

Basic First Responder Training Curriculum for Incidents Involving Grain Storage, Processing, and Handling Facilities

INSTRUCTOR GUIDE



Developed by
Purdue University
Agricultural Safety & Health Program
Department of Agricultural & Biological Engineering
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PowerPoint Presentations

- Train-the-Trainer Overview Used only with Train-the-Trainer class
- Introduction - Pre-Testing - Training Overview
- Unit 1 - Confined Spaces in Agriculture
- Unit 2 - Summary of Emergencies at Grain Storage and Handling Facilities
- Unit 3 - Preplanning/Training/Rescue Equipment for Emergencies at Grain Storage and Handling Facilities
- Unit 4 - Emergency Response Strategies for Incidents at Grain Storage and Handling Facilities
- Unit 5 - Introduction to Demonstrations and Hands-on Training Activities

Grain Bin Safety Video

- Short Version
- Long Version

Disclaimer

The contents of this Instructor Guide, including methods, recommendations, and interpretations of existing workplace health and safety standards and practices are presented solely for educational purposes. The authors and Purdue University make no claims concerning the effectiveness of any method or procedure in any specific circumstances, and assume no liability whatsoever for any loss or damage that may result from the use of any information contained in this publication. In cases where legal interpretation is uncertain, legal advice should be sought. Use of the contents of this publication is solely at the risk of the user.

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Introduction

During the past few years there has been an increased level of interest in the safety of grain storage and handling operations. This interest has been stimulated by the record number of grain related entrapments and engulfments documented in 2010, several high profile incidents such as the one in Mt. Carroll, IL that took the lives of two teenage boys, increased enforcement efforts by OSHA, and the higher than usual amount of media attention given to the problem.

With respect to relative risks, the probability of an entrapment, engulfment, asphyxiation, entanglement, fall, or electrocution occurring at a grain storage or handling facility is very low. This is not to say that the resulting deaths and injuries are not important, but in a resource limited environment, there are other workplace health and safety issues that may arise more often and may demand higher attention. Consequently, the resources invested on enhancing worker safety at these facilities need to be targeted where the potential for returns is the greatest. It is firmly 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, including both those designated as non-exempt under the current OSHA standards and those that are considered exempt, specifically those located on farms, feedlots, and certain seed processing operations. If carefully analyzed, every entrapment, engulfment, asphyxiation, entanglement, fall, or electrocution could have been prevented if the appropriate intervention measures had been known and taken. Maintaining a corporate culture of safety, adoption of general workplace safety practices, continuing worker training, incorporation of state-of-the-art safety design features and compliance with current OSHA workplace safety and health standards would go a long way in reducing the need for substantial investments in first responder training.

The reality is, however, the human element is highly unpredictable in specific circumstances and consequently, there will always be the probability that emergency situations will occur. The current climate provides a “teachable moment” or window of opportunity to further enhance the capacity of emergency first responders to more effectively and safely respond to the most probable emergencies at grain storage and handling operations. This resource is designed to be used as a tool to assist fire/rescue instructors to conduct basic first responder classes, generate greater awareness of the hazards associated with grain storage and handling rescue situations, and reinforce the need for specialized response capabilities.

Fair Use of the Curriculum

Development and testing of this curriculum was made possible by funding from the Occupational Safety and Health Administration, U.S. Department of Labor. Under the provisions of the grant, the contents are for public use and can only be used for non-profit purposes. The repackaging of this material, either by print or electronic means, for the purpose of selling it for profit is prohibited.

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. It is anticipated that any updates or modifications will be made available at that site.

Purpose of Instructor Training

This Instructor Guide is designed for use in equipping qualified emergency response/fire-rescue instructors who desire to teach the Basic First Responder Training Curriculum for Incidents Involving Grain Storage and Handling Facilities (Basic First Responder Training). The Basic First Responder Training provides a basic or awareness-level training for first responders on safely and effectively responding to entrapments, engulfments, asphyxiation, entanglements, falls, and electrocutions at grain storage and handling facilities. The Instructor's Guide includes the instructional tools needed to plan and conduct training including an evidence-based curriculum and supporting visuals that have been field tested to provide content at primarily the basic or awareness level. The instructor training is designed to require approximately 7 hours of classroom and hands on instruction. An electronic copy of the Instructor's Guide and supporting resources will be provided to those completing the instructor training, or the full contents of this Instructor Guide is available at www.grainsafety.us.

Instructor Qualifications

There are currently no specific certification requirements to conduct training on responding to incidents involving grain storage and handling facilities. However, to be effective at

conducting training for first responders using this curriculum, instructors should meet the following minimum criteria:

1. Be a current emergency first responder/fire-rescue instructor.
2. Prior completion of National Incident Management Systems (NIMS) training
3. Have a working knowledge of grain storage, transport, and handling facilities and equipment.
4. Prior completion of a basic first responder training class related to incidents at grain storage, processing, and handling facilities.
5. Familiarity with the relevant OSHA standards related to confined spaces and grain handling and storage facilities, especially 1910.272 and 1910.146.
6. Familiarity with NFPA 1670, Standard on Operations and Training for Technical Search and Rescue Incidents and NFPA 1006, Standard for Technical Rescuer Professional Qualifications.

It is assumed that each instructor participating in this instructor training comes with both skills and knowledge common to emergency management and unique skills and experiences gained through field experience. It is also assumed that the instructor has the skills needed to effectively communicate in an educational setting and assess learner competencies.

Objectives of Instructor Training

Upon successful completion of this training, instructors should be able to:

1. Explain the specific goals and objectives of the Basic First Responder Training Curriculum for Incidents Involving Grain Storage, Processing, and Handling Facilities.
2. Explain the instructional resources included in the curriculum.
3. Plan, promote, and conduct an evidence-based training workshop on the basics of responding to incidents involving grain storage and handling facilities.
4. Explain the need for compliance with relevant OSHA standards during a response to an incident at a grain storage and handling facility.
5. Be familiar with the basic rescue equipment needed at the scene of an emergency involving grain storage and handling facilities.

6. Explain the basic first response strategies used in responding to entrapment, engulfments, asphyxiation, entanglements, falls, and electrocutions at grain storage and handling facilities.
7. Conduct an evaluation of the class and assess what participants learned.
8. Identify and locate supplemental resources related to the class.

Instructor Training Agenda

The following agenda is recommended for conducting an approximate 7 hour class for instructors wishing to teach the Basic First Responder Training. It is based upon the experiences gained from several pilot classes conducted at locations throughout the Corn Belt.

Instructor Training Agenda

8:00 – 8:30	Registration and independent review of course material
8:30 – 9:00	Introductions, Pre-testing, and Training Overview
9:00 – 9:30	Review of Unit 1 – Confined Spaces in Agriculture
9:30-10:00	Review of Unit 2 – Summary of Emergencies at Grain Storage and Handling Facilities
10:00-10:30	Break
10:30-11:15	Review of Unit 3 – Preplanning/Training/Rescue Equipment
11:15-12:00	Review of Unit 4 – Emergency Response Strategies
12:00	Lunch and show grain safety video
12:45-1:00	Review of Unit 5 –Demonstrations and Hands-on Activities
1:00-1:30	Group Tour of Grain Storage and Handling Facilities
1:30-3:30	Hands-on Activities <ul style="list-style-type: none"> • Workstation 1 – Tour of Inside of Grain Storage Structure • Workstation 2 – Emergency Bin Emptying Strategies and Grain Bin Panel Cutting Demonstration
2:30-3:00	Break
3:00-3:30	Hand-on Activities <ul style="list-style-type: none"> • Workstation 3 – Demonstration of Grain Containment Systems and Devices
3:30-4:00	Group Review of Hands-on Activities

4:00	Post-test
4:15	Question and Answers
4:30	Distribution of resources
4:40	Class evaluation

To assist in presenting the introductory component of the Instructor Training a set of Power Points have been included in the attachments.

Up to this point, the focus of the Instructor's Guide has been on the Instructor Training. The balance of the guide will focus on the contents of the Basic First Responder Training.

Curriculum Overview

The goal of the Basic First Responder Training is to provide basic awareness-level training needed by emergency first responders to enhance their capacity to safely and effectively respond to entrapments, engulfments, asphyxiations, entanglements, falls, and electrocutions involving operations that transport, store, or process free flowing agricultural products such as grain, feed, or grain by-products. It is intended to address incidents that occur at facilities that are required to be in compliance with relevant OSHA workplace safety and health standards, including 1910.272 Grain Handling Facilities (Attachment 1) and 1910.146 Confined Space Entry (Attachment 2), as well as currently exempt farm, seed processing, and feedlot operations that utilize grain, seed, and feed storage handling facilities. The training is designed to be beneficial for fire/rescue and emergency medical personnel, law enforcement and members of on-site corporate first response teams. Desired outcomes include increased awareness of the hazards associated with grain storage and handling, prevention of secondary injuries to first responders and increased survival rates for victims of entrapment, engulfment, entanglement, falls, and electrocutions at grain storage and handling operations.

