in the mining industry [39 CFR 56]. These requirements address the storage of loose, unconsolidated materials [39 CFR 56.16002], safe access [39 CFR 56.11001], and the use of safety belts and lines [39 CFR 56.15005]. NIOSH believes that these requirements are also appropriate for similar applications in general industry.

CONCLUSIONS

The facts of the seven incidents reported here suggest that the following factors may have contributed to the fatalities:

1. Materials became lodged in storage areas, prompting workers to enter the areas to dislodge them.
2. When workers entered storage areas, they were unaware that the stored material was unstable or bridged.
3. Workers were operating below or on top of unstable stored grain or other materials.
4. Properly equipped standby personnel were not present.
5. Safety belts or harnesses were not used.
6. Supply and discharge equipment for moving grain or other material was not de-energized or locked out.
7. Proper emergency procedures were not used.

RECOMMENDATIONS

NIOSH makes the following recommendations in response to concern about the seven factors noted in the fatal incidents described here:

1. Workers should be trained to assume that all stored materials are bridged and that the potential for entrapment and suffocation associated with stored grain or other loose materials is constant. The training should include information on safe work practices and rescue.
2. Workers should not be allowed to enter a storage area from the bottom when material is adhering to the sides or is bridged overhead.
3. When workers must enter storage areas, they should stay above the material at all times and should never stand on top of stored material.

Page 5 - REQUEST FOR ASSISTANCE IN PREVENTING ENTRAPMENT AND SUFFOCATION
CAUSED BY THE UNSTABLE SURFACES OF STORED GRAIN AND OTHER
MATERIALS

4. Safety signs should be posted to warn workers of the hazards of working with stored grains and other loose materials. Safety signs alone are not sufficient to provide the information needed to prevent fatalities; such signs should be only one component of a comprehensive safety program.
5. Bins, hoppers, silos, tanks, transport vehicles, and surge piles where loose materials are stored, handled, or transferred should be equipped with mechanical devices or other means of handling materials so that workers are not required to enter such storage areas. Bridging can usually be prevented by mechanical agitation or vibration of stored materials.
6. Any time a worker enters a storage area (bin, tanks, etc.), the supply and discharge of materials must be stopped and the supply and discharge equipment must be locked out [NIOSH 1983].
7. Workers entering storage areas should wear safety belts or harnesses equipped with properly fastened life lines. A similarly equipped standby person should be stationed outside the area [NIOSH 1979, 1986b].

The following NIOSH documents contain additional information pertinent to this alert:

NIOSH [1979]. Criteria for a recommended standard: working in confined spaces. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 80-106.

NIOSH [1983]. Guidelines for controlling hazardous energy during maintenance and servicing. 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. 83-125.

NIOSH [1983]. Occupational safety in grain elevators and feed mills. 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. 83-126.

NIOSH [1986]. Request for assistance in preventing occupational fatalities in confined spaces. 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. 86-110.

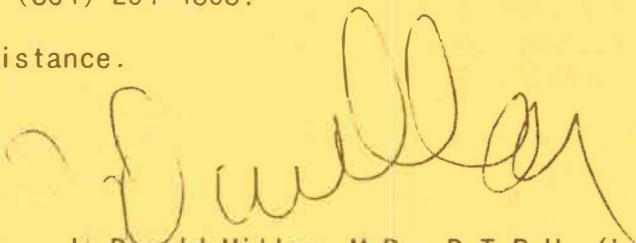
Page 6 - REQUEST FOR ASSISTANCE IN PREVENTING ENTRAPMENT AND SUFFOCATION
CAUSED BY THE UNSTABLE SURFACES OF STORED GRAIN AND OTHER
MATERIALS

Copies of these and other NIOSH publications may be obtained on request
from the following address:

National Institute for Occupational Safety and Health
Technical Information Branch
Publications Dissemination Section
4676 Columbia Parkway
Cincinnati, OH 45226

NIOSH requests that these recommendations be brought to the attention of
workers, supervisors, managers, and owners by the editors of appropriate
trade, construction, and farm journals, by the members of farm extension
associations, and by all individuals and organizations responsible for
providing a safe workplace. Requests for additional information or
questions related to this announcement should be directed to
Mr. John Moran, Director, Division of Safety Research, National Institute
for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown,
West Virginia 26505, telephone (304) 291-4595.

We greatly appreciate your assistance.

A handwritten signature in dark ink, appearing to read "J. Millar", is written over the typed name and title.

J. Donald Millar, M.D., D.T.P.H. (Lond.)
Assistant Surgeon General
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control

Page 7 - REQUEST FOR ASSISTANCE IN PREVENTING ENTRAPMENT AND SUFFOCATION
CAUSED BY THE UNSTABLE SURFACES OF STORED GRAIN AND OTHER
MATERIALS

REFERENCES

CFR [1986]. Code of Federal regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

Field WE, Bailey RW [1979]. Entrapments and suffocations in flowing grain. Presented at the 1979 Winter Meeting of the American Society of Agricultural Engineers, December 11-14, 1979, New Orleans, LA, Paper No. 79-5535. St. Joseph, MI: American Society of Agricultural Engineers.

FMEC [1980]. Loss prevention data, 1-25, process tanks and silos. Norwood, MA: Factory Mutual Engineering Corporation.

Ginnold R [1975]. Grain elevator occupational safety and health problems. Madison, WI: University of Wisconsin--Extension.

Miller WN, Kinty C, Powell R, Hinkle R [1986]. Report of coal storage stockpile disaster (five fatalities) in raw coal storage bin. Charleston, WV: West Virginia Department of Energy.

MSHA [1986a]. Fatalgram 86-008. Metal and nonmetal mine safety and health activity. Washington, DC: U.S. Department of Labor, Mine Safety and Health Administration.

MSHA [1986b]. Fatalgram 86-009. Metal and nonmetal mine safety and health activity. Washington, DC: U.S. Department of Labor, Mine Safety and Health Administration.

NIOSH [1979]. Criteria for a recommended standard: working in confined spaces. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 80-106.

NIOSH [1983a]. Guidelines for controlling hazardous energy during maintenance and servicing. Morgantown, WV: 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. 83-125.

NIOSH [1983b]. Occupational safety in grain elevators and feed mills. 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. 83-126.

NIOSH [1986a]. Fatal accident circumstances and epidemiology: truck driver suffocates in sawdust bin in Pennsylvania. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, FACE 86-19-11.

Page 8 -- REQUEST FOR ASSISTANCE IN PREVENTING ENTRAPMENT AND SUFFOCATION
CAUSED BY THE UNSTABLE SURFACES OF STORED GRAIN AND OTHER
MATERIALS

NIOSH [1986b]. Alert: request for assistance in preventing occupational fatalities in confined spaces. 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. 86-110.

NSC [1977]. Entry into grain bins and food tanks, data sheet 663. Chicago, IL: National Safety Council.

Parent JC [1976]. OSHA internal memorandum: grain elevator fatality, April 16, 1976. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, \$300

Third Class Mail



POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396

DHHS (NIOSH) Publication No. 88-102