AGAINST THE GRAIN

SAFE GRAIN STORAGE AND HANDLING PRACTICES FOR YOUTH AND BEGINNING WORKERS

BASIC AWARENESS LEVEL TRAINING FOR YOUTH TO SAFELY WORK IN THE GRAIN INDUSTRY

INSTRUCTOR'S GUIDE

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Disclaimer

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It should also be noted that no educational curriculum or training program can guarantee the safety of those who complete it, nor prevent future unsafe behaviors that could lead to injuries or deaths. All safety education and training must be supported by management, employers, and supervisors, and continually reinforced.

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Introduction

During the past few years there has been an increased level of interest in the safety and health of those employed at grain storage and handling operations. This interest was stimulated by the record number of 59 grain related entrapments and engulfments documented in 2010, of which over half resulted in fatalities. (See Attachment 1 for a recent summary of incidents) In addition, there have been several high profile incidents such as the one in Mt. Carroll, Illinois, that took the lives of two teenage boys (See online report at www.npr.org), and another in Oklahoma that resulted in leg amputations on two teenagers working in the same bin; increased enforcement efforts and fines by OSHA; and the higher-than-usual amount of national media attention given to the problem. One issue that has come clearly to the forefront is the impact that these incidents have on youth and beginning workers. In fact the data shows that one in five of all documented

incidents involving storage, handling, and transport of grain involve individuals under the age of 21 (Issa, 2014).

With respect to relative risks, the probability of a young worker experiencing an entrapment, engulfment, entanglement, asphyxiation, fall, or electrocution at a grain storage or handling facility is very low. Historically, the risk of injury and death for youth is much higher when they are operating motor vehicles, swimming, operating recreational vehicles, or participating in certain sports. This is not to say that the resulting deaths and injuries at grain operations are not important, but in a resource limited environment, there have been other youth-related workplace health and safety issues that have demanded higher attention. Consequently, the limited resources invested in enhancing worker safety at these facilities should be focused where the potential for returns is the greatest. It is also believed that the greatest investments should be made toward efforts that are designed to reduce the frequency and severity of workplace incidents at all grain storage and handling facilities. These include both those designated as non-exempt under the current OSHA standards such as commercial operations, and those that are considered exempt from compliance with OSHA standards, specifically those located on farms, feedlots, and certain seed processing operations. If carefully analyzed, every entrapment, engulfment, asphyxiation, entanglement, fall, or electrocution at these facilities could have been prevented if the appropriate intervention measures had been known and implemented. Maintaining a corporate or family culture of safety, adoption of general workplace safety practices, orientation training for new workers, continuing worker training and supervision, incorporation of state-of-the-art safety design features and compliance with current child safety regulations and OSHA workplace safety and health standards would go a long way in reducing the frequency and severity of injuries to young and beginning workers in the grain industry.

It is hoped that this curriculum will contribute to enhancing the safety and health of those under the age of 21 who are potentially exposed to the hazards of grain storage, handling, and processing.

Background

As previously noted, one out of five victims of entrapment, engulfment, entanglement, asphyxiation, falls, or electrocution at grain storage and handling facilities is a child or young adult under the age of 21. The average age of engulfment victims in grain transport vehicles, for

example, is 11, with nearly all of them being males. Some of the highest profile incidents recently reported in the media have involved multiple young males entrapped, engulfed, or entangled while working inside grain storage structures. The primary causes of these tragic events has been the lack of awareness of the basic hazards associated with storage and handling of grain, lack of appropriate safety equipment, failure to comply with safe workplace practices, and lack of supervision and relevant training. In many cases, victims, with little or no training were assigned tasks, such as removing residual grain from bins, entering bins with out-of-condition or crusted grain, entering bins with sweep and unload augers operating, and loading and unloading grain transport vehicles. Inexperienced young workers are no match for the powerful forces of flowing grain or the aggressive nature of grain handing equipment. Every young worker deserves the same workplace safety protections as their more experienced co-workers and, it could be argued, even more careful supervision and thorough training.

Training Goal

The goal of this curriculum is to provide basic-awareness level safety and health training needed by youth interested in employment, or who have been recently employed, in the commercial grain industry, or who already work on family operated farms with grain storage operations. The desired outcome is a reduction in the number of injuries and fatalities involving youth engaged in grain storage and handling activities.

Target Audiences

Those who would benefit most from the training include the following:

- Farm youth working on family operated grain farms
- High school students interested in a career or summer employment in agriculture or the grain industry
- College students preparing for a career in the commercial grain industry
- FFA members
- Beginning workers in the commercial grain industry

Learning Outcomes

On completion of all five units included in this training, participants should be able to:

1. Explain the importance of the grain industry to a viable U.S. economy.
2. Identify career opportunities within the grain industry.
3. Describe the flow of grain from field to its final products.
4. Describe the various types of facilities and equipment used to transport, store, handle, and process grain and grain by-products.
5. Describe the characteristics of an agricultural confined space.
6. Identify the types of confined spaces that can be found in and around agricultural workplaces including grain storage and handling operations.
7. Explain the key terminology related to the safe storage, handling, and processing of grain.
8. Describe the characteristics of free flowing grain.
9. Identify the primary hazards associated with grain storage, handling, and processing facilities, especially those related to confined spaces.
10. Explain the key requirements for long-term storage of grain.
11. Explain the relationship between out-of-condition grain and grain by-products, and an increased risk of entrapment, engulfment, and entanglement.
12. Explain the seven general types of entrapment or engulfment that can occur in grain storage, handling, and processing facilities.
13. Explain the types of personal protective equipment and clothing used or worn in the grain industry to prevent personal injuries.
14. Explain the basic safe work practices that should be followed to reduce the frequency and severity of injuries at grain storage, handling, and processing operations.
15. Explain the restrictions related to the employment of youth under the age of 16 in agricultural workplaces contained in the Agricultural Hazardous Occupations Order.
16. Explain the rights of workers to be provided a safe and healthy workplace under the provisions of the Occupational Safety and Health Act (OSHA).
17. Explain the rights of workers to refuse to perform certain hazardous tasks for which no training has been provided, or to file a complaint regarding unsafe work practices under the provisions of the Occupational Safety and Health Act (OSHA).

18. Describe the steps that should be taken in an emergency at a grain storage, handling, or processing facility.

Curriculum Development Process

Since 1978, Purdue University's Agricultural Safety and health Program has been documenting grain-related entrapments, engulfments, and asphyxiations, and more recently entanglements, falls, and electrocutions in and around grain storage facilities. Over 1,100 cases have been documented and entered into the Purdue Agricultural Confined Spaces Incident Database (PACSID). Approximately one out of five of the victims included in the database are under the age of 21. The data summarized from these cases provided the foundation for developing this curriculum. (See Attachment 1 for more details.)

With support from a Susan Harwood Grant through the U.S. Department of Labor, a formal curriculum development process was initiated. The relevant literature was reviewed, including both prior injury prevention research related to preventing child and young adult injuries, and regulatory protections for those under 18. Utilizing the data found in the PACSID and the review of literature, a list of over 70 potential contributing factors was developed and refined by the project team. The team determined that the list needed to be prioritized before being used for curriculum development purposes due to the limited amount of time that could be devoted to this type of training.

Based upon the list of prioritized learning outcomes, a series of five PowerPoint presentations were developed that addressed each objective. Each presentation was designed to be presented in a standalone 45-minute session.

In early 2012, a panel of experts was assembled for two days to prioritize the contributing factors, clarify the language of the desired learning objectives, and to identify any factors potentially overlooked. This process was led by Dr. Brian French, Ph.D., a curriculum development specialist at Washington State University.

During the Spring and Fall of 2012, the draft instructional content was used with 4-H youth, secondary agricultural education students, (grades 9-12) and post-secondary students studying agriculture. Approximately 70 youth participated in the pilot training. It was also reviewed by agricultural education specialists for its applicability for youth ages 16-20. A series of three, 5-hour workshops that targeted youth ages 16-20 were then conducted to test the materials and

make revisions as needed. Conducting the 5-hour sessions, that included a tour of a commercial grain facility turned out to be problematic due to low attendance. Content was reviewed and reduced to allow it to be taught within a 3-hour time block with a recommendation to conduct the facility tour as a supplemental activity. Both pre- and post-tests were developed and administered to those involved in the pilot training. The material was then submitted to OSHA for review.

During the Spring of 2014 over 600 secondary agricultural education students participated in some or all of the curriculum components.

The final curriculum was then made available at the project website, www.agconfinedspaces.org (http://www.ydae.purdue.edu/tractor/)

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Curriculum Limitations

Successful completion of this or any other safety education program does not guarantee that the participants will perform tasks in a safe manner. Knowing the safe way to complete a task and demonstrating safe work practices in an educational setting does not mean that safe behaviors will always be exhibited in the workplace.

The information presented in the *Against the Grain* curriculum cannot be substituted for appropriate screening of new employees, employee orientation, supervision, correction, discipline, evaluation, and a demonstrated employer commitment to providing a safe and healthy workplace. In fact, current workplace safety and health regulations that apply to young and beginning workers are based on the recognized higher risks these workers face. They place a greater responsibility on employers to ensure that they meet the age requirements for performing certain hazardous tasks, have been adequately trained and equipped, and provide appropriate levels of supervision. (For more information on restrictions to youth employment in agriculture,

see Attachment 2 for a copy of the current Agricultural Hazardous Occupations Order or visit the OSHA Youth in Agriculture website at https://www.osha.gov/SLTC/youth/agriculture/).

Furthermore, the authors do not imply that the contents of this curriculum cover all potential hazards that a young and beginning worker will encounter at a grain storage, handling, or processing facility. The topics included in the instructional content have been selected to reflect the most frequent causes of serious injuries or fatalities, as identified by past injury data and subject matter experts. Additional hazards that may be unique to an individual facility or related to regional or geographic differences should be identified and incorporated in the curriculum where appropriate. (For more information on general agricultural hazards for youth working in agriculture visit, www.agconfinedspaces.org; http://www.ydae.purdue.edu/tractor/)

As the instructor, you are not certifying or affirming by using this curriculum that any student who participates, and who may even pass all the testing, will perform safely in the workplace. You are only able to confirm that the participant attended the training and passed the prescribed testing that covered the identified learning outcomes. Since the curriculum does not include the opportunity for participants to demonstrate safe work practices, actual or future on-the-job performance cannot be ascertained.