This Instructor Guide is designed to include the resources needed to conduct the Basic First Responder Training.

Contributing Authors

1. *Bill Field, Ed.D.*

Bill Field is a professor and 36 year member in the Department of Agricultural and Biological Engineering at Purdue University, and also holds the position of Extension Safety Specialist for Purdue's Cooperative Extension Service. He has conducted training throughout the state on a wide variety of safety, health, and emergency management-related issues. He has edited three editions of *Responding to Agricultural Emergencies*, a guide for rural first responders, and currently teaches courses in agrosecurity and homeland security.

2. *Steve Wettschurack*

Steve Wettschurack is a certified farm accident rescue instructor for Purdue's Cooperative Extension Service. He has an extensive background in emergency management and response as a 35 year veteran volunteer firefighter, a 25 year veteran EMT, as Community Emergency Response Team (CERT) Instructor and has served as the chairman of the Tippecanoe Local Emergency Planning Committee. He is also a past member of the Governor's Emergency Response Commission for the state of Indiana (1999-2005). Since 2010 he has conducted approximately 65 7-hour grain rescue classes in Indiana, Michigan, and Ohio. In addition to his current duties at Purdue, he stays active in the local agricultural community, assisting with the harvest at Foster Farms in Boswell, IN.

3. *Steve Riedel, M.S.*

Steve Riedel holds a B.S. in Marine Systems Engineering from the Maine Maritime Academy and a M.S. in Agricultural and Biological Engineering from Purdue University. He has 16 years of experience as an operating engineer aboard Merchant and Naval vessels. His graduate research addressed the problem of agricultural confined spaces, including grain storage systems.

4. *Matt Roberts, M.S.*

Matt Roberts grew up on a beef and cash grain farm in northern Indiana and received his B.S. and M.S. in Agricultural Systems Management at Purdue University. He conducted the first comprehensive research on the topic of rescue strategies for entrapments in grain storage structures and has completed annual summaries of grain entrapments nationally

over the past four years. He currently farms and works as a part-time consultant for Purdue.

5. *Gail Deboy, Ph.D.*

Gail Deboy served as an agricultural safety specialist at Purdue University for over 10 years. He has a Ph.D. in Mechanical Engineering and was raised on and still manages a farm. He has assisted with developing new educational resources for safe grain handling. He holds one patent and one record of invention and was a volunteer EMT.

6. *Pam O'Conner, M.S.*

Pam O'Conner worked as a professional auditor for 14 years and recently completed a M.S. in Agricultural Systems Management at Purdue University in the area of estimating the cost of bringing current exempt grain storage facilities into compliance with OSHA Grain Handling Standards. She assisted with updating the Purdue Agricultural Confined Spaces Incident Database.

7. *Don Haberlin, M.S.*

Don Haberlin taught vocational agricultural education for 36 years at Western Boone High School in Indiana and served as an FFA advisor. He has worked on agricultural education curriculum development for the State Department of Education. He is serving as an agricultural education consultant.

8. *Salah Issa, M.S.*

Salah Issa, a graduate student in the Department of Agricultural and Biological Engineering, has assisted with the analysis of relevant incident data incorporated into the curriculum. He co-authored the 2012 and 2013 Summary of Grain Entrapments in the United States and prepared the List of Supplemental Resources included in the curriculum.

9. *Lamar Grafft, M.S.*

Lamar Grafft has served as a Rural Health and Safety Specialist with Iowa's Center for Agricultural Safety and Health since 1993. He continues to serve as a Paramedic/Flight Paramedic for Mercy Medical Center, Cedar Rapids, IA. He is currently the Associate Director of the North Carolina AgroMedicine Program.

10. Charlene Cheng, M.S.

Charlene Cheng, a graduate student in the Department of Agricultural and Biological Engineering, has provided ongoing assistance with the analysis of relevant agricultural confined spaces incident data incorporated into the development of this Curriculum.

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Intended Audience

The Basic First Responder Training curriculum covered in this instructor training has been designed to be most beneficial to emergency first responders who have the potential of responding to an entrapment, asphyxiation, engulfment, entanglement, fall, or electrocution at a grain storage, handling, or processing facility. This includes municipal and volunteer fire/rescue personnel, emergency medical services, law enforcement, and on-site emergency response teams at commercial storage and handling facilities. Since the training is focused on hazard awareness and basic response strategies, the contents should be especially useful for rural emergency first responders who are generally volunteers and may have less access to specialized or tactical training, yet, have the greatest potential of being called to the scene of grain storage and handling-related incidents. As noted, the purpose is not to provide comprehensive operational or tactical training, but rather enhance awareness of potential site hazards and basic response strategies that have been shown to be effective in the past. It is assumed that Incident Commanders at the site of an emergency will utilize the resources available to them from specially trained tactical teams.

Curriculum Development Methodology

Purdue's Agricultural Safety and Health Program has been conducting free flowing agricultural material (FAM) and agricultural confined spaces rescue training for over 30 years,

dating back to when workers first became entrapped in facilities used to store large volumes of ear corn, feeds, and free flowing grains. When the transition from ear corn to shelled corn occurred during the 1950s-60s, the frequency of these events and the importance and demand for training increased. This training has varied considerably over the years due to changes in grain storage practices, introduction of new workplace safety and health regulations(OSHA)¹, time limitations in some training settings, access to training resources and facilities, expectations of first responders, introduction of specialized tactical rescue teams, and enhanced understanding of contributing factors, such as the role of out-of-condition grain. Purdue has conducted numerous studies over the years to document the hazards associated with grain storage, processing, and handling and currently maintains the only database of related incidents involving injuries and fatalities. Findings have been widely disseminated in archival literature and educational resources used throughout the grain industry (see Attachment3.²) Findings have also contributed to enhancing the content of emergency first responder training being conducted throughout the country. However, a review of the literature found no formal training curriculum that was evidence-based or identified specific core competencies required to effectively and safely respond to the most common emergencies that occur at grain storage, handling, and processing facilities.

With support from a Susan Harwood Grant (No. SH22307SH1 - SH3) awarded to Purdue by the U.S. Department of Labor, an effort was initiated in the Fall of 2011 to develop a basic, or awareness-level, first responder training curriculum that would be based upon the published research findings and use a sound educational curriculum development methodology. Completion of the curriculum, including the hosting of train-the-trainer classes, was supported by follow-on Susan Harwood Grants.

The first step was to review the current training strategies and training subject matter content in use. Training options examined ranged from three hour classes to 32 hour classes. Target audiences ranged from farmers and commercial grain operation employees to highly skilled

¹ There are specific OSHA workplace safety and health standards that apply to grain storage and handling facilities. These include the Grain Handling Standard (29CFR1910.272) and Confined Space Entry Standard (29CFR1910.146). These standards are included as Attachments 1 and 2, or access them at www.OSHA.gov.

²For the most up-to-date information on grain-related incidents visit www.grainsafety.us.

tactical rescue team personnel³. Subject matter ranged from the basic hazards of grain engulfment to high angle rescue, ropes training, air quality monitoring, and use of SCBAs in confined spaces. Project staff attended various training programs and participated in three national events that addressed grain rescue strategies (Assumption, IL, St. Louis, MO, and Cedar Rapids, IA). Staff participated in post event debriefings or after action meetings and interviews with first responders who had participated in grain entrapment rescues. The team also had access to the research findings of Matt Roberts who summarized grain rescue strategies based upon data contained in the Purdue Agricultural Confined Space Incident Database (see Attachment 4).

Building on the training material that was already in use by Purdue staff and the review of other training initiatives, a series of 14 pilot classes were held that incorporated three measurement tools:

- 1) Pilot subject matter content pre-test
- 2) Pilot subject matter content post-test
- 3) First responder participant survey

From these pilot classes, 430 matched pre- and post-tests were gathered along with 484 participant surveys. Nearly all the participants were emergency first responders, including members of on-site emergency response teams. Analysis of the pre-tests identified specific areas where training was needed such as on topics related to the:

- 1) difference between exempt and non-exempt facilities
- 2) scope (frequency and severity) of the problem
- 3) potential of secondary injury to an entrapped victim
- 4) potential anchor points on grain storage structures
- 5) forces required to extricate an entrapped victim
- 6) hazards to first responders
- 7) hazards associated with rapid removal of structure contents
- 8) potential for fire or explosion during a rescue
- 9) contributing factors of out-of-condition grain
- 10) use of grain containment devices, including grain rescue tubes

³ Most tactical rescue teams are urban based. It cannot be assumed that these teams have been trained in responding to entrapments, asphyxiations, engulfments, or entanglements inside of grain storage structures.

