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Special Thank You for the Invitation

Photos from Brock® Grain Systems
Overview

- Introduction & Background
- Problem Statement
- Research Methods & Limitations
- Findings
- Conclusions & Recommendations
- Ongoing research
Introduction & Background

• Why the on-going interest in grain storage, handling and transport incidents?
  – Historically, these incidents account for the largest number of cases related to agricultural confined spaces
  – Record number of U.S. cases in 2010
  – Recent high profile events involving multiple victims
  – North Central Education / Extension Research Activity Committee 197 Agenda Priority
  – Targeted enforcement by OSHA
  – Expanded grain rescue training efforts
Introduction & Background (Cont.)

- Critical issues that increase the complexity of responding to the problem of grain entrapment
  - Exempt vs. non-exempt facilities
    - On-farm storage vs. commercial storage
  - Lack of accepted definitions for confined spaces
  - Rapid growth in the amount of both on-farm and commercial storage
  - Lack of a comprehensive incident reporting system
  - Inconsistent interpretations of relevant OSHA Regulations
    - CFR 29.1910.146 – Permit required confined space
    - CFR 29.1910.272 – Grain handling facilities
    - CFR 29.1928 – Agricultural workplaces
  - Cost of bringing older facilities into compliance
  - Inconsistent information being disseminated
Problem Statement

• Confined-space hazards in production agriculture are significant causes of work-related injuries and fatalities
  – ~10% of all farm-related incidents
  – Record number of grain-related entrapments in 2010

• The lack of reliable data and clearly defined terminology has made developing an effective evidenced-based solution difficult

• The frequency of these events appears to be increasing

• There is a need to prioritize prevention efforts
Research Methods & Limitations

- Sources of data collection included:
  - Online search engines
  - Newspaper clipping services
  - Death certificates
  - Police reports
  - Onsite investigations
  - Litigation documents
  - Cross-referenced of incident data with other land-grant universities & agencies

- Limitations
  - Not comprehensive - there are recognized gaps
  - No requirements to report incidents, especially if non-fatal
  - Inaccurate/incomplete reporting of incidents
Definitions

• **Entrapment** – used in a broad way to describe an event in which an individual is trapped, possibly due to engulfment, inside a structure considered a confined space such as a bin, silo, or grain transport vehicle where self-extrication is not possible.

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

• **Flowing Agricultural Material** (FAM): free-flowing agricultural crops or material (including grain).

• **OSHA