Liability Issues

As our society has become more litigious, the concern over instructor liability has been raised more frequently, especially when the topic relates to the safety and health of young and inexperienced workers. As with many professions, becoming engaged with the well-being of others increases the potential of being identified as a defendant in a liability claim if serious losses are experienced. No document or liability waiver, no matter how well written, provides absolute immunity from future liability claims from an injured party, especially if negligence is claimed.

The authors are not aware, however, of any individual or organization that has been named as a defendant in a legal action resulting from the claim that inappropriate safety instruction led to the injury of a young or inexperienced worker. More specifically, no case was identified in which an instructor, paid or volunteer, has been held liable for injuries to youth under the age of 16 who have completed the certification requirements of the Agricultural Hazardous Occupations Orders (AgHOs).

If you chose to use the *Against the Grain* curriculum, you are encouraged to take your responsibility seriously, just as you would if you were teaching a young person to swim or drive a motor vehicle where the potential consequences for mistakes are very high. Sometimes, this may mean that you decide that a particular youth or young worker is not physically, emotionally or intellectually mature enough, or adequately prepared to take on certain responsibilities or perform certain hazardous tasks. This decision should not be viewed as a failure on your part or on the part of the student, but rather as a successful intervention that may prevent a serious injury or death.

If questions remain regarding the risk of being held liable as the instructor of this curriculum, contact the Risk Management Coordinator for your employer or the agency sponsoring the training.

Testing

Testing is an essential part of the learning process and allows for documentation of student readiness. It enables the instructor to assess learning outcomes and to identify gaps that may exist in the instructional process such as important topics that may have been skipped due to distractions, responding to participant questions, or a lack of time.

Based on the pilot training, pre- and post-tests were developed, incorporating those questions that a high percentage of participants completing the pilot training responded to incorrectly on the pre-test and questions that specifically addressed desired core competencies.

A reproducible copy of both the pre- and post-tests that are suggested for use with the curriculum are included as Attachments 3 and 4. The pre and post-tests are identical except for title. The key for the test is found in Attachment 5

If you are issuing a certificate of completion, it is advisable that you require everyone to complete at least the post-test to document that an adequate percentage of the desired core competencies were assessed. It is suggested that you keep these on file as documentation of successful completion.

As noted earlier, some youth in the pilot training were uncomfortable with the testing aspect of the curriculum. This did not mean that they didn't know the subject matter but were anxious about reading and completing the tests. You may consider alternative testing methods such as

reading the questions aloud to those uncomfortable with written tests. No alternative language translations of this material are available at this time.

It is suggested that a passing score of 80 percent be achieved before the participant is recognized as successfully completing the course. In some cases methods of providing individual remedial instruction might be needed.

Certification

Being able to document participation in training may be beneficial for some youth seeking employment in the grain industry to confirm their completion of relevant safety training. Therefore, it is important to maintain an accurate and complete record of all participants who have completed the training. Participants should be required to register, and provide their contact information. Only those who attended all training modules in the *Against the Grain curriculum* should be confirmed as having received the training. The certificate is designed, however, to allow you to check or initial each unit that the participant completed. This was found helpful where the training was conducted over several days and some students were absent for one or more of the instructional units. Attachment 6 is a copy of a blank certificate that can be reproduced and issued to all those who complete the training. Currently there is no certifying agency that recognizes a certificate for safety and health training for employment at grain storage, handling, or processing facilities. However, providing a certificate was seen as important to those attending the pilot classes and provided documentation of their participation for use on their resumes. The date of instruction and instructor's signature should be on all issued certificates.

Class Evaluation

Instructors are encouraged to conduct a training evaluation for every training event. This feedback provides a valuable tool for program improvement. Included as Attachment 7 is a suggested training evaluation tool. It can be modified as needed.

Supplemental Resources

There are numerous supplemental resources available online and in print form that would contribute to a better understanding of the hazards associated with grain storage and handling

facilities. Conducting an online search using the key words “grain safety,” “grain entrapment,” “agricultural confined spaces,” “grain entrapment prevention,” “grain suffocation,” “auger entanglement,” etc., will yield electronic publications, videos, interviews, data, and images of actual rescues. It should be noted that not all the information provided by online sources is technically accurate, safe to employ, or scientifically tested. Care should be taken to assess any technical information before including in safety training. See Attachment 8 for a list of supplemental resources, including key websites and print resources. Attachment 9 is a four page publication entitled *Suffocation Hazards in Flowing Grain*. Attachment 10, *OSHA Fact Sheet – Worker Entry into Grain Storage Bins*, can also be reproduced for distribution to participants. Attachment 11 specifically addresses youth working in agriculture, OSHA Youth in Agriculture Fact Sheet.

Suggested Demonstration Aids

In most instructional settings it has been found that, “A picture is worth a thousand words”. This is especially true for youth. It is also true that a simple demonstration aid can be worth even more. The following easily acquired or fabricated demonstration aids, are suggested for instructors to use in communicating specific aspects of the ***Against the Grain*** training to participants.

1) Samples of different grains and feed types, (corn, soybeans, popcorn, milo, wheat, bean meal, ground/cracked corn). Most of these grains/feeds are easily located at a farm supply store, commercial grain facility, or local farmer. The grain or feed should be well dried or they will eventually mold. They can be stored in labeled plastic containers with tight lids (plastic peanut butter jars). Some participants will not know the difference between the grains or feeds and their specific characteristics. For example, the sample containers can demonstrate that smaller seeds flow easier and bean meal can become easily compacted. The containers can be easily passed around for participants to have a closer look.
2) Sample of crusted or out-of-condition grain in a tightly sealed plastic container. A chunk of crusted moldy grain can be located at a local grain handling facility or farm and stored securely in a tightly sealed plastic jar. Due to the presence of mold and other micro toxins, the container should be labeled and sealed with tape to prevent unintentional

opening during handling. Some participants may have respiratory reactions if exposed to the contents.

3) In-flowing grain demonstrations. Using a clear, 5 gallon reusable drinking water container, cut off the top and drill a 1 ¾" opening that can be plugged with a PVC threaded plug. Fill the container with clean dry grain (corn, popcorn, wheat, soybeans). Place the container over an empty 5 gallon bucket and remove the plug. Have the participants observe the behavior of the grain as it empties from the representative grain bin. Point out the inverted flow and the angle of repose. Replace the plug and repeat the demonstration, but this time place a toy human figure 5-7" tall on the surface of the grain. Remove the plug and observe how fast the "victim" is pulled to the center and engulfed.
4) Two foot piece of auger and section of clear Plexiglas tubing that fits over the auger. These aids will allow for participants to observe how an auger works to move grain and the potential shear point between the auger and outer tube. Using a piece of cloth or strip of soft foam, the process of auger entanglement can be demonstrated.
5) Lockout/tagout kit. Every worker at grain storage and handling operations should be aware of the need to lockout and tagout the electrical supply prior to entering a bin or other confined space or to secure the scene of an entrapment or engulfment. The lockout/tagout kit can be passed around for participants to examine. In some cases, especially at exempt on-farm operations, grain storage structures might not be equipped with electrical boxes designed to be locked out. In such cases, a worker needs to be assigned to the power supply to ensure against inadvertent energizing of components.
6) Basic harness and lifeline. Having all participants see and handle the harness and lifeline will help reinforce the importance of these safety devices currently required at all commercial grain storage and handling facilities during certain confined space entry. For some individuals just handling the safety harness or attempting to put it on will confirm that he or she is not trained or physically prepared to use these safety devices.
7) Respiratory protection. Due to the excessive dust that can be generated during grain handling, there is a need to have access to adequate respiratory protection for all those exposed to airborne dust. The most appropriate protection in most cases is the use of N-95 disposable dust masks that will need to be changed frequently during the rescue. It is

suggested that several two-strap dust masks with an N-95 rating be made available for students to handle and try on.

8) Eye, hearing, foot, hand, and head protection. Having samples of different types of eye, hearing, foot, hand, and head protection available for students to examine would reinforce the use of this essential personal safety protection. In almost all commercial facilities, this equipment is required for every employee. In some cases, employees found working without required personal protective equipment can be disciplined or terminated. (As part of the pilot training for this curriculum, each of the 600 participants received a complimentary ANSI certified hard hat, safety glasses, and pair of ear protection. These were made available through local sponsors.)
9) Confined space warning sign. Having an actual hazard alert sign used on grain storage structures will introduce participants to these warnings and provide a visual reinforcement.
10) Models of grain handling and transport equipment. Some participants may be familiar with the different equipment used to handle or transport grain. Scale model toys of gravity wagons, hopper bottom semi-trailers, grain augers and other equipment are available at relatively low cost.

How to File a Complaint with OSHA

As part of the Susan Harwood Grant Program, instructional resources are required to provide information on how employees and their representatives can file a complaint and request an OSHA inspection of their workplace if they believe there is a serious hazard or their employer is not following OSHA standards. This right is provided for in the OSH Act and employers are in violation with the law if they discriminate in any way against a worker for filing a complaint.

Included as Attachment 13 is additional information on filing a complaint with OSHA.

Training Visuals

Included with the ***Against the Grain*** curriculum is a set of recommended PowerPoints and instructor notes that have been designed to address the goal of the training and each of the learning outcomes. You are encouraged to review this material, especially the instructor notes, before presenting the PowerPoints.

The PowerPoints are organized into the following units.

1. Against the Grain – Orientation
2. Against the Grain – Confined Spaces in Agriculture
3. Against the Grain – Summary of Grain-related Incidents Involving Youth
4. Against the Grain – Working Safely Around Grain Storage and Handling Facilities
5. Against the Grain – Emergency Response for Youth and Beginning Workers

Each unit is designed to be presented during a 45-50 minute time frame, and can be easily extended by using demonstration aids and the case studies provided to generate discussion.

All PowerPoint images are from original sources or are used with permission of the original source, and can be duplicated as needed, with appropriate credit.

You should feel free to supplement PowerPoints with content of your own, such as local case studies or material that addresses unique situations related to local practices, crops, or facilities, and make-up of participants.

Imbedded in the PowerPoint slides are several videos that can be shown and provide complementary information.