On average, the 430 first responders who completed both the pre- and post-tests scored approximately 64% on the pre-test, or incorrectly answered over one-third of the pre-test questions. Upon completion of the training a knowledge increase of 15-20% was demonstrated through post-testing.

Analysis of post-test data found a substantial knowledge gain in key areas, but also showed areas where knowledge did not increase due to failure to present the desired information clearly, misinterpretation of information presented, or lack of question clarity. Findings were used to modify both instructional content and pre- and post-test questions.

The general class evaluation responses from 484 participants also provided extremely valuable information for design of the curriculum. This included:

- 1) 86 (18%) participants had personally responded to a grain entrapment (higher than expected)
- 2) 427 participants were active fire/rescue, emergency medical, or law enforcement personnel and 42 were part of a first-response employee team at a commercial grain facility (there was some overlap with some individuals serving in both roles)
- 3) 450 considered the 8 hour, or less, (1 day) class to best fit their needs and time availability – 14 thought it was too short and 19 indicated it was too long
- 4) 199 (41%) rated the instructional content very good and 250 (52%) rated it excellent
- 5) the most frequent written comment was regarding how valuable the hands-on training was to the participants (288)

The pilot training demonstrated the need to balance the training contents between what is needed for both experienced and inexperienced first responders, and their extremely diverse understanding of grain handling and storage facilities. For example, a few participants had previous farming experience, or were farmers and were very familiar with the hazards of grain storage and handling, while others had little or no knowledge of the industry and performed poorly on the pre-test. In addressing the needs of the inexperienced first responder, the few who had considerable experience, including those who had participated in a rescue at a grain storage facility, found some of the content redundant. Another balance that had to be achieved was between the classroom instruction and hands-on learning experiences provided during the class.

Based upon the pilot training classes it was determined that:

- 1) the contents should be presented at the “basic awareness level” and focus on basic strategies and safety measures that have the highest probability of preventing secondary victims at the scene of a grain-related incident, and have been shown to be the most effective in executing a successful rescue.
- 2) the contents should address those topics that were identified as basic “knowledge gaps” through the initial pre- and post-testing of participants. For example, participants had little general knowledge concerning how grain flowed out of a grain storage structure or the hazards associated with airborne grain dust and microtoxins. Both of these issues were incorporated into the instructional content.
- 3) the training should include an opportunity for those who have been involved in a related emergency response to share their experiences giving them a greater stake in a class that may be, otherwise, redundant in some areas.
- 4) the training should not exceed one day or approximately 8 hours to accommodate the large number of volunteer emergency first responders who find longer training sessions burdensome, both economically and time wise.
- 5) the training should intentionally not include content that is generally provided through other first responder training, is considered highly specialized, or limits first responder participation due to specific physical limitations or prior training requirements such as high angle/ropes rescue or SCBA use. For example, it was noted that a large number of the first responders participating in the pilot trainings would, most likely, not physically qualify to participate in high rise or high angle training, but most probably would be the first responders to a scene of a grain-related entrapment, asphyxiation, engulfment, entanglement, fall, or electrocution. It was also noted that more than expected numbers of participants had facial hair that would have prevented them from meeting current standards for SCBA use and confined space entry where a toxic atmosphere might be present. The instructional content would need, however, to address appropriate use of personal protective equipment.
- 6) the contents of the training should include a balance between classroom instruction and experiential/hands on learning. Consequently training sites would be needed that provided access to grain storage facilities, a limited amount of dry grain, and various types of common rescue equipment.

- 7) participants should be afforded the opportunity to enter an empty grain storage structure in order to allow them the opportunity to identify key components such as access points, sweep augers, in floor augers, and other equipment.
- 8) participants should be provided the opportunity, at some point, to operate metal cutting tools (power saw, air chisel, plasma arc cutter, etc.) to cut through actual grain bin panels. This should include use of all appropriate personal protective equipment.⁴
- 9) participants should be provided handouts and supplemented resources, including websites that would allow them to pursue additional self-instruction on topics not covered in the training due to a lack of time.

It was further observed in the pilot testing that not all the participants were comfortable with completing either the pre- and post-tests or the training evaluation. To assume that all participants have adequate reading and reading comprehension skills may be a mistake leading to unnecessary embarrassment and frustration. To further assume that a lower reading level equates to a less skilled or capable first responder is also a mistake. This training should not be the setting to critique the participants reading skills. It was determined that the instruction, though competency-based could not fail participants based upon their reading skills. Since the bulk of the instruction was at the awareness level, there appears to be greater flexibility in measuring outcomes. However, if an instructor chooses to assess participant's knowledge and skills through mandated post-testing there are no restrictions preventing him or her from doing so.

⁴ It was determined by the OSHA staff with oversight jurisdiction of the curriculum development project that participants should not be asked or allowed to operate metal cutting tools due to the potential liability issues. During the use of this training curriculum, metal cutting techniques should instead be demonstrated by an experienced operator. Participants should be encouraged to pursue additional training opportunities where they could be instructed on the use of various metal cutting equipment.

Definitions

The following terms are frequently associated with grain storage and handling facilities, and emergencies that might occur at these facilities. They are listed in alphabetical order.

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 list of confined spaces that are found in various agricultural worksites is included as Attachment 5.

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 should not be less than 5,000 pounds.

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 MC of the corn, the steeper the angle.

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.

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

Bulk Density – A general measurement of the density of a material. For example, the bulk density of a bushel of corn is approximately 56 pounds per bushel.

Carbon Dioxide – A gas generated during the decomposition of biological materials such as corn. In cases in which 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).

Confined Space Entry Standard (OSHA 29 CFR 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, to construction, or to shipyard employment, but may under some interpretations apply to emergency first responders.

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 grain can crust together to form large chunks of solidified grain or bridging of the grain surface.

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. In the context of this training, 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 of 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.

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 times 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 approximately 25” in diameter.

Grain Dust – The fine dust that is formed by the breakage of 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 or respiratory hazards. Some individuals can be extremely sensitive to the substances found in the dust including microtoxins.

Grain Entrapment Rescue Tube (GERT) – A rescue device designed specifically for partial grain entrapment victim extrication.

Grain Handling Standard (OSHA 29 CFR 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.

Grain Retaining Wall (GRW) – A term used to describe a device constructed around an individual that is partially entrapped in grain. The device 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.

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

Grain Vacuum Machine – A powered vacuum machine used to move grain pneumatically using a vacuum pump. These machines are used to remove residual grain from storage structures or open piles. They have been used successfully to remove grain from around partially submerged victims.

Infloor 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 infloor auger for transport out of the bin. Infloor 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.

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.

Mold – A living, biological material that grows on other biological materials under the right conditions. If grain or feed is stored too wet and the temperature is in the appropriate range mold can grow rapidly in the grain or feed producing billions of mold spores that can easily become air borne when the grain or feed is agitated. Some people are extremely hyper sensitive to exposure to mold. All workers and first responders 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.

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 into the air when the grain is agitated and easily inhaled.

Moisture Content (MC) – The amount of moisture within grain kernels. For example, grain is best stored when the MC does not exceed 14%.

NFPA – National Fire Protection Association (www.nfpa.org)

NFPA 1008 Standard – Standard for Technical Rescuer Professional Qualifications defines the qualifications for technical rescuer.

NFPA 1670 Standard – Standard on Operations and Training for Technical Search and Rescue Incidents defines the criteria for different levels of training and emergency operations for technical rescue teams.

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

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 1, 2, and 17.

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 1, 2, and 17.

Plug Flow – When the entire cross section of a column of grain is removed through the bottom opening it is referred to as 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. They can be raised and lowered to accommodate different height storage structures. They come in various lengths from 10-60’ and 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 (PACSID) – A database of documented incidents involving deaths or injuries related to agricultural confined spaces.

Silo – A grain or silage storage structure made of concrete or glass lined steel. These structures are sometimes referred to as vertical or tower silos.

Stirrator Auger – A powered auger, typically mounted vertically in a grain bin to stir the grain during storage to maintain the desired moisture content.

Sweep Auger – A powered auger installed inside a circular grain storage structure to remove residual grain that cannot be removed by gravity. The auger is installed on a power source located in the center of the structure and rotates slowly around the structure “sweeping” grain towards the center opening in the floor.

Tank – A structure designed for grain storage that is often times constructed of panels of mild steel welded together.

Walking Down the Grain – A practice used to remove residual grain stuck to the inside bin walls during which a worker enters the bin with the unloading equipment operating and circles the inside of the bin scraping the walls with a shovel or other tool. This practice is specifically forbidden by OSHA 1910.272 due to the high risk of entrapment.

Wet Basis (WB) – This is a term used to describe the amount of moisture content with grain kernels using the assumption that all grain is made up of only moisture and dry matter (Loewer et.al., 1994).

Minimum Core Competencies/Objectives

Based upon the preliminary review of the literature, development of the pilot training material, results of the pre- and post-testing of 430 emergency first responders and the responses to a training survey of 484 pilot training participants, the following minimum core competencies were identified (See Attachment 6 for a reproducible list of the competencies). It is anticipated that at the completion of the proposed training that participants should be able to:

1. Identify the typical types of confined spaces found in agricultural workplaces and the typical hazards associated with each.
2. Describe the national scope and significance of the problem of entrapments, engulfments, asphyxiations, entanglements, asphyxiations, falls, and electrocutions that occur at grain/feed storage, processing, and handling facilities.
3. Identify the general types of potential emergencies that could potentially occur at grain storage and handling facilities.
4. Explain the difference between OSHA exempt versus non-exempt facilities and how this may influence the first response strategies and the role of both volunteer and paid first responders, including specialized tactical rescue teams.
5. Identify the two relevant OSHA standards that apply to first responders at the scene of an entrapment, engulfment, asphyxiation, entanglement, fall, or electrocution located at a grain storage, handling, transport or processing facility.
6. Identify work practices that reduce the risk of agricultural confined space-related emergencies.
7. Describe the rights that workers have under OSHA to file a complaint regarding unsafe working conditions.
8. Describe the basic nature and characteristics of free flowing agricultural material including weight, bulk density, angle of repose, funnel flow, plug flow, and avalanche and crusting potential.
9. Describe the basic operation of typical grain storage structures and how grain/feed flows through them.
10. Describe the vulnerability of free flowing agricultural materials to go out-of-condition and how the presence of spoiled grain and feed increase the risk of entrapment, engulfment, entanglement, and respiratory distress.

11. List the common factors that contribute to the potential for entrapment, engulfment, asphyxiation, entanglement, falls, or electrocutions at grain/feed storage, handling, and processing operations.
12. List the seven most common categories of flowing grain/feed entrapments and engulfments.
13. Identify the most significant hazards to emergency first responders at the scene of an entrapment, engulfment, asphyxiation, entanglement, asphyxiation, fall, or electrocution at a grain/feed storage, handling, or processing operation, including:
 - Secondary entrapment
 - Falls
 - Exposure to toxic atmospheres and airborne grain dust
 - Exposure to energized electrical components
 - Heat stress
14. Describe the importance of pre-planning for emergencies at grain storage and handling facilities, and compliance with established standard operating procedures.
15. Identify essential personal protective equipment that should be used by emergency first responders at the scene of an entrapment, engulfment, asphyxiation, entanglement, fall, or electrocution at a grain/feed storage, handling, or processing facility.
16. List the initial steps that should be taken by the first responder upon arriving at the scene of an entrapment, engulfment, asphyxiation, entanglement, fall, or electrocution at a grain/feed storage, handling, or processing operation.
17. List the key rescue equipment that has proven beneficial at the scene of an entrapment, engulfment or entanglement inside a grain/feed storage structure.
18. Identify appropriate and inappropriate anchor points on or around grain/feed storage structures, and how the lack of an adequate anchor point can influence rescue strategies.
19. Describe the types of injuries that a victim could experience due to entrapment, engulfment, asphyxiation, entanglement, fall, or electrocution in or around grain/feed storage, handling, and processing facilities.
20. Demonstrate the use of a grain containment device, such as a grain rescue tube, in free flowing grain to extricate a partially buried victim.
21. Describe the various strategies for rapid removal of grain/feed from a storage structure to expedite rescue or recovery.

22. Describe the procedures for safely cutting of a corrugated steel bin panel to expedite the removal of a grain bin's contents.
23. Describe the potential for structure failure due to a rapid removal of grain/feed from a grain storage structure or due to compromising the integrity of the structure due to inappropriate cutting of supporting components.
24. Demonstrate the process of lockout/tagout of unloading equipment on grain storage structures.
25. Describe the difference between a sweep auger, stirrator auger, and an infloor unload auger, and the hazards involved with both.
26. Describe the basic strategies for responding to an electrocution.
27. Describe the primary hazards associated with clean-up and recovery operations following a rescue attempt.
28. Describe the role that a grain vacuum machine could play to expedite a rescue or recovery from grain/feed.
29. Describe the hazards associated with using a grain vacuum machine.
30. Identify sources of supplemental resources related to responding to an entrapment, engulfment, asphyxiation, entanglement, asphyxiation, or fall at a grain/feed storage, handling, or processing facility.

It is safe to assume that there are numerous other skills needed to conduct a successful rescue from a grain entrapment or engulfment, or extrication from an auger. It is believed however, that many of these skills will be available from other first responders at the scene or could be acquired from other emergency response training. Again, it is also assumed that Incident Commanders will utilize the expertise of specially trained tactical rescue teams when available.

Curriculum Limitations

It is assumed that every participant in the Basic First Responder Training brings with him or her a unique set of experiences, skills, and knowledge. This is no different than a team of first responders arriving at the scene of any complex emergency. Each individual, whether paid or volunteer, is a first responder, but each arrives with different strengths and weaknesses. Some may arrive with extensive training in confined spaces or toxic atmospheres while others will be

more experienced with handling traffic or crowd control duties, fire suppression, or HazMat issues. Others may be physically able and/or knowledgeable to carry out a high angle rescue while their team mates may feel safer with their feet on the ground or providing emergency medical care. There is no way to predict the skill sets that might be available at an incident involving grain storage or handling facilities. In most cases, those responding do the very best with what they have available to them at the time. In no way should these resources be interpreted to suggest that one set of skills are more important than another. In the game of baseball, the pitcher may get paid more, but not having a left fielder in position will result in a lot of lost games, no matter how good the pitcher is.

First responder training is generally categorized by NFPA based upon the different levels of “capabilities”, knowledge or skill sets being addressed. NFPA 1670 (Standard on Operations and Training for Technical Search and Rescue Incidents) defines three levels of capability – Awareness, Operational, and Technician. This training is intended to fall primarily into the category of “basic awareness” with limited activities that could be considered operational level. It is specifically designed for first responders who may lack a basic understanding of the types of incidents that could occur at grain storage and handling facilities and basic first response strategies. The training is not intended to meet the full expectations for the operational capability level or the higher capabilities demanded at the technician level and therefore does not intentionally include training on ropes, high angle rescue, entry into toxic environments, or exposure to hazardous materials. Entrapments, engulfments, asphyxiation, entanglements, falls, and electrocutions at grain storage and handling facilities can involve lengthy and complex extrications that will require a diversity of resources and levels of expertise that are almost never available from any one rescue team or agency. Attempting to carry out a complex rescue without the needed skills or equipment can place responders at risk of injury and even death. This training will be a starting point for many participants, and in some cases the only training they will need related to the incidents being addressed. In other cases it will provide participants the opportunity to review or be exposed to new response strategies being introduced. It is intended that the training will help each participant recognize their individual capabilities and limitations, and prevent him or her from taking actions that would place him or her in a position of unacceptable risk. Participants are encouraged to pursue additional or more in depth training as they are able. In this field, there is never too much training.

No seven hour class is capable of addressing all of the potential hazards and issues that may arise during a response to a relatively rare emergency involving grain storage and handling facilities, especially where a victim requires extrication. Furthermore, no class, regardless of length, is able to prepare first responders for the physical and emotional stress that accompanies incidents that have historically been largely body recovery operations. Individuals should not be pressed into situations that they don't feel comfortable with or be requested to perform tasks for which they have not been trained.

The key word in the title of this class is BASIC. As noted in the class goal statement, the intent of the class is to enhance the awareness and capacity of first responders who are, for the most part, unfamiliar with grain storage and handling operations, to safely respond to emergency situations and improve the potential for successful rescue. This course is only a small part of what is needed to achieve these goals. It is just one piece of the puzzle in providing communities containing grain storage and handling facilities with the capacity to effectively respond to incidents at these operations.

Finally, it is also assumed that in most cases when the call is made to 911 for emergency assistance, it is already too late. Someone has already been entrapped, engulfed, asphyxiated, entangled, fallen, electrocuted or overcome by a toxic environment and is in need of help. Someone has taken an unacceptable risk, violated a safe work practice, ignored a hazard, or was in the wrong place at the wrong time. Every worker deserves a safe workplace and the opportunity to go home safe and healthy, including every first responder. The priority at grain storage and handling facilities should be on prevention of circumstances that require emergency response capabilities rather than just emergency preparedness and management. Setting unrealistic expectations for emergency first responders to "fix" a problem that should have been prevented by compliance with safe work practices and standards is unreasonable.

Need for Regulatory Compliance

Historically, many first responders to significant events, such as confined space entrapment, have become secondary victims due to the use of response strategies that exposed them to unacceptable levels of risk. The National Institute for Occupational Safety and Health has reported that more than 35 percent of confined spaces-related fatalities each year involve first responders both untrained and trained. In many cases, the first responders were simply unaware

of the hazards involved until it was too late. For example, approximately 30% of the victims of manure storage incidents on farms were untrained first responders who placed their lives at risk to rescue the primary victim. Based upon a review of over 1,000 cases documented by the Purdue Agricultural Confined Space Incident Database, the incidence of trained emergency first responders becoming secondary victims at the scene of grain storage and handling incidents is extremely rare, however, it has occurred.