Definitions

The following terms are frequently associated with grain storage and handling facilities, and emergencies that might occur at these facilities. You are encouraged to review this list to become familiar with both the terminology and definitions. They are listed in alphabetical order.

Aeration Fan – A powered fan generally mounted at the base of the bin that is operated to blow outside air through the stored grain to maintain desired moisture content. In some cases the fan may be located at the top of the structure and draws air out.

Agricultural Confined Space – Any space found in an agricultural workplace that was not designed or intended as a regular workstation, has limited or restricted means of entry or exit, and has associated with it potential physical and/or toxic hazards to workers who intentionally or unintentionally enter the space. A reproducible list of confined spaces that are found in various agricultural worksites is included as Attachment 13.

Agricultural Hazardous Occupations Order (AgHOs) – An amendment to the 1939 Fair Labor Standards Act adopted in 1968 that prohibits children under the age of 16 from being hired to perform certain hazardous jobs on the farm such as entering confined spaces. An exemption

is provided in the law that allows 14 and 15 year-old youth to perform certain hazardous tasks if they have successfully completed approved training. See Attachment 2.

Age Restriction – Refers to a minimum age required to perform a work-related task. The U.S. Department of Labor has imposed age restrictions on youth employed to operate tractors over 20 hp, enter crop storage spaces and work with certain breeding livestock. Youth under age 16, for example, are not allowed to be employed to operate fork lifts, handle anhydrous ammonia, or enter storage pits or silos.

Agricultural Employer – Any person, corporation, association, or other legal entity that owns or operates an agricultural establishment; contracts with the owner or operator of an agricultural establishment in advance of production for the purchase of a crop and exercises substantial control over production; or recruits and supervises employees or is responsible for the management and condition of an agricultural establishment.

Anchor Point – A secure point or fixture that provides adequate support to meet the current OSHA standards for use of a life line for confined space entry or fall protection system. Minimum load capacity for an anchor point used for fall protection should not be less than 5,000 pounds. Nearly all grain bins in use today do not have designated anchor points that meet current OSHA standards.

Angle of Repose – The angle that free flowing material in a pile will form when allowed to be at rest. The angle of repose for dry corn is approximately 25-28%. The higher the moisture content of the corn, the steeper the angle, the lower the moisture content, the lower the pile.

Anhydrous Ammonia – A common source of nitrogen fertilizer on farms and stored at many grain and feed storage operations. Anhydrous ammonia, or NH_3, is an undiluted form of ammonia that is highly caustic. Anhydrous means “without water”. It is a liquid when stored in pressurized tanks, but rapidly vaporizes to a gas at atmospheric pressure. Exposure to ammonia may cause blindness, lung damage, freeze burns, and death. Flushing the eyes and skin with water is the most effective first-aid measure in the event of exposure.

ANSI – American National Standards Institute. A non-profit testing and standards organization that establishes standards for personal protective equipment such as hard hats, safety glasses, safety lines and hearing protection used in the grain industry.

Asphyxiation – Death due to a lack of oxygen caused by either insufficient oxygen levels in the atmosphere or airway blockage.

Bulk Density – A general measurement of the density of a material. For example, the bulk density of a bushel of corn is about 56 pounds per bushel. The bulk density of oats, a lighter grain, is approximately 32 pounds per bushel while wheat can exceed 60 pounds per bushel.

Carbon Dioxide – A gas generated during the decomposition of biological materials such as corn. In cases where grain has been stored too wet, there is a potential for carbon dioxide to be present in the space above the grain. Carbon dioxide is non-toxic, but in high concentrations it can cause asphyxiation.

Coffer Dam – "An empty space serving as a protective barrier." (Webster's, 2001) This term is sometimes used to describe devices, such as a grain rescue tube, that are placed around an individual partially entrapped in grain.

Confined Space – An area that is large enough and so confined that an employee can enter and perform assigned work, has limited or restricted means for entry or exit, and is not designed for continuous employee occupancy (OSHA Permit – Required Confined Spaces Standard, 29 CFR Parts 1910.146). See Attachment 14, or go to www.OSHA.gov.

Confined Space Entry Standard (OSHA 29 CRF 1910.146) – An OSHA workplace safety and health standard containing requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces. This standard does not apply to agriculture including most grain storage structures, to construction, or to shipyard employment, but may under some interpretations apply to emergency first responders. A copy of the standard is included as Attachment 14. It is also available at www.OSHA.gov.

Corrugated Steel Bin – A grain or feed storage structure fabricated from panels of corrugated steel that are bolted together in the shape of a cylinder. These can range from eight feet in diameter and ten feet tall to over 150 feet in diameter and over 100 feet tall.

Crusting – Out-of-condition or spoiled grain can crust together to form large chunks of solidified grain or bridging of the grain surface. Crusting inside a grain bin can become so severe that it can support the weight of a worker without revealing open voids beneath the surface.

Dump Pit – An opening in the floor of a grain facility that allows grain to be unloaded from a grain transport vehicle by gravity into the grain handling system. The opening is required to have adequate guarding and the pit is considered a confined space.

Engulfment – Events in which an individual is submerged, i.e., fully buried, in flowable agricultural material such as corn, small grain, or feed.

Entanglement – A situation in which the clothing, hair, or extremities of a person becomes wrapped around or caught in an energized piece of equipment. Entanglements have occurred in energized in-floor augers, sweep augers, stirrators, and belts and pulleys found on grain handling equipment.

Entrapment – Used in a broader way to describe events in which an individual is trapped, possibly due to being partially submerged, in free flowing material inside a structure considered a confined space such as a grain bin, silo, or grain transport vehicle where self-extrication is not possible.

Explosion – An explosion requires all the essential ingredients of a fire (fuel, oxygen, and ignition source) in addition to containment. Grain dust is recognized as a potentially explosive material when suspended in the air. See Attachment 15.

Fair Labor Standards Act – A federal law governing worker safety and benefits, such as overtime pay, minimum wage, child labor, and equal pay for equal work. Most hourly workers are governed by this law, but there are some exceptions. For example, many truck drivers and railroad workers are not covered by this law, and many agricultural workers are not covered by the overtime pay provisions of this law. The law includes the provisions of the Agricultural Hazardous Occupations Order (AgHOs). See Attachment 2.

First Aid Kit – A portable package containing bandaging materials, antiseptic, and other medical supplies. First aid kits should be located at appropriate locations with easy access.

First Responder – In general, the person who is the first to arrive at the scene of any injury or other emergency, but specifically a person who has passed a first-responder education class in first aid and often carries a pager so that he or she can respond rapidly to emergency incidents in the community. First responders often save lives by providing first aid until more advanced emergency medical services arrive.

Flammable – Capable of being easily ignited and burning quickly. Gasoline is highly flammable and should never be used as a cleaning solvent or to start fires because explosions and serious burns can occur. Likewise, grain dust is highly flammable and cause a tremendous explosion if suspended in the air in the current proportions.

Flash Point – The lowest temperature of a liquid at which its vapors will ignite in air when exposed to a flame. Gasoline is much more explosive than diesel fuel because the flash point of gasoline is a much lower temperature than that of diesel fuel. Material Safety Data Sheets contain flash point temperatures for all substances.

Flowable Agricultural Material (FAM) – Free-flowing agricultural crops or material including grain and feed.

Funnel Flow – The flow of grain from a storage structure is primarily funnel flow. When an opening at the bottom of the structure is opened, a flow of grain begins directly over the outlet and a moving column of grain is formed to the top of the grain mass. A funnel shaped opening on the top surface is formed allowing for the last grain put into the structure to be the first grain out. You can observe funnel flow by watching sand drain from one side of an hour glass.

Grain Bin – A structure designed to hold grain that is often made of corrugated galvanized steel sheets bolted together to form layers of rings that are covered with a roof.

Grain Bin Hatch – The grain bin hatch is generally mounted into one of the roof panels of the bin. It has historically been about 25” in diameter.

Grain Bridge – A layer of spoiled grain on the surface of the grain stored in a grain bin. When grain is unloaded from the bottom of the bin, the spoiled layer at the top can remain in place without any supporting grain beneath it, thus forming a bridge. An unsuspecting worker who walks on this bridge may fall through and become buried in the collapse of grain.

Grain Dust – The fine dust that is formed by the breakage of grain and other foreign material in the grain during handling through augers, conveyors, or pneumatic handling systems. It is very fine and can be easily suspended in the air creating potential explosion and respiratory hazards. In the correct proportions suspended grain dust can have more explosive power than a comparable amount of dynamite. Some individuals can be extremely sensitive to the substances found in the dust including microtoxins. See Attachment 16.

Grain Entrapment Rescue Tube (GERT) – A rescue device designed specifically for partial grain entrapment victim extrication. These are currently, several commercial sources of grain rescue tubes.

Grain Handling Standard (OSHA 29 CRF 1910.272) – An OSHA workplace safety and health standard containing requirements for the control of grain dust fires and explosions, and

certain other safety hazards associated with grain handling facilities. For example, it specifically forbids the "walking down" of grain within a bin or silo during unloading operations. A copy of the standard is included as Attachment 17 or it can be found at www.OSHA.gov.

Grain Retaining Wall (GRW) – A term used to describe a wall or coffer dam constructed around an individual that is partially entrapped in grain. The wall acts as a means to protect the partially entrapped victim from becoming covered by more grain and allows rescuers to evacuate the grain from within the protected space thereby freeing the entrapped victim. A grain rescue tube can be used for this purpose.

Grain Transport Vehicle (GTV) – Any vehicle used to transport free-flowing grain and feed including trucks, semi-trailers, gravity and hopper bottom wagons, railroad cars, and portable mixing vehicles and feed grinders.

Grain Vacuum Machine – A powered vacuum machine used to move grain pneumatically. These machines are used to remove residual grain from storage structures or open piles. They are increasingly found on larger farms to remove residual grain from bins. They have been used successfully to remove grain from around partially submerged victims. They have also been a contributing cause of both entrapments and suffocations when used inappropriately.

Gravity Wagon – A wagon designed to transport free-flowing grain that unloads using only the forces of gravity. These wagons, widely used to transport grain between the field and grain storage sites, can range in capacity from under 100 to nearly a 1,000 bushels. Due to the potential of engulfment and suffocation in grain flowing in or out of the wagons, children and workers should never be allowed to ride in empty gravity wagons or on top of loaded ones.