As noted earlier, one of the primary goals of this training is to reduce the potential of secondary victims at the scene of an entrapment, engulfment, asphyxiation, entanglement, fall, or electrocution at a grain storage or handling facility. This goal can only be accomplished if each responder is aware of the potential hazards and complies with accepted practices, including for example, the use of appropriate personal protective equipment.

Based upon current interpretations of the OSHA standards and legislative language concerning fire/rescue personnel, first responders in some states with state funded OSHA plans, whether paid or volunteer, are considered employees of local municipalities and therefore must comply with safe work practices contained in the relevant OSHA standards. In states with a Federal OSHA Plan, employees of municipalities are not covered by OSHA regulations (See Attachment 7 for an example of an interpretation of the Indiana OSHA as to its application to volunteer fire fighters). In other words, a volunteer fire fighter responding to a confined space incident may be required to comply, to the extent possible, with the current OSHA Confined Space Entry requirements found in 29CFR1910.146, the OSHA Grain Handling Facilities Standard, 29CFR1910.272 and the provisions of 29CFR1910.156. The role of volunteer first responders has not been clarified in all states. Fire/rescue agencies should contact their state OSHA to confirm their need for compliance.

These restrictions create challenges for many small rural fire departments that may not be equipped or trained to respond to a complex confined space or high angle incident. Or, due to the employment status of some of its volunteer members, may not be able to have trained personnel reach the scene in a timely manner. In addition, since historically, over half of entrapments and engulfments have taken place on farms, generally located in isolated locations, the response time for largely urban-based tactical rescue teams to arrive at the scene may be excessive. Determining the legal and acceptable response strategies can become a complex issue at the scene, and therefore should be resolved prior to an incident occurring.

Historically, most grain storage entrapment extrications have been conducted by local volunteer fire/rescue services that were, most likely, completely unaware of the provisions of the OSHA confined space entry and grain handling facility standards. Due to the current lack of timely and economically viable alternatives, this approach will continue to occur for some time into the future.

In cases where first responders have been found in non-compliance with the applicable standards, the five common issues with respect to confined spaces were:

- 1) failure to monitor the confined space prior to entry, including air quality and the presence of free standing/crusted grain
- 2) failure to remove hazards from the confined space (energized equipment)
- 3) bringing hazards into a confined space
- 4) failure to have trained rescue personnel
- 5) failure to use a mechanical means of rescue

It is clear that the current relevant standards do not address every contingency related to every entrapment, engulfment, asphyxiation, entanglement, fall, or electrocution that could occur at a grain storage and handling facility. In some cases alternative strategies will need to be improvised utilizing the resources and personnel available. Regardless of the complexities, careful assessment of the risks need to be carried out and measures taken to protect every first responder at the scene.

Developing a Standard Operating Procedure for Grain Rescue

In discussing the compliance issues with representative of both state and federal OSHA, it was suggested that local volunteer fire/rescue agencies that serve large numbers of grain storage and handling operations develop standard operating procedures specifically for responding to grain entrapments and engulfments. These procedures would be narrow in scope and clearly specify what constitutes a grain storage structure, grain entrapment and grain engulfment. It would identify the procedural steps that members of the responding agency could take and those that would not be allowed. Its scope would not include other forms of permit required confined spaces. Many first response agencies already have in place certain standard operating procedures for other emergencies such as chemical spills and chemical fires. The same templates could be used.

Other Anticipated Outcomes of Training

It is anticipated the use of this curriculum will have other potential benefits, including:

- 1) The frequency and severity of injuries to emergency first responders responding to these incidents will be reduced.
- 2) The probability of successful rescues will increase due to enhanced rescue strategies that will contribute to a more timely response and reduce the potential of secondary injury to the victim.
- 3) Individuals participating in the training will become more aware of the general hazards associated with the transport, storage, and handling of grain/feed.
- 4) There will be an increased community awareness concerning the hazards associated with grain/feed storage, handling, and processing.
- 5) Currently non-exempt facilities will enhance their first response capabilities by having employees participate in the training.
- 6) Currently exempt farms, seed processors, and feedlots will become more aware of the hazards associated with grain/feed transport, storage, and handling facilities and voluntarily take steps to reduce the risk for entrapment, engulfment, entanglement, falls, or electrocutions.
- 7) Access to appropriate rescue equipment, such as grain rescue tubes will increase, especially in rural communities where the exposure to entrapment and engulfment hazards is greatest.
- 8) There will be additional mutual aid agreements put in place between emergency services that will be utilized to enhance the timeliness and capacity of emergency first responders responding to entrapments, engulfments, entanglements, asphyxiation, and falls at grain storage and handling facilities.
- 9) Emergency preplanning will receive greater attention through enhanced collaboration between owners of grain storage and handling operations and first response agencies.
- 10) There will be increased compliance with current OSHA safety and health workplace standards, including the provisions of the Grain Handling and Permit – required Confined Spaces standards.

Training Site Selection

The classroom component of the training can take place in any setting that is conducive for learning. It should allow for everyone to sit at a table and view PowerPoint images, while also limiting external distractions. The proposed training also needs access to the following for the experiential/hands on component:

- 1) An operational grain storage and handling facility in order to point out and discuss the design of these facilities and the flow of grain through them, location of access points, and location of mechanical and electrical controls.
- 2) An empty grain storage structure so that first responders can enter the structure and become aware of interior design configurations including the presence of ladders, access doors, aeration flooring, sweep augers, in floor unload augers, wells or floor openings, grain stirrators, and potential anchor points.
- 3) Various forms of grain restraint rescue equipment including two or more types of grain rescue tubes.
- 4) A contained volume of grain such as in a truck or gravity flow wagon that can be used to demonstrate and practice the use of grain restraint devices such as grain rescue tubes.
- 5) Appropriate metal cutting equipment to demonstrate appropriate cutting of corrugated steel panels.
- 6) Supply of corrugated steel grain bin panels.

In selecting a site, the host should confirm that the insurance carrier for the site will cover any incidents that may potentially occur during the course of the training that could lead to the recovery of damages. These incidents could include a participant being struck by a vehicle in the parking lot, a fall on unlevel ground, or a case of heat exhaustion that requires medical attention. Training activities held on private property such as farms are generally not covered by most property or personal liability insurance or the levels of such coverage are very low. In some cases, property owners who have agreed to host a training event that have pursued adding one-time umbrella coverage found the cost prohibitive, in some cases exceeding \$1,000 for a one-day training. It is believed that nearly all paid and volunteer emergency first response agencies have appropriate coverage for on-site and off-site training exercises.

Commercial grain storage and handling operations have proven generally receptive to hosting trainings because it enhances their on-site capacity to respond to emergencies and

strengthens the relationship with local first responders who would respond to a 911 call from the site. Since most commercial grain facility insurance carriers encourage employee training and OSHA requires them to conduct emergency management planning, insurance coverage is not nearly the issue that it can be on private property or farms.

Another alternative to consider are the several hundred farms that are owned and operated by Land Grant Institutions across the U.S. Many of these sites were established as training facilities and are generally adequately covered by the university's general liability insurance.

Finally, as the problem of grain entrapment has become increasingly addressed, several states have developed either permanent or portable grain rescue and confined space rescue simulation facilities. Such sites are now located in Pennsylvania, Ohio, Indiana, Illinois, Kansas, Iowa, and Oklahoma. Check with the State Fire Marshall, State Fire/Rescue Institute or Cooperative Extension Service to determine if these sites are available for training.

Class Size

The pilot training workshops that have been conducted to date have ranged in size from 15-45. It has been noted that class size is not as important for the classroom instruction, which is primarily lecture style. However, for the experiential or hands on component, when the class size exceeds 30, the quality of the instruction and participation level is diminished. Consequently, it is recommended that the target class size be in the range of 25-30.

Additional participants could be accommodated if there was additional instructional help for the experiential learning components and there was access to more facilities or workstations that would allow each learning group to not exceed 10 participants.

Recommended Participant Dress

Since emergency first responders at the scene of most entrapments, engulfments, asphyxiations, entanglements, falls, and electrocutions will be wearing some form of protective equipment, it is encouraged that all participants who plan to participate in all aspects of the training bring the equipment that they would be wearing if actually responding to an emergency. This is especially important to demonstrate the difficulty in accessing some grain storage structures with protective gear due to the size of access doors and hatches. In the case of those

attending who are law enforcement and emergency medical personnel, they would need to wear protective equipment if they wish to observe certain activities such as the bin panel cutting exercise. Eye, face, and hearing protection is especially important for the bin panel cutting and respiratory protection is advised, especially if moldy grain is present. Instructors are encouraged to have an ample supply of eye protection, N-95 dust masks, and disposable hearing protection for attendees who arrive without them. Dress for the classroom portion of the training should be comfortable.