GFI – Ground-Fault Interrupter – An electrical circuit breaker that senses the difference between the electrical currents flowing through the hot and neutral wires of an AC circuit. When it senses a difference, it trips very rapidly (in about ten milliseconds) thus preventing a serious electrical shock if a person is touching an energized part of the circuit. GFIs are required by building codes in receptacles where water or moisture is likely to be present.

Guard – A device to protect a person from a hazard. There are three types of guards: shields, enclosures, and barriers. To prevent entanglement injuries, shields over belts and pulleys and PTO guards should always be replaced after removal for maintenance of the driveline.

Guards should be used over openings over in-floor grain augers to prevent workers from stepping into the opening and contacting the auger.

Heat Exhaustion – A physical condition caused by excessive heat and dehydration, with possible symptoms of moderately elevated temperature, weakness, nausea, dizziness, and profuse sweating. If a farm worker experiences the symptoms of heat exhaustion, he or she should immediately move to a cool area and drink cool liquids without caffeine or alcohol. The temperature inside a metal grain bin can be 10-20º higher than outside temperatures. Working for extended periods in a grain bin or a hot day can lead to heat exhaustion. See Attachment 18.

Heat Stress – a general term used to refer to the effect of heat on mental and physical well-being. See Heat Stroke and Heat Exhaustion. Heat stress on the farm often leads to general tiredness and can result in injuries due to the lack of alertness and ability to concentrate. Working inside metal grain bins on a hot day can lead to heat stress. See Attachment 18.

Heat Stroke – A physical condition caused by excessive heat and dehydration which prevents the body from regulating its temperature. Symptoms of heat strokes are high body temperature, lack of perspiration, disorientation, and in later stages, collapse, unconsciousness, and death. Any stage of heat stroke is an extremely dangerous condition and must be treated as quickly as possible by emergency medical personnel. Working inside of grain storage on hot days can cause heat stress. See Attachment 18 for the OSHA Fact Sheet – Protecting Workers from the Effects of Heat.

In-floor Auger – An auger installed under the floor of the grain storage structure. Grain drops through one or more openings in the floor onto the revolving in-floor auger for transport out of the bin. In-floor augers that are not guarded properly have been a significant source of leg and foot amputations when workers have stepped through the floor opening into the revolving auger.

In-flowing Grain – As grain flows towards the center floor openings in a bin or other grain storage structure it forms an inverted cone shape in the grain directly over the opening. As the bottom of the cone is lowered by removal of grain, the surface of the grain flows toward the center of the cone by gravity.

Liquefied Petroleum Gas (LPG) – A flammable mixture of hydrocarbon gases, including propane or butane, that is widely used as a fuel to dry grain. It is usually stored in large

quantities in white tanks at grain storage and processing facilities. The tanks are normally labeled to allow for easy identification of their contents.

Lockout/Tagout – A safe work practice that ensures that powered equipment cannot be intentionally or unintentionally energized by placing locks and warning tags on each power source. Each lock has only one key so that no one other than the worker who put the original lock on the control switch can remove it.

Microtoxins – Small particles of biological materials that are toxic to humans when inhaled. Microtoxins are comprised of mold spores, insect waste, and fine grain dust that becomes suspended in air when the grain is agitated and easily inhaled. Exposure to these materials can lead to serious respiratory distress. See Attachment 16.

Moisture Content (MC) – The amount of moisture within grain kernels. For example, grain is best stored when the MC does not exceed 14% of its weight in moisture. When grain is stored for long periods above 14% it will begin to spoil or go out of condition.

Mold – A living, biological material that grows on biological materials under the right conditions. If grain or feed is stored too wet, above 14%, and the temperature is in the appropriate range, mold can grow rapidly in the grain or feed producing billions of mold spores. These spores easily become airborne when the grain or feed is agitated. Some people are extremely hyper sensitive to exposure to mold. All workers should use respiratory protection when working around moldy agricultural materials. The growth of mold also causes grain and feed to become crusted or to lump together making it less likely to flow from the outlets.

NFPA – National Fire Protection Association (www.nfpa.org) The NFPA establishes fire protection standards and guidelines for other emergency management practices.

N-95 Dust Mask – A standard dusk mask used in the grain industry to remove airborne dust, molds, and microtoxins. A dusk mask rated at N-95 will remove 95% of most airborne dust. In dusty conditions, dust masks need to be replaced frequently to provide the necessary protection.

Out-of-Condition Grain – Grain that is stored at excessive moisture levels (more than 14%) for long periods will begin to spoil and form crusted masses of moldy and damaged grain. Out-of-condition grain is a significant contributor to flowing grain entrapments and engulfments.

OSHA – Occupational Safety and Health Administration An agency within the U.S. Department of Labor that establishes and enforces workplace safety and health regulations.

OSHA-Exempt Grain Facilities – OSHA exempt grain facilities are those operations that, generally, do not need to comply with OSHA 1910.272 Grain Handling Standards. These include farms, with 10 or fewer employees, feed lots and certain seed processing operations. For more details see Attachments 19, regarding exempt agricultural operations.

OSHA-Non-exempt Grain Facility – Any commercial grain storage, processing, or handling operation not specifically exempted by OSHA is a non-exempt grain facility and must comply with the provisions of OSHA 1910.272 and other relevant standards. For more details see Attachments 17 and 19.

Oxygen-Deficient – An environment where there is a lower concentration of oxygen than in the earth's atmosphere (less than 19%). Oxygen-deficient environments sometimes occur in manure pits, silos, fruit storage, and wet grain storage bins. This condition requires workers to wear a self-contained breathing apparatus or to properly ventilate the space prior to entry. Federal law restricts youth under the age of 16 from being employed to work in oxygen deficient structures. No one at agricultural operations, and under 18 in non-exempt settings should ever enter an oxygen deficient space without the proper training and appropriate personal protective equipment.

Personal Protective Equipment – PPE-equipment used to protect a workers body, such as hard hat, goggles, gloves, ear plugs, dust mask, etc. Chemical manufacturers publish material safety data sheets which instruct chemical handlers regarding the use of appropriate PPE. Employees at commercial grain storage and handling facilities are required to wear certain type of PPE. Employers are required to provide the required PPE and the appropriate training to use it.

Plug Flow – When the entire cross section of a column of grain is removed through the bottom opening it is called plug flow. In other words, the first grain loaded into the structure is the first grain out.

Portable Grain Auger – An auger typically mounted on wheels to allow for easy transport and movement from one bin to another. It can be raised and lowered to accommodate different height storage structures and comes in various lengths from 10-60'. Augers are common on most grain farms and commercial grain operations. They are a contributing factor to auger

entanglements (especially at the inlet) and electrocutions when they are moved into contact with overhead power lines.

Purdue Agricultural Confined Spaces Incident Data (PACSID) – A database of documented incidents involving deaths or injuries related to agricultural confined spaces. For recent summaries visit www.grainsafety.us or review Attachment 1.

Safety Glasses – Glasses that have been certified to meet safety standards for different work tasks, such as mixing chemicals, working in dusty environments, or operating grinding equipment. In environments where flying debris might enter the eyes, most employers require everyone in the production area to wear safety glasses. Agricultural workers should also wear safety glasses when performing tasks that could cause eye injuries. If safety glasses are required to safely perform the job, they must be provided by the employer.

Safety Ground – A means of providing added protection from electrical shock by the addition of a ground wire. Two-prong adapters should not be used on power tools because they bypass the safety ground and could cause electrocution of a worker. Only heavy duty grounded extension cords in good condition should be used around grain safety and handling facilities.

Safety Harness – A harness worn by a worker that is attached to a safety line that can, if properly used, reduce the risk of falls and entrapment. Specialized training is required to safely use a safety harness.

Safety Line – A rope that meets certain requirements for strength that is used to connect the safety harness of a worker to an appropriate anchor point or retrieval system. Not all ropes can be used as safety lines, only those that meet established specifications.

Silo – A grain or silage storage structure made of concrete or glass lined steel. These structures are sometimes called vertical or tower silos. Some silos can be over 100 feet tall and have the capacity to store tens of thousands bushels of grain.

Spontaneous Combustion – Self-ignition of a combustible material caused by the heat generated from a chemical reaction. Wet hay, wet grain, and silage can cause spontaneous combustion resulting in disastrous fires which can be extremely difficult to extinguish and actually smolder for many days. Workers should never enter a structure in which there is evidence of spontaneous combustion, such as elevated temperatures, smoke, steam, or the smell of burning material.

Stirrator Auger – A powered auger, typically mounted vertically in a grain bin to stir the grain during storage to maintain the desired moisture content and prevent spoilage. These augers are powered by electric motors and can cause entanglement.

Sweep Auger – A powered auger installed inside a circular grain storage structure to remove residual grain that cannot be removed by gravity. The auger can include its own motor or be installed on a power source located in the center of the structure. When energized, it rotates slowly around the structure "sweeping" grain towards the center opening in the floor. Current workplace safety regulations restrict access to the bin or storage structure when the sweep auger is operating. See Attachment 20 regarding OSHA interpretations regarding worker exposure to sweep augers.

Tank – A structure designed for grain storage that is often constructed of panels of mild steel welded together. Tanks with the capacity of several hundred thousand bushels of grain are used at some commercial grain operations.

Walking Down the Grain – A practice used to remove residual grain stuck to the inside bin walls and manually assist the flow of grain towards the floor openings. During this operation workers have historically entered the bin with the unloading equipment operating and circle the inside of the bin scraping the walls with a shovel or other tool and shoveling grain down the cone. This practice is specifically forbidden by OSHA 1910.272 due to the high risk of entrapment. Employees have the right to refuse to perform this hazardous task.

Wet Basis (WB) – This is a term used to describe the amount of water content (M.C.) of grain kernels using the assumption that all grain is made up of only moisture and dry matter.

Whistle Blower – An individual who reports an illegal act or situation to the appropriate regulatory or legal authority. The actions of a whistleblower are protected by law.

Most Frequently Asked Questions

The following questions and brief answers relate to entrapments, engulfments, entanglements, asphyxiations, falls, and electrocutions at grain/feed storage, handling, and processing facilities. Much of the material is used with permission from the Liberty Grain Rescue System© User's Manual, Edition 7, 9/11, and Edition 8, 8/13.

Grain Entrapment and Engulfment

1.1. What is the difference between a grain entrapment and a grain engulfment?

An entrapment occurs when a victim becomes buried in grain beyond the point of self-extrication, while an engulfment is an incident where the victim is completely buried or submerged beneath the surface of the grain. Approximately half of documented grain entrapments lead to engulfments, which in turn are almost always fatal.

1.2. Who are the most common victims of grain entrapments and engulfments?

Historically, approximately 70% of all documented victims of grain entrapment and engulfment have been farmers, farm employees, and farm family members. More recently, there has been a slightly growing percentage of victims who are employees of commercial grain storage and handling facilities. Almost all incidents have involved adult males, with the exception of suffocations in grain transport vehicles which have been predominately male children between the ages of 10 and 15. See Attachment 1 for additional details.

1.3. What types of grain have been involved in grain entrapments and engulfments?

Entrapments and engulfments have been documented in a wide variety of grains, including corn, soybeans, oats, wheat, flax seed, and canola. The majority (over 50%) of documented cases have involved corn.

1.4. Why are more cases of grain entrapments and engulfments documented in the Corn Belt than other regions of the country?

Entrapments and engulfments occur where most of the grain is grown and stored. Therefore, more cases are reported from states such as Indiana, Iowa, Illinois, Minnesota, and Ohio where there are large acreages of corn and soybeans, and substantial on-farm storage capacity. Because of storage issues related to corn, including the high humidity of the region, more cases have been documented in corn than in any other type of grain. Relatively few cases are seen in the upper Midwest or western states where the humidity is lower and more small grains, such as wheat, are grown.

1.5. Why do more entrapments occur on farms than in commercial operations?

The primary reason is that there are more farms that store grain than there are commercial grain storage operations in the U.S. The U.S. Department of Agriculture estimates that there are over 300,000 that store grain while there are only about 13-14,000 commercial grain storage operations. In addition, farmers have a greater risk due to a number of factors, including:

- Farmers tend to work alone and have no backup in the event of an entrapment.
- Farmers are generally not required to comply with federal confined space safety regulations.
- On-farm grain management practices may lead to more out-of-condition grain.

- Farmers handle less grain less often throughout the year that may lead to more mistakes and unsafe practices.
- Farms are also an extension of the family home which increases the risk for children to be present and be exposed to grain storage and handling facilities.

1.6. Why has Indiana documented more grain-related entrapments and engulfments than any other state?

Purdue University has been documenting grain entrapments and engulfments since the late 1960s. It is almost certain that some states that produce more grain, such as Illinois and Iowa, actually have had more incidents that remain undocumented. Indiana has more reported cases due to more aggressive data collection efforts. In 2010, for example, Illinois and Minnesota reported the most number of incidents. Better surveillance techniques, such as online searches, have helped make recent data collection more comprehensive.

1.7. What is the Purdue University Agricultural Confined Space Incident Database?

Purdue University began documenting cases of grain entrapment and engulfment in the late 1960's. This data was eventually entered into a computer database. In the 1990s the database was expanded to include incidents involving manure storage and handling facilities. Current efforts are underway to expand the database to include all types of agricultural-related confined spaces. Currently over 1,700 cases have been documented including over 1,100 in grain storage and handling facilities.

1.8. Is the problem of grain entrapments and engulfments getting worse?

Yes. Unlike most other types of agricultural fatalities and injuries, the number of documented grain-related entrapments and engulfments on farms and commercial facilities over the past 20 years has been gradually increasing. A new record for documented entrapments and engulfments occurred in 2010 with 59 individuals, of whom 50% died. Lower numbers of documented cases in 2011, 2012, and 2013 did not substantially modify the increasing trend of these incidents.

1.9. What is contributing to the increased number of documented grain-related entrapments and engulfments?

There are several factors that are contributing to more documented cases. These include:

- Better incident reporting by the media and governmental agencies.
- Increased crop yields due to new production practices and technology.
- Changing genetics of corn where the focus on yield has produced corn with more storage problems.
- Larger volumes of grain harvested, handled and stored.
- Larger capacity storage facilities on both farms and commercial facilities.

- Larger capacity handling systems.
- Increased cost of energy to dry grain that causes some grain producers to store inadequately dried grain (over 14%) for long durations.
- Climate conditions that have increased the amount of out-of-condition grain in storage.
- Aging storage facilities that fail to adequately protect the stored grain leading to spoilage and difficulty removing the grain from storage.
- New generation of employees who may not recognize the threats associated with grain storage and handling.

1.10. Why does out-of-condition grain contribute to an increased risk of entrapment?

Grain that has not been dried properly (to under 14% MC) will begin to spoil and form crusting or large clumps of grain glued together by the mold and spoiled material. This crusted material can prevent the grain from flowing freely and causes plugging at outlets. To regain flow through the outlets, workers will enter the grain storage structure and use long pipes to reach the outlet to break up the crusted material. This may expose them to crusted surfaces covering voids or sudden flows of grain that are nearly impossible to escape from (see www.grainquality.org). In addition, crusted material can stick to the walls of the storage structure. A worker who attempts to break the crust free from the wall from below can be buried under a sudden avalanche of grain.

1.11. How does corn genetics affect the risk of entrapment?

Current plant breeding efforts have been focused on improving yield or bushels per acre. The outcome has been, in some cases, very high yielding varieties that appear to demand greater levels of management and monitoring to maintain grain in good condition during storage. In other words, these newer varieties require greater care during drying to ensure storability and monitoring during storage to prevent spoilage.

1.12. Do OSHA workplace safety standards apply to on-farm grain storage?

Generally no. Grain storage structures located on farms, feedlots, and certain seed processing operations, are currently exempt from most OSHA safety rules. This exemption also covers feed storage structures. However, if the farmer operates a commercial grain storage facility, his employees are covered by the OSHA standards. In some cases, farmers with more than 11 employees or who provide migrant worker housing may also have to comply with OSHA workplace safety rules. Owners/operators of larger farms with more than 11 employees should contact their State Department of labor concerning their need for compliance. See Attachment 18 for additional information on the OSHA agricultural exemption language. In some cases such as the OSHA Grain Handling Standard (1910.272), the standard specifically exempts farms, feed lots and seed processing operations.

1.13. Are children or youth under 16 allowed to be employed in grain storage structures?

No. Under the Agricultural Hazardous Occupations Order, children and youth, under the age of 16 are prohibited from being assigned to work inside any confined space, including grain bins and silos (see OSHA Youth in Agriculture Fact Sheet). The children of farmers are, however, exempt from these restrictions. Under the provisions of the Fair labor Standards Act, a worker must be at least 18 to perform certain hazardous tasks including confined space entry. See attachments 2 and 11for additional resources on youth working in confined spaces.

1.14. What is meant by walking down the grain?

This once widely used practice consisted of putting one or more workers inside of a grain storage structure to clean crusted grain off the inside walls and to break up crusted grain to prevent plugging. It was also used to speed up the grain moving towards the center of the bin to fully use the unload capacity of unloading equipment. This practice is illegal under the OSHA Grain Handling Standard, (1910.272). No employer can require an employee to perform this task.

1.15. Are grain bins classified as confined spaces?

Yes and No. Technically, grain storage bins meet the criteria for being classified as a confined space. Under the current OSHA Standards, however, grain storage structures on farms are exempt from complying with the confined space standards. The same structures at a commercial facility or industrial setting are classified as confined spaces. Some courts have ruled that the intent of Congress when including the agricultural exemption was to exclude on-farm grain storage from the OSHA definition of a confined space.

1.16. How fast does it take to become engulfed in flowing grain?

Just seconds. With today's high volume grain handling equipment, a victim caught in a column of free flowing grain can be completely buried in less than a minute. A victim has little time to respond before escape becomes impossible.

1.17. What types of injuries do victims of grain entrapment and engulfment experience?

Most victims of full engulfment in grain die of asphyxiation due to ingestion of grain in the mouth, throat, and nose. Non-fatal injuries that have been documented include exposure to toxic dusts; hypothermia from long term exposure to chilled, wet grain; entanglements in unloading augers; impact injuries from being struck by falling chunks of grain or falls into the storage structure; and limb dislocations due to attempts by rescuers to pull victims from grain.

1.18. Can suffocations occur in grain transport vehicles?

Yes. There have been numerous cases of both entrapment and engulfments in gravity flow grain wagons, semi and straight grain trucks, and railroad cars. The overwhelming majority of these cases historically have been young boys. The average age of victims is between 11 and 12. The percentage of incidents that result in fatalities is higher than other grain-related cases.

1.19. How can the use of a grain vacuum machine lead to entrapment?

With the increased use of grain vacuum machines to handle grain, there have been cases documented in which the victim, using a hand held vacuum inlet pipe, was pulled into the grain and suffocated. This type of entrapment occurred when the inlet tube was placed near the feet and the grain was removed from underneath the victim. Within a few seconds the victim was pulled in beyond the point of escape. The vacuum unit is so powerful that it is difficult to choke or slow the flow, and some inlet tube assemblies are not equipped with a means to shut off the flow at the operator station. During a rescue attempt in which a grain vacuum machine is used, only those trained in its use should be allowed to operate it.

1.20. Can a life line and harness prevent entrapment or engulfment in flowing grain?

Yes and No. If used properly and attached to an adequate anchor point, a life line and harness used in conjunction with an outside observer provide important measures of safety. However, a life line and harness used without the other required prevention measures provide little protection. There have been numerous reported incidents in which the victim entered an unsafe situation alone, tied himself off with life line and harness, yet still became entrapped or suffocated. The only value of the life line was that it identified the location of the victim beneath the grain surface. Life lines require a second observer with the ability to maintain tension on the line while the user is inside the space. Even with a lifeline and harness no one should enter a bin from which grain is being removed from the bottom, when unloading equipment is operating, or where there is crusted material stuck to the walls of the bin above the worker.

1.21. Are there adequate anchor points on a typical farm grain storage bin to secure a lifeline or provide a rescue anchor point?

No. Almost all on-farm bins were designed to store grain, not to provide adequate anchors to meet the current confined space entry or fall protection regulations. Roof components or bin ladders are not designed to provide sufficient anchor points and could fail if overloaded. There are efforts underway to develop equipment to retro fit current grain storage structures to provide adequate anchor points. In some cases, trained first responders can rig adequate anchor points that are on the ground, outside the structure. There have been documented cases in which the victim tied himself off to an internal or external bin ladder as an anchor point. The forces, however, of the grain flow were so great that the ladder mounting bolts failed and pulled the ladder into the grain along with the victim.