Potential Training Hazards

Any training that attempts to simulate, in some fashion, an incident requiring the presence of emergency first responders has the potential of exposing participants to hazards that can cause personal injury or illness. This includes climbing inside a grain storage structure, observing a metal cutting demonstration or touring a facility with uneven surfaces. The very nature of nearly all emergency training causes a certain level of risk to be present. This is adequate justification to restrict the training to only those who have been engaged in some aspect of emergency management and have a high probability of actually responding to emergency situations. This training is not designed for those with a passing interest or who are at increased vulnerability to injury due to age, physical condition, or lack of prior training. Since one of the primary goals of the training is to enhance the safety of emergency personal responding to an incident at a grain storage, handling, or processing facility, a priority of the training is to have every participant return home safely.

Some of the hazards to first responders at the scene that have been identified in previous pilot training events or in the literature include:

- 1) Slips and falls in and around grain storage and handling structures being used as part of the training. Grain, especially dry corn and soybeans, can be extremely slippery, acting like ball bearings beneath the feet. Care is needed to prevent falls while accessing doors and hatches on storage bins and getting in and out of grain rescue simulators. Metal bin ladders with shallow rung depths were not designed for bulky protective footwear, and sheet metal bin roofs covered with dust can be incredibly slippery. It was readily noticeable during the pilot training that not all emergency first responders were physically able, or comfortable, with accessing upper levels of grain storage and handling

facilities. It is an inappropriate assumption that all participants are fire/rescue personnel trained to climb ladders, work at heights, or access confined spaces. Participants should not be asked to take part in activities for which they are not trained or do not feel comfortable performing. It has been determined that participants in the training should not be allowed to access the upper levels of grain storage structures unless they are equipped with a stairway that meets current OSHA Standards.

- 2) Participants may incur cuts, burns, and abrasions if unprotected hands come into contact with the edges of grain bin roofing or hot bin panels being cut during the grain bin cutting demonstrations. Hand protection is needed during certain aspects of the training.
- 3) Heat stress and dehydration can be a significant problem if the training occurs during summer or on extremely hot days. The condition becomes even worse during the hands on activities when participants are wearing heavy protective clothing or bunker gear. If part of the training exercise takes place inside of a grain storage structure such as a metal grain bin, the inside temperatures can be 10-20° higher than outside or ambient temperatures. In fact, at some actual rescue scenes, heat stress and exhaustion due to the large amount of grain manually moved becomes a significant problem. It is important to have adequate water available for hydration, limit activities if heat becomes oppressive, and to designate someone to keep an eye on all participants for signs of heat stress. For more information on the hazards of heat exposure refer to OSHA and NIOSH factsheets at www.OSHA.gov or call 800-321-OSHA. A copy of one of the OSHA factsheets on heat stress is included as Attachment 8.
- 4) Every grain storage and handling facility contains a variety of dusts, molds, and accompanying microtoxins. These hazards are an integral part of these work places and are difficult to avoid. Grain dust can easily become airborne and cause serious respiratory distress, especially for those who already are vulnerable to allergies or have pre-existing conditions such as asthma or emphysema. At several rescue scenes, first responders suffered serious allergic reactions and had to be hospitalized due to exposure to high levels of toxic dusts. If first responders are aware of their hypersensitivity to grain dust and related toxins, they should avoid being directly engaged in the activities where airborne dust is present. Appropriate respiratory protection (N-95) should be made available to everyone participating in the training. In some cases, some first responders

became aware for the first time just how sensitive they were to grain dust during participation in the training.

- 5) Grain storage facilities, especially those on farms, may be contaminated with livestock manure and other infectious agents. Care should be taken to protect any open wounds or skin abrasions from contamination and to provide hand washing facilities prior to eating. All first responders should have up-to-date tetanus vaccinations.
- 6) One proposed demonstration includes cutting of steel grain bin wall panels with a variety of powered equipment including power saws and abrasive wheels. It is absolutely essential that everyone observing or in close proximity of this activity wear appropriate eye and face protection. It could be assumed that all fire/rescue personnel will arrive with adequate protective gear, but this may not be true with emergency medical and law enforcement personnel. These individuals must be provided adequate protective gear or not participate in or be in close proximity of the demonstration. In addition, because of the noise level of the cutting equipment used, hearing protection is strongly advised. Inexpensive foam ear inserts may be used for this purpose.
- 7) In some training exercises observed, participants were requested to be “volunteer victims” to be partially entrapped in grain in order to demonstrate grain rescue strategies. There have been several reports of volunteers in uncontrolled settings, who were partially entrapped, experiencing physical and emotional distress, including high levels of anxiety and hyper-ventilation. In one documented case, one of the volunteer rescuers became entrapped during a training exercise along with the volunteer victim and both had to be extricated. In no case is there a need to partially bury a volunteer who is uncomfortable with participating, nor is there a need to entrap a volunteer victim above his or her waistline to demonstrate the efficacy of a grain rescue device. Under no circumstances should a victim be intentionally entrapped in a volume of grain with the potential of full engulfment. All grain bin rescue simulation facilities should contain an internal floor that eliminates the risk of full engulfment.
- 8) Grain vacuum machines have been increasingly used during grain rescue and recovery operations. They are also used to remove grain from inside the grain rescue tube placed around a partially entrapped “victim” during training exercises. All participants need to be aware of the potential for entrapment during use of these machines. The operator

should never be working alone, unsupervised, or standing on the surface of the grain with the vacuum inlet at his or her feet. Only vacuum machines with a control feature at the inlet should be used during a rescue or recovery operation.

If the training involves a larger number of participants than recommended or occurs at different work stations, assigning someone to be the “Safety Officer” to ensure that everyone is wearing the appropriate personal protective equipment and is performing tasks safely should be considered.

Participant Waiver Form

As grain rescue training becomes more available with a wider range of participants, it may be important to develop a standard form for participants to sign that would make them aware that all training of this type involves potential hazards and to partially protect the host from certain forms of liability. However, no form can waive or replace the responsibility to offer the safest training possible or to protect against negligence. Determining the fine line between what is a reasonable effort to protect participants from injury and what is unacceptable negligence can be difficult, especially in the eyes of a lawyer or jury.

A model participant waiver form is included as Attachment 9.

Training Format

As indicated, it was determined that the contents of the training curriculum would cover approximately seven contact hours to best fit the expectations and time limitations identified through the first responder survey. This design, again, assumes that participants come to the class with a basic understanding of best emergency management practices such as Incident Command, securing the scene, and importance of personal protective equipment. In addition, based upon the findings from the initial pre-tests, topics that were shown to have a relatively high understanding among first responders are not heavily emphasized in the training.

Based upon the list of identified minimum core competencies, training materials and agenda were developed that allocated time to ensure that each competency was adequately addressed, and in cases where there was generally low awareness level, the topics were allocated additional time, or were repeated in both the classroom and experiential settings.

The following is a suggested schedule for the proposed training that includes a 45-minute lunch break (see Attachment 10 for agenda template that can be modified for specific applications). Instructors are free to modify the agenda to address local or regional issues to incorporate input from first responders with prior experience in responding to relevant incidents.

As can be noted, the morning session can be conducted in a classroom and includes approximately 4 hours of instructional content. The afternoon session involves a substantial amount of time standing, walking, and observing demonstrations. At the completion of the afternoon session, everyone will return to the classroom for post-testing, Q&A, and training evaluation.