1.22. Is the air inside a typical grain storage structure toxic?

Most often, no. Grain that is properly dried and stored does not produce toxic gases. The exception would be where grain has been stored too wet, above 14% moisture content, and carbon dioxide is released as the grain ferments and spoils. This is less likely during cold weather due to the decomposition process being much slower. Wet storage bins used to increase the capacity of grain drying systems can also have carbon dioxide present if the grain is allowed to stay in the bin too long. As the OSHA standards require, if there is any doubt about the air quality in an agricultural confined space, the air should be tested prior to entry without a self-

contained breathing apparatus. Under the OSHA Grain Handling Standard, atmospheric testing is not mandatory for bin entry.

1.23. Is the dust in a grain bin toxic?

Yes and No. Grain dust is not considered toxic to most people but can cause respiratory distress, especially if the dust contains mold spores or other biological agents. Some molds, however, found in grain are considered toxic to both humans and animals. If there are high levels of dust in suspension, the use of respiratory protection is strongly recommended (see www.grainquality.org).Attachment 15 includes an OSHA Fact Sheet on grain dust and a resource on health effects of grain dust.

1.24. Why do such a large percentage of grain entrapment victims end up suffocating?

Many of the documented incidents indicate that the majority of victims were working alone at the time of entrapment or that the observer was so far from the controls that the unloading process could not be shut off quickly enough to prevent complete engulfment. Once caught in the flow of grain it takes only seconds until self-extrication becomes impossible. Grain can easily enter the nose and mouth resulting in asphyxiation.

1.25. Can engulfment occur outside of a storage structure?

Yes. Cases have been documented in free standing piles of stored grain and where storage structures have failed, allowing grain to avalanche out covering nearby workers. Workers have been buried and suffocated beneath bin access doors, not realizing that there was still caked or free flowing grain in the structure. When the access door was removed, the material flowed out and covered the victim.

1.26. Why are grain entrapments and rescue techniques currently being studied?

Prior studies conducted by Purdue University's Agricultural Safety and Health Program (PUASHP) have identified a gap in the research related to safe grain handling, transport, and storage, as well as rescue strategies. For over 30 years, data have been collected and over 1,100 cases of grain entrapments and engulfments have been documented. The overall objective is to identify the hazards associated with grain handling, transport, and storage, and reduce the associated risks through education efforts for farmers and commercial grain handlers and training for first responders. Research findings are also used to provide assistance to the grain industry in formulating engineering standards and to government agencies for regulatory issues.

1.27. How does the agricultural industry compare to other industries, in terms of fatalities?

Agriculture has the highest death rate, with 29 fatalities per 100,000 workers (National Safety Council *Injury Facts*, 2012 Edition). This is ten times higher than the fatality rate for all other industries. While most industries have experienced a declining trend with respect to their fatality rate, agriculture has remained fairly constant, and has been consistently ranked as one of the top three most hazardous occupations.

1.28. How do grain engulfments and entrapments compare to other agricultural incidents?

Grain entrapments and engulfments account for only a small percentage of on-farm incidents. For example, there were 198 documented on-farm fatalities in Indiana between 2000 and 2009. Tractor incidents accounted for 86 fatalities (43.4%), while grain engulfments and entrapments accounted for nine fatalities (4.5%). The Ohio Commission on the Prevention of Injury reported that from 1993 to 2002, there were 250 documented fatalities in Ohio. Tractors incidents accounted for 147 fatalities (58.8%), while grain bins and grain wagons accounted for 10 fatalities (4%). It is likely that the number of non-fatal grain-related incidents is 20%-30% higher, since many incidents go unreported when self-extrication is possible, but the number is still a small fraction of the total number of agricultural incidents. And while the overall trend of on-farm fatalities is decreasing, grain related fatalities have been increasing. Currently, it is estimated that less than 5% of all farm-related fatalities involved suffocation, asphyxiation or entanglement in agricultural confined spaces.

1.29. Can on-farm grain storage structures be easily retrofitted to be in compliance with the current OSHA standards?

Generally, no. The overwhelming majority of on-farm grain storage structures were designed and fabricated prior to the implementation of the OSHA standards, or without consideration to the OSHA standards (1910.272 and 1919.146). The cost of meeting the current standards that apply to commercial (non-exempt) facilities would be significant or prohibitive under the current grain marketing system that farmers are required to use. Many older structures would have to be removed from service due to the lack of adequate anchor points, lock out – tag out provisions, and lack of fall protection on ladders. The biggest barriers would be the need for confined space entry training, acquisition of required personal protective equipment, access to air monitoring equipment and additional trained personnel to provide external support during access to the structures.

1.30. What is being done to enhance the safety of grain storage structures found on both exempt and non-exempt operations?

The American Society of Agricultural and Biological Engineering is in the process of developing engineering design standards that should make future grain storage structures safer to use and avoid the need for accessing them. Research is being conducted to reduce the probability of grain going out of condition further reducing the need to access the grain storage space. In addition, alternative means of removing residual grain are being developed that should reduce worker exposure to exposed augers.

2. Grain Rescue Strategies

2.1. Where is an entrapment or engulfment victim most likely to be located in the grain mass?

In most cases the victim, even if fully submerged, will be located directly below the center of the funnel shaped surface of the grain or directly over the outlet from which grain was being drawn at the time of entrapment. If the grain flow duration is longer than a few minutes it is very

unlikely that the victim will be near the surface of the grain. In most cases there is no need to probe for the victim since his or her position can be closely estimated.

2.2. Why is it important for first responders not to enter a structure immediately upon arrival at the scene if the victim is partially buried?

The victim will usually be at the bottom of the inverted cone formed in the grain surface directly over the outlet in the floor. He will be well below the upper levels of surrounding grain. In some larger bins there can be 10 or more feet of grain, above the victim, standing at the angle of repose. Entering the structure can cause the higher grain along the bin walls to cascade toward the center of the bin and possibly cover the victim or bury him more deeply in the grain. There are documented cases of first responders causing grain flows that have fully engulfed partially buried victims.

2.3. If a victim is fully engulfed, should it be assumed that a fatality has occurred and the process of recovering the body should begin?

No. Fully engulfed victims have been known to survive for a few hours – especially when there were air pockets between spoiled clumps of grain or the victim was able to cover his mouth and nose. This scenario, however, is very rare. In a recent case a victim survived for several hours under the surface of the grain because he was wearing a full face air filtration system that kept grain out of his airway. Rescue efforts should continue until the status of the victim can be confirmed.

2.4. Will the weight of the grain on a partially entrapped victim prevent him from breathing?

Generally, no. It is not the pressure of the grain on the victim that suffocates the victim, but rather the grain that obstructs his air way. However, fully and partially buried victims have reported feeling the increased pressure of rescuers walking on the grain surface above them, which is another reason to minimize the number of rescuers on the grain surface. Cases have been reported in which large masses of spoiled or frozen grain have fallen on individuals, causing injury.

Victims may report having difficulty breathing which may be caused by pressure, exposure to excessive amounts of dust, and high levels of anxiety.

The belief that the pressure of the grain can cause suffocation and physical injury may stem from the observations that fatality victims of engulfment may have skin deformation caused by the kernels of grain pressing against the skin following death.

2.5. Why can't the main access door in the bin, at ground level, be opened to let the grain out quickly?

The typical grain bin has a two part door system that includes an outside door that opens outward and an inside door that swings in. The outside door can be easily opened by opening the outside latch. The inside door cannot be opened if there is grain in the bin because of the grain against

the door. Even if the door could be opened or cut, the rapid uneven flow of grain out of the opening could cause the bin to become unstable and collapse.

2.6. Is it safe to open the outside door of a grain bin?

Not always. If someone forgot to close the inside door before filling the bin, grain will rapidly flow out of the bin and engulf anyone near the door. Fatalities have been documented in such circumstances. If the outside door is bulging out or grain is leaking out around the edges, the area should be secured and efforts made to remove the grain from the structure. It is also possible for a victim to be buried beneath an inspection door on a hopper bottom bin if the door is removed with grain still inside the bin.

2.7. What are the most serious hazards to first responders at the scene of a grain entrapment?

A variety of injuries have been documented to first responders involved with a grain storage rescue including: falls from bin, over exertion, allergic response to airborne mold spores and dust, over heating due to the higher temperatures that can develop inside the bin, and being run over by equipment being used to remove evacuated grain from around the bin. There have been a few documented cases in which first responders have become entrapped in grain during victim recovery efforts.

2.8. Should the unloading system of a grain storage structure be used to free a victim?

No. Turning on the unloading auger or opening the bottom openings will cause the victim to be drawn deeper into the grain mass. Extrication, in most cases, involves removing the grain from around the victim. The unloading system controls should be locked out in the event of an entrapment.

2.9. Can there be elevated carbon dioxide (CO2) levels inside a wet holding bin?

Yes. As unconditioned corn with more than 14-16% moisture content begins to spoil, it releases carbon dioxide that can accumulate above the surface of grain. In some cases, levels of CO_2 have been documented above what is considered safe without self-contained breathing apparatuses (SCBA). If there is any doubt regarding the air quality inside the bin, it should be tested prior to entry so the appropriate personal protection equipment can be used.

2.10. Why should the aeration or drier fans be turned on during a rescue?

Turning on the aeration fan during a rescue will provide an air flow to a victim that may be completely buried and contribute to better air quality inside the bin for rescuers. If the outside temperature is high, the inside temperature will be even hotter. Air movement through the bin will also help reduce the inside temperature, reducing the risk of heat stress of first responders. In some cases where there is a lot of broken and dirty grain, turning on the aeration fan can increase the amount of suspended dust inside the bin. Respiratory protection should be available for all first responders at the scene.

2.11. Why can't a partially entrapped victim be easily dug out of the grain?

First, the amount of grain that needs to be removed to free a victim is substantial and requires large capacity grain handling equipment such as a gain vacuum machine. Second, the nature of grain to free flow makes it nearly impossible to keep it from flowing back onto the victim without some form of barrier such as a coffer dam. Rarely, has a partially entrapped victim been extricated by digging them out regardless of the number of personnel involved.