Basic First Responder Training for Incidents Involving Grain Storage and Handling Facilities

Agenda

- 8:00 – 8:30 Registration and Independent Review of Course Material
- 8:30 – 9:00 Introductions, Pre-Test, and Training Overview
- 9:00 – 9:45 Unit 1: Confined Spaces in Agriculture
- Definitions/key terms
 - Types of confined spaces found in agriculture
 - Relevant OSHA Standards
 - Hazards related to agricultural confined spaces
 - OSHA exempt vs. non-exempt facilities
 - Overview of facilities used to transport, handle, and store grain
 - Augers and other energized equipment
 - Role of out-of-condition grain
 - Importance of preplanning
- 9:45 – 10:15 Unit 2: Summary of Emergencies at Grain Storage and Handling Facilities
- Definitions
 - Frequency of problem
 - Contributing factors
 - Nature and characteristics of free flowing grain
 - Common categories of flowing grain/feed entrapments and engulfments
 - Entanglements
 - Asphyxiations
 - Falls
 - Electrocutions
- 10:15 – 10:30 Break
- 10:30 – 11:15 Unit 3: Preplanning/Training/Rescue Equipment
- Components of preplanning
 - Developing a first response protocol (SOP)
 - Mutual aid agreements
 - Role of training
 - Personal protective equipment
 - Rescue equipment
 - Grain handling equipment
 - Grain restrain systems/Grain rescue tubes

- 11:15 – 12:00 Unit 4: Emergency Response Strategies
- Importance of rapid response
 - Potential hazards to first responders
 - Initial steps in responding
 - Review of key rescue equipment that would be beneficial
 - Identifying appropriate and inappropriate anchor points
 - Types of injuries victims may experience
 - Techniques for rapid removal of grain
 - Potential for structure failure during rapid removal
- 12:00 – 12:45 Lunch (Grain Safety Video Presentation)
- 12:45 – 1:00 Unit 5: Overview of Demonstrations and Hands-on Activities
- Break up into teams
 - Assign safety officer for each team
- 1:00 – 4:00 Demonstrations and Hands-on Exercises
- Group tour of grain safety and handling facility (if available)
 - Workstations
 - #1 – Tour of inside of typical grain storage structure
 - #2 – Emergency bin emptying strategies and grain bin panel cutting demonstration
 - #3 – Using grain containment devices and grain rescue tubes
 - Group review of activities
- 2:00 – 2:30 Break or During Rotation
- 4:00 – 4:45 Q&A and Post-Test
- 4:45 – 5:00 Evaluation and Closing Comments

Testing

Testing is an essential part of the learning process. 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 responding to participant questions, or a lack of time.

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

A reproducible copy of both the pre- and post-tests that are suggested for use are included as Attachments 11 and 12. The pre and post-tests are identical except for title. The key for the test is found in Attachment 13.

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 the desired core competencies were achieved.

As noted earlier, some participants 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.

Certification

Being able to document participation in training is a requirement for many emergency first responders. Therefore, it is important to maintain an accurate and complete record of all participants in the training. Participants should be required to register, including providing contact information. Only those who attended for the full seven hours of the training should be acknowledged as having received the training. Attachment 14 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 in responding to entrapments, engulfments, asphyxiations, entanglements, falls, or electrocutions at grain/feed 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 in meeting continuing education training requirements. The 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 15 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 problem of emergencies at grain storage and handling facilities. Conducting an online search using the key words “grain entrapment,” “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 tested. Care should be taken to assess any technical information before applying to actual rescue situations. See Attachment 16 for a list of resources, including key websites and print resources. Attachment 17 is a four page publication entitled *Suffocation Hazards in Flowing Grain*. Attachment 18, *OSHA Fact Sheet – Worker Entry into Grain Storage Bins*, can also be reproduced for distribution to participants.

Suggested Demonstration Aids

In most instructional settings it has been found that, “A picture is worth a thousand words”. It is also true that a simple demonstration aid can be worth even more. The following, easily acquired, demonstration aids, are suggested for instructors to use in communicating specific aspects of the Basic First Responder 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 (peanut butter jars). Some participants will not know the difference between the grains or feeds and their specific characteristics. For example, 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 3/4" 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.
- 5) Lockout/tagout kit. Every first responder should be aware of the need to lockout and tagout the electrical supply to the scene of an entrapment or engulfment. The lockout/tagout kit can be passed around for participants to examine. In some cases, grain storage structures might not be equipped with electrical boxes designed to be locked out. In such cases, a first responder 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 measures currently required at all commercial grain storage and handling facilities for 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 at the scene of an entrapment or engulfment, there is a need to have access to adequate respiratory protection for all first responders. For some this can be in the form of SCBA while for others it will consist of N-95 disposable dust masks that will need to be changed frequently during the rescue. In some cases participants in the training may request respiratory protection if they are exposed to grain dust during the hands on training. It is suggested that two strap dust masks with an N-95 rating be made available.
- 8) Small samples of different gauges (thicknesses) of corrugated steel panels used to construct grain bins. These samples will enable participants to better understand the thickness of the bin walls that may have to be cut. In some cases, double layers of panel sheets will be bolted together to form a stronger bin wall.
- 9) Grain rescue tube or containment system – There are several grain rescue containment devices on the market. It would be ideal to be able to show training participants one or more types. In some cases these could be acquired from a local commercial grain operation or fire department. Attached as Attachment 19 is a list of contact information for commercially available units.
- 10) Portable, battery operated vacuum that can be used to remove grain from inside the grain rescue tube.

How to File a Complaint with OSHA

As part of the Susan Harwood Grant Program, instructors 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.

In some states, these rights extend to emergency first responders who may be called upon to perform tasks in violation of existing workplace safety and health regulations. No one, including emergency workers, should be required to perform unsafe activities that place at risk their health and safety.

Included as Attachment 20 is additional information on filing a complaint with OSHA.

Training Visuals

Included with the Instructor Guide is a set of recommended PowerPoint's and instructor notes that have been designed to address the goals and objectives of the training, including each of the minimum core competencies.

The PowerPoint's are organized into six components as follows:

- Introductions, Pre-testing, and Training Overview
- Unit 1 – Confined Spaces in Agriculture
- Unit 2 – Summary of Emergencies at Grain Storage and Handling Facilities
- Unit 3 – Preplanning/Training/Rescue Equipment
- Unit 4 – Emergency Response Strategies
- Unit 5 – Introduction to Demonstrations and Hands-on Activities

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

Instructors should feel free to supplement PowerPoint's with content of their own or material that addresses unique situations related to practices, geography, or make up of audience.

In addition to the PowerPoints, a copy of both the short and long version of "Grain Bin Safety," a video produced by the National Corn Growers Association and the National Grain and Feed Association, are included. This video can be shown during the lunch break or viewed online at www.grainsafety.us.

Case Studies for Discussion

Responding to an entrapment, engulfment, entanglement, asphyxiation, fall, or electrocution at a grain/feed storage, handling, or processing facility can be extremely complex. It can involve difficult technical problems, lack of personnel (especially in rural communities), conflicts over the most effective strategy to use or the influences from well-meaning co-workers and family members. The following five brief case studies are designed to stimulate discussion that might better prepare participants if faced with a similar circumstance.

Presentation of the case studies can be woven into the training at appropriate times, can be assigned to tables of participants to discuss over lunch or used selectively at the end of the training to assess general levels of response capability.

Case Study #1

A farmer found his two sons collapsed in the top of a 110' oxygen-limiting silo. He immediately called 911 and then proceeded to enter the silo in an attempt to rescue the boys. The first responder to arrive at the scene was a law enforcement officer who was met by a farm employee. He could not make contact with the farmer who was now in the silo. The second responders were two EMTs and their ambulance. Neither had training to climb the silo or was comfortable with doing so. The third responding agency consisted of three volunteer firemen in a pumper truck with only limited rescue equipment on board. None of the three was comfortable with climbing the outside of the silo due to the height. Nor were they trained in confined space rescue. The farm employee then proceeded to climb the silo with six emergency responders on the ground. He looked through the roof hatch and saw that all three victims were now unconscious. The only one he could reach without physically entering the silo was the farmer who he was able to pull onto the roof of the silo. The farmer survived but the two boys died.

Discussion Questions:

- 1) Are most emergency responders, even in the fire service, trained and equipped to work at heights above 100' which are common at grain storage, handling, and processing facilities?
- 2) Should the Incident Commander have allowed the employee to climb the silo and attempt a rescue?
- 3) How could pre-planning contribute to avoiding this type of response issue?
- 4) What local options may have existed that could have been tapped to conduct the rescue?

CASE STUDY #2

A farm employee is buried to his shoulders in free flowing grain inside a 30,000 bushel bin located on a farm in a remote area. Three local volunteer fire departments are on the scene and their leaders are discussing rescue options. None of the units on scene have much experience with high angle rescue or confined spaces, but have considerable experience with grain storage and handling operations. The nearest tactical rescue team is over 45 minutes away with an estimated arrival and set up time of 1-1½ hours.

Discussion Questions:

- 1) Should the tactical team be contacted?
- 2) Should a rescue attempt be executed relying on personnel with a working experience of grain storage and handling operations?
- 3) What are the liabilities involved?

CASE STUDY #3

An employee of a commercial grain storage facility becomes deeply entrapped in a 100,000 bushel corrugated steel bin. The on-site employee staffed first response team spent over 2 hours attempting to extricate the victim before realizing that he was only settling further into the grain. A call to 911 was made 2 ¼ hours after the victim was reported entrapped.

Discussion Questions:

- 1) Why do you think the operators of the facility delayed calling for assistance?
- 2) How could pre-planning and a site visit by local emergency responders reduce the probability of this delay in requesting assistance?
- 3) How important is a rapid response to enhancing the likelihood of a successful rescue?

CASE STUDY #4

An employee at a commercial grain storage facility entered a large corrugated steel bin while the unit was being unloaded. He became deeply entrapped before the unloading operation could be shut down. A call was made to a local fire/rescue service that responded and began to cut openings in the side of the structure at the level of the victim using a ladder truck to reach the needed height. One of the first responders entered the bin and was pulled into the flow of grain moving towards one of the openings made in the bin. He had to be extricated due to being pinned by the grain against the bin wall near the opening.

Discussion Questions:

- 1) Should first responders enter the bin to aid the victim immediately upon arriving at the scene?
- 2) How frequently do first responders become secondary victims in situations like this?
- 3) What procedural step should have been taken when cutting the opening to prevent this entrapment?

CASE STUDY #5

An employee of a commercial grain operation was overcome inside a steel bin by the fumes from out-of-condition, overheating corn that was stored too wet. The grain was so hot that it was producing a mixture of steam and smoke. The local volunteer fire department was called and quickly responded to the scene. The Assistant Fire Chief, the Incident Commander at the scene, entered the bin through the ground level access door in an attempt to assist the victim. He was wearing an SCBA, but had no lifeline or harness. In his attempt to revive the unconscious victim he removed his face mask and put it on the victim. The result was the victim survived and the Assistant Fire Chief was overcome and died.

Discussion Questions:

- 1) What were the hazards to first responders in this situation?
- 2) What did the Assistant Fire Chief do wrong?
- 3) Who at the scene could have prevented this incident?

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. They are used with permission from the Liberty Grain Rescue System© User's Manual, Edition 7, 9/11, and Edition 8, 8/13.

1. 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 75% 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.

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 are grown.

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

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, 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 1,500 cases have been documented including over 1,000 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 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 51 individuals, of whom 50% died. Lower numbers of documented cases in 2011 and 2012 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.
- 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. 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 21 for additional information on the OSHA agricultural exemption language.

1.12. Are children allowed to be employed in grain storage structures?

No. Under the Agricultural Hazardous Occupations Order, children under the age of 16 are prohibited from being assigned to work inside any confined space, including grain bins and silos (see <http://www.ydae.purdue.edu/tractor/default.htm>). 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 attachment 22 for additional resources on youth working in confined spaces.

1.13. 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. This practice is illegal under the OSHA Grain Handling Standard, (1910.272).

1.14. 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 definition of a confined space.

1.15. 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.

1.16. 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.

1.17. 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.

1.18. 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.

1.19. 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, 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. Or where there is crusted material stuck to the walls of the bin.

1.20 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 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. 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.

1.21 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.

1.22 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 23 includes an OSHA Fact Sheet on grain dust and a resource on health effects of grain dust.

1.23 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.

1.24 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.

1.25 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 grain handling, transport, and storage, as well as rescue strategies. For over 30 years, data have been collected and over 1,000 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 professional grain handlers and training for first responders. The PUASHP staff also uses research findings to provide assistance to the grain industry in formulating engineering standards and to government agencies for regulatory issues.

1.26 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.

1.27 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, the PUASHP reported that from 2000 to 2009, there were 198 documented on-farm fatalities in Indiana. 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.

1.28 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.

1.29 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 indentation formed in the grain surface directly over the outlet in the floor. He will be well below the upper levels of the grain. In some larger bins there can be 10 or more feet of grain above the victim. Entering the structure can cause the higher grain along the bin walls to cascade down onto and possibly cover the victim or bury him or her 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.

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 suspended 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.

2.9 What is the safest way to cut open a storage bin to evacuate the grain in the least amount of time?

On small grain storage bins (less than 30,000 bushels), the quickest way to release the grain in order to reach a completely submerged victim is to cut openings around the base of the bin and allow the grain to flow directly on the ground. The recommended strategy is to cut “V”-shaped openings as high up on the side of the bin as possible or at the level that the victim has been located. This will result in the need for less grain to be removed. Openings should be cut uniformly around the base of the bin to allow for even or uniform release of the grain and reduce unequal pressures on the structure.

2.10 Is there a danger of bin/structure collapse if holes are cut in the side of the structure to release the grain during a rescue?

Yes and No. It is not recommended that holes be cut into the side of larger grain storage structures such as concrete silos, welded steel tanks, or corrugated steel bins over 30,000 bushels in capacity. The structural integrity of these structures, if cut, is not well understood or documented. The safest strategy is to remove the grain with large grain vacuum units. Before cutting openings in any large structure, consult with the manufacturer, or a Professional Engineer (P.E.) experienced with the design and characteristics of these facilities. Compromising and failure of these structures can put first responders at great risk of injury or death. If cuts are made they should start as high as possible, just below the level of the grain and progress down the bin allowing the grain to be removed evenly.

2.11 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 CO₂ 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.

2.12 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.

2.13 Why is respiratory protection needed for first responders during a grain rescue?

A common characteristic contributing to entrapments and engulfments is out of condition grain due to spoilage from molds. During a rescue billions, of mold spores and organic dust particles become airborne and become a significant respiratory threat to anyone at the scene. A good quality dust mask that is frequently changed, or in some cases, full self-contained breathing apparatus will be needed. Post assessment of all first responders should take place to ensure that there is no evidence or symptoms of an allergic response that for some individuals may be severe. Symptoms may include shortness of breath, watery eyes, and fever. These signs should be taken seriously and medical attention sought.

2.14 Why is it important to limit the number of first responders who enter the scene of a victim entrapped or engulfed in grain?

No more than two first responders should be on the grain surface in which a victim is entrapped or engulfed. Additional personnel will only increase the risk of secondary entrapment and further compact the grain, making rescue more difficult. There have been documented cases in which over 25 first responders entered the structure to attempt to dig out the victim. Not only does this approach rarely ever work, it placed numerous personnel at unnecessary risk of injury.

2.15 Is it possible to safely extricate a deeply entrapped victim by using a harness, lifeline and mechanical lifting aid?

No. Applying the needed force to free a victim deeply buried in grain has a high risk of causing serious bodily injury and even death. The drag and weight of the grain on the victim's body is so great that it may take hundreds of pounds of pull to free him. In some cases, the victim may also have pre-existing conditions such as knee or hip replacements, or chronic back injuries that could be complicated by applying excessive force. The safest extrication strategy has been to remove the grain from around the victim and then lift him free. A victim wearing a full-body harness and accessible with a lifeline should be secured to an appropriate anchor point. The harness keeps distribute the local reducing the risk of injury. Historically, most victims are not wearing a body harness at the time of entrapment.

2.16 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 grain 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.

2.17 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. A list of contact information for commercially available grain rescue tubes is included as Attachment 19.

2.18 How can the grain be removed from inside the grain retaining device or tube?

The quickest method that has been found to remove grain from inside the retaining wall or tube is a portable vacuum. If the rescue tube size is kept to a minimum around the victim, the amount of grain that needs to be removed is relatively small, usually not more than two to four bushels. Small, portable, 18-volt battery powered vacuums have been successfully used to remove the grain without the need for power cords. Portable shop vacuums have also been demonstrated to work effectively.

2.19 Why, in some cases, does the victim become hypothermic while buried in the grain?

To prevent spoilage, grain is conditioned, by passing dry outside air through the grain mass using large fans. As the outside temperature drops the cold air drawn into the bin can reduce the grain temperature at the core of the structure to near outside temperatures that may be in the 30's and 40's. A victim deeply buried in the cold grain can become chilled quickly, leading to hyperthermia. It may become necessary due to extended rescue procedures to provide blankets or other warming aids to prevent hyperthermia.

2.20 Would using a cutting tool such as an abrasive wheel or torch to cut open the side wall of a metal bin cause a dust explosion?

No. There have been no substantiated reports of a dust explosion caused by cutting open a metal storage bin during a rescue attempt. However it is recommended that first responders wear full protection and that a charged line be available during cutting operations. It should be noted that corn, and most grains, have relatively high ignition temperatures and that it is the grain dust in suspension that offers any significant risk of ignition.

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 (use of entry permit).
- Utilizing lockout/tag out procedures to ensure unloading equipment is not unintentionally energized while someone is inside the structure.
- Clearly posting warning signage communicating the potential for engulfment at each access point.
- Always having working a 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 the prices of crops 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 eaves 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.

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.farmsafety.org, www.grainsafety.us, www.grainsafety.org, www.eXtension.org, www.grainentrapmentprevention.com and www.ydae.purdue.edu/tractor/default.htm 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

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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 16 is a relative 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.

Attachments

There are several attachments included that may be freely downloaded and/or reproduced for use in conducting the *Basic First Responder Training Workshop for Incidents Involving Grain Storage and Handling Facilities*. Attachments 1-23 are printed documents that are formatted to be easily downloaded. Attachments 24-30 are PowerPoint presentations designed specifically for use in the training. Each PowerPoint slide includes “Instructor Notes” that provide speaking points and background information to help present the contents of the slide. 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. SH22307SH1 and SH23575SH2), 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. It is anticipated that any updates or modifications will be made available at that site.