2.12. What is a grain rescue device or tube?

Historically, it has been found that building a grain retaining wall or coffer dam around the victim and then removing the grain from within the remaining space is an effective rescue strategy. In the past, pieces of plywood, back boards, garbage cans and barrels with the bottom removed, and other items have been used successfully to protect the victim from back flowing grain. Currently there are several commercially available grain rescue tubes that have been demonstrated to be effective extrication tools for partially entrapped victims.

3. Grain Entrapment Prevention Measures

3.1. What are the most effective strategies to prevent grain-related entrapments and engulfments?

First, the most important measure to prevent grain entrapments is proper grain management. Grain that is stored at the correct moisture content, 14% or less for long term storage, and is protected from the elements remains in good condition and is easier to remove from the storage structure without plugging. There is a direct correlation between out-of-condition grain and the increased probability of entrapment. Other important prevention strategies include:

- Never entering a storage structure while it is being unloaded.
- Never entering a grain storage structure without an outside observer or before letting others know of your plans (use of entry permit).
- Utilizing lockout/tag out procedures to ensure unloading equipment is not intentionally or unintentionally energized while someone is inside the structure.
- Clearly posting warning signage communicating the potential for engulfment at each access point.
- Always having a working radio or cell phone when working alone or when performing hazardous tasks around grain storage. In some cases, cell phones will not function inside a metal grain bin.
- Implementing a policy that all grain storage structures, open piles of grain, and grain transport vehicles are off limits to children, visitors, and non-essential employees.

3.2. Why are farms and feedlots exempt from the OSHA Grain Handling Standards?

There are two reasons: political and economic. When the standards were drafted by the U.S. Congress, language was incorporated to exempt farmers, feedlot owners, and certain other agricultural production sites to reduce opposition to the passage of the legislation. Second, the tremendous cost of bringing the hundreds of thousands of on-farm grain storage structures into compliance with the current requirements of the standard would fundamentally force a change in the way agricultural production is carried out and how the prices of crops are determined. It may not be economically possible to make the changes needed for compliance without substantial financial investments that are not included into the cost of production.

3.3. Where can I get more information on effective stored grain management practices?

The first place to look is the local County Extension Office, which has access to grain management resources from across the country. Manufacturers of grain storage systems are also an important resource, along with neighbors who have documented their ability to successfully store grain. There are also websites such as www.grainquality.org that provide helpful information.

3.4. What grain storage structure design features can contribute to reducing the probability of grain spoilage and entrapments?

- Use of stirrators to mix the grain.
- Temperature monitors to detect grain heating, a sign of spoilage and insect infestation.
- Installation of vents on roofs away from the direction of prevailing winds.
- Sound roof with overhanging eves that prevent rain and snow from blowing in.
- Weather seals on doors, hatches, and other access points.
- Maintaining a weather proof seal around the base of the bin.
- Installation of inside ladders.
- Warning decals posted at all access points.
- Cleaning the structure every time it is emptied to reduce the likelihood of passing along mold and insect contamination to the next crop.

3.5. How can the practice of "coring the bin" enhance grain quality and save lives?

Coring the bin is a management practice that involves removing a load or two of grain from the structure once it has been filled to remove dusts, fines, and broken corn that tends to accumulate in the center of the bin during filling. This damaged material tends to attract insects and more readily absorbs moisture, leading to spoilage, crusting, and plugging the flow. By removing this material the quality of the grain is enhanced and the risk of entrapment is reduced.

3.6. Will a rope or chain hanging from the center of the storage structure provide adequate protection in the event of an entrapment?

In most, cases no. The speed of entrapment is so fast that it is highly unlikely that a worker in the bin has the instincts to grab a safety line quickly enough. Second, the use of these devices may lead to greater risk taking on the assumption that if a problem occurs, there is always the safety line to fall back on. Finally, past incidents have documented that the draft and the down pressure on an engulfed victim is so great that the roof or bin ladder would probably fail under the load. In nearly all current on-farm storage bins there is not an adequate anchor point to support the weight of an engulfed victim. The key is to stay out of bins during unloading operations or when crusted grain surfaces are present.

3.7. Why are grain transport vehicles so dangerous to children?

Each year a small number of children, nearly all boys ages 10-12, are suffocated while inside a transport vehicle of some type. Most of these incidents involve gravity flow grain wagons and carts and straight grain trucks. The children are allowed to ride in these vehicles either empty or full, and are entrapped and suffocated when they are covered by grain being loaded or unloaded. Children should be prohibited from riding on loads of grain or being transported in empty grain transport vehicles.

3.8. Where can I get more information on grain handling safety?

One of the best sources is the local County Extension Office that has access to safety resources from across the Land Grant System. There are also websites such as www.grainsafety.us, www.eXtension.org, http://www.ydae.purdue.edu/tractor/default.htm, and www.grainentrapmentprevention.com that contain helpful information. For additional information on rescue from grain engulfments and responding to other agricultural emergencies consider reviewing the following resources:

1. Responding to Agricultural Emergencies. NRAES-10, Cornell University, Ithaca, NY. 1999. Available from HOBAR Publications (1-800-846-7027).
2. Rural Rescue and Emergency Care. American Academy of Orthopedic Surgeons, Rosemont, IL. 1993.
3. Don’t Go With the Flow, National Grain and Feed Association, Washington, D.C. 1992. (www.ngfa.com).
4. www.grainquality.org (Purdue University website that includes a PowerPoint presentation on grain handling safety).
5. www.grainsafety.us (Purdue University website that directs to www.grainquality.org).
6. www.grainentrapmentprevention.com

4. Questions Related to Young and Beginning Workers

4.1 How old must a youth be to work in a confined space?

It depends. There are no restrictions if the youth is the child or dependent of a farmer. A worker employed on a farm must be at least 16 to be assigned to enter a silo or grain bin. At an OSHA non-exempt grain operation, the worker should be at least 18 to work inside a grain storage structure.

4.2 Can a young or beginning worker refuse to perform a task that he or she is not trained to perform?

Yes. If a worker is assigned to perform a task that he or she considers dangerous, the worker has a right to say no, especially if no training has been provided.

4.3 Does a young or beginning worker have the right to file a complaint about unsafe working conditions without fear of discrimination?

Yes, the OSHA regulations provide clear protections for all workers to file a complaint about unsafe working conditions with the state or federal OSHA office without fear of losing their job or being discriminated against.

4.4 Do young and beginning workers have to provide the necessary personal protective equipment to perform an assigned task safely?

No. If a worker is assigned to perform a task considered hazardous, his or her employer is required to provide the necessary personal protective equipment without cost.

4.5 Because a young worker may be the smallest employee at the site, does that mean he or she can be assigned to enter a confined or limited access space?

No. A worker should not be assigned a task based up on his or her physical size. Only employee with the required training and equipped with the appropriate personal protective equipment should be assigned to perform tasks that are known to be hazardous.

4.6 What should be the first response of a young or beginner worker in the event of an injury or other emergency?

The first response should be to call his or her supervisor for assistance. If the supervisor cannot be reached, a call should be made to 911 to seek emergency assistance. Other responses include:

- Evacuating from the hazard
- Shutting down equipment when it is safe to do so

4.7 Why is regular supervision important for young and beginning workers?

No young employee can be expected to perform all the assigned tasks without adequate training or supervision. These employees do not have the skills or maturity to appropriately respond to

every circumstance that may develop. Having good communications with the supervisor by means of cell phone or radio can reduce the risk of unsafe decisions.

Case Studies

Actual case studies are an effective way to communicate important concepts to students. Each of the PowerPoint presentations contains at least one case study that attempts to drive home the serious consequences of unsafe work practices or the lack of supervision over young workers at grain storage and handling facilities. The following five case studies are based on actual events with details changed to protect the identity of those involved. After each case study there are three probing questions. As time allows, read the brief narrative of what was reported from each incident and ask the students to discuss the questions. The goal is to have them remember what could happen if they ever faced a similar situation.

Case Study #1

Boy dies in fall from grain bin

Rural Daily News

Paris – A farming accident Thursday evening claimed the life of a 15-year old boy here.

Jacob Herman, 1234 Old Anson Road, died at about 5:00 p.m. Thursday, according to reports.

Herman died as a result of a fall from the roof of a grain bin on the family farm, according to a report by Sherman County Coroner, Michael Barber.

Herman was apparently working on the top of the grain bin, according to coroner's reports, opening the roof hatch in preparation for the placement of a grain auger at the bin. He fell approximately 22 feet to his death, reports states.

Herman was found by a fellow employee who notified 911 at 6:00 p.m. Sherman County Sherriff's Department and the Paris Volunteer Fire Department were notified at 6:03 p.m. EMS personnel arrived on the scene at approximately 6:15 p.m., and called for the coroner at 6:20 p.m.

According to Barber, Herman was dead when medics arrived at the scene, although he may have not died immediately. "He suffered massive skull fractures and numerous internal injuries."

Barber ruled that the death was accidental.

Discussion Questions

1. How many of you have been asked to work at the top of a silo, grain bin, or other tall structure?
2. Based upon your knowledge of the design of roofs found on typical grain bin, what factors might have contributed to Jacob Herman's fall?
3. Is every 15 year old comfortable climbing on tall agricultural structures? If a young worker is uncomfortable with heights, should he or she be asked to work on these structures? Does the Agricultural Hazardous Occupations Order allow youth under the age of 16 to be assigned to work on the roof of a grain bin?

Case Study #2

Boy dies in load of corn

Rural Daily News

Fly Creek – Lewis Sinclair, age 10, became buried and suffocated in a wagon load of corn being unloaded at his parent's farm north of Fly Creek. His father, Fred Sinclair, had put his son on the top of the load of corn so that he would know where he was. The senior Sinclair then proceeded to unload the corn into a PTO-operated auger that fed the corn into one of the farm's storage bins. He was completely unaware that his son had been drawn into the flow of exiting grain until part of the boy's body became visible at the outlet.

Emergency response personnel from the Fly Creek Fire Department were called using Sinclair's cell phone and first-responders arrived within minutes. The wagon was pulled on its side to empty the wagon and recover the boy. Efforts to resuscitate the boy were unsuccessful and he was pronounced dead at the scene by County Medical Examiner, Clette Horowitz. The cause of death was possible asphyxiation due to the corn kernels blocking the boy's airways.

Discussion Questions:

1. How many of you, when younger, played on a load of grain or in a grain storage structure?
2. Is anyone able to explain how the boy went from the top of the load to being stuck in the outlet? Why did it happen so fast?
3. What simple rule could have prevented this young boy's death?
4. Why is having a cell phone while working on a farm an important safety measure?

Case Study #3

Teen successfully rescued from grain bin

Farm Country Daily News

Morris – Nineteen year-old Clarence Jones looked death in the face this past Wednesday morning and survived. Jones was scrapping crusted grain with a shovel from the wall of an 18,000 bushel grain bin at the Otsego County Elevator. While inside, an employee of Elmer's Trucking arrived to fill a semi with corn being stored in the bin. Assuming no one was in the bin, Paul Stevens, the truck driver, engaged the unloading auger and began filling the truck.

When Stevens heard Jones' cries for help he immediately shut off the auger and climbed the bin ladder to find Jones buried up to his chin in corn. He climbed back down and used his truck radio to call the Otsego County Emergency Dispatcher. Rescue and fire units from Morris, Lakeview, Wooster, and Hyde Park responded to the scene.

Using metal cutting power saws, openings were cut around the base of the bin to allow the grain to drain from the bin. One rescue worker entered the bin and provided Jones with an oxygen mask and portable tank of oxygen. Chief Ingalls of the Morris Fire Department estimated that rescuers had to manually move over 2,000 bushels of grain away from the base of the bin. Crews worked in shifts and a small skid steer loader was brought to the scene to assist.

It took over 2 hours from the time that first-responders arrived at the scene to free Jones from the grain. He was removed through a door on the bottom of the bin and transported to St. Luke's for observation. Two fire fighters were treated at the scene for heat exhaustion and unknown injuries from a fall.

According to Dennis Bean, Extension Safety Specialist, this was the third case of grain bin entrapment in the state since the beginning of the year. He noted that most people, especially younger workers, are not aware of how fast a person can become engulfed in flowing grain. Once the person is buried above his or her knees, it is almost impossible to escape on their own. No charges were pending against the truck driver, but OSHA staff were at the scene investigating the incident.

Discussion Questions:

1. Is anyone familiar with the term walking down the grain? Does everyone know that it is illegal to assign anyone to work in a grain bin while it is being unloaded?

2. How could the use of lock-out procedures had prevented Clarence's entrapment? What should the truck driver have done before starting the auger?
3. Have you ever considered the risks to first-responders who are called to the scene of a serious, or life threatening event? In this case one experienced heat exhaustion and another was injured due to a fall.

Case Study #4

Two brothers electrocuted at local elevator

Gearing Up Daily News

Greenbush – Horace and Elisha Hostettler, ages 17 and 20 respectively, of rural Greenbush were killed instantly when the auger they were moving came into contact with a 7,200-volt power line that ran between the grain storage facility they were working at and State Road 18. The high voltage also set the tires of the auger on fire causing the high grass around the bins to burn.

Members of the Greenbush Fire-Rescue Service had the grim task of removing the bodies that had been burned beyond recognition. The local electric cooperative that serviced the facility had to disconnect the electric service to allow rescue workers to reach the victims. Captain Jonathan Edward indicated that both men were most likely in contact with the metal portion of the auger when it made contact with the power line. With that much voltage it was unlikely that either could have survived.

Discussion Questions:

1. Who knows whether or not power lines that serve farms and local rural businesses are insulated to prevent electrocution in the vent of unintentional contact? Why is this information important to know?
2. Why are there overhead power lines found so often in close proximity to grain storage structures?
3. What could the Hostettler brothers had done to reduce the risk of contacting the power lines?

Case Study #5

Heat blamed in farmer's death

Farmland Daily News

Lafayette – Robert King, an 18 year-old farm worker of 12456 W. County Line Road, died at 3:00 p.m. Saturday in Lafayette Memorial Hospital after an apparent heat stroke Friday while removing residual grain from a steel grain bin. The outside temperature at the time was approaching 95°.

King was working with his father Martin King when he began to suffer the symptoms of heat exhaustion. King continued to work until he suffered from the heat induced stroke.

Martin King rushed to his son's aid but was unprepared as to how to care for his ailing son. "I didn't know what to do," King said, "I rushed over to him and tried to comfort him." I had never seen anyone experiencing heat stroke before. "I felt completely helpless."

Martin then proceeded to call for help using his cellular phone. Lafayette Fire and Rescue rushed to the scene to transport King to the hospital where he died.

"The heat takes too many lives each year. People just don't realize the danger they face when they work in this intense heat," stated Dr. Norman Ricketts of Lafayette Memorial Hospital. "If you are working out in the field or inside grain bins take plenty of fluids and rest in a shady area often." Dr. Ricketts estimated that the temperature inside the bin could had been 10-20° hotter than the outside temperature.

Discussion Questions:

1. Has anyone in the class ever experienced the effects of excessive heat exposure or heat exhaustion? What are the symptoms?
2. What alternatives could Mr. King had considered that might have prevented his son's death?
3. What should the immediate step be if you observe someone exhibiting symptoms of heat stress? If you don't know, do you know who to call?

Documentation of Worker Training

There's an old saying in the safety profession that goes "If you didn't document the training, you didn't do it." With respect to meeting not only the OSHA training requirements, but also the moral obligation to properly train young and beginning workers, adequate documentations is

essential. At the completion of each instructional unit it is strongly suggested that every participant sign an attendance record to use as a record of training. This record can be used during an OSHA inspection to confirm that training has been accomplished and to keep track has been accomplished and to keep track of employees who may not have received the training due to absence from work. Included as Attachment 21 is a sample attendance record form.

It is also encouraged that for high risk tasks such as auger operation or accessing grain storage structures that documentation of special training be maintained. Included as Attachments 22 and 23 are two sample record forms that can be modified as needed.

References

1. _____ Liberty Grain Rescue System® User's Manual 2013. www.libertyrescuesystems.com
2. Kingman, D.M., G.R. Deboy, and W.E. Field. Contributing factors to engulfments in on-farm grain storage bins: 1980 through 2004. Journal of AgroMedicine. 2003; 9(1):39-63.
3. Freeman, S.A., K.W. Kelley, D.E. Maier, and W.E. Field. Entrapments in bulk agricultural materials at commercial grain facilities. Journal of Safety Research, 29(2):123-124. 1996.
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7. Kelly, K.W. and W.E. Field. Characteristics of flowing grain-related entrapments and suffocations with emphasis on grain transport vehicles. Journal of Agricultural Safety and Health. 2(3):133-145, 1996.
8. Don't Go With the Flow, National Grain and Feed Association, Washington, D.C. 1992. (www.ngfa.com).
9. Responding to Agricultural Emergencies. NRAES-10, Cornell University, Ithaca, NY. 1999.

Attachment 8 is a comprehensive list of supplemental resources related to the problem of entrapments, engulfments, entanglements, asphyxiations, falls, and electrocutions at grain storage, handling, and processing facilities. The list is provided for those who desire to dig much

deeper into the subject matter. There is also considerable information on the Internet that can be easily located by searching terms such as “grain safety”, “grain entrapment”, and “grain rescue”.

Attachments

There are several attachments included that may be freely downloaded and/or reproduced for use in conducting the *Against the Grain* training. Many of the attachments are printed documents that are formatted to be easily downloaded. Appropriate acknowledgement of their source should be included with any reproduction and distribution of these materials. They may be modified to accommodate local needs or training resources. However, under the provisions of the U.S. Department of Labor’s Susan Harwood Grant Program (Grant No. SH24885-SH3), these materials cannot be used or duplicated for commercial or for-profit purposes. For questions concerning the use of these materials, contact William E. Field, Professor, Purdue University, Department of Agricultural and Biological Engineering, West Lafayette, IN 47907 (field@purdue.edu), or 765-494-1191.

The complete text of this Instructor’s Guide will be archived at www.grainsafety.us, and www.agconfinedspaces.org (http://www.ydae.purdue.edu/tractor/). It is anticipated that any updates or modifications will be made available at that site.

List of Attachments

PowerPoints

#1 Against the Grain – Orientation

#2 Against the Grain – Confined Spaces in Agriculture

#3 Against the Grain – Summary of Grain-related Incident Involving Youth

#4 Against the Grain – Working Safely Around Grain Storage and Handling Facilities

#5 Against the Grain – Emergency Response for Youth and Beginning Workers

Attachment 1

2013 Summary of U.S. Agricultural Confined Space-Related Injuries and Fatalities

Attachment 2

Agricultural Hazardous Occupations Order

Attachment 3

Recommended Pre-test – Reproducible Master

Attachment 4

Recommended Post-test – Reproducible Master

Attachment 5

Pre- and Post-test Key

Attachment 6

Blank Certificate of Completion

Attachment 7

Suggested Participation Evaluation Tool

Attachment 8

List of Supplemental Resources

Attachment 9

Suffocation Hazards in Flowing Grain – Reproducible Master

Attachment 10

OSHA Grain Safely Hazard Alert – Worker Entry into Grain Storage Bins and Safety and Health Topics – Reproducible Master

Attachment 11

OSHA Youth in Agriculture Fact Sheet – Reproducible Master

Attachment 12

How to File a Complaint with OSHA – Reproducible Master

Attachment 13

List of Agricultural Confined Spaces – Reproducible Master

Attachment 14

OSHA Confined Space Entry Standard (28 CFR 1910.146)

Attachment 15

OSHA Fact Sheet – Hazard Alert: Combustible Dust Explosions – Reproducible Master

Attachment 16

Human Health Concerns from Grain Dusts and Mold During Harvest

Attachment 17

OSHA Grain Handling Standard (28 CFR 1910.272)

Attachment 18

OSHA Fact Sheet – Protecting Workers from the Effects of Heat

Attachment 19

OSHA Interpretations Regarding Exempt Agricultural Operations – Reproducible Master

Attachment 20

OSHA Interpretations Regarding Worker Exposure to Sweep Augers

Attachment 21

Documentation of Worker Training

Attachment 22

Example Worker Participiation Record for Accessing Grain Storage Structures Training

Attachment 23

Example Worker Participation Record for Operating Grain Auger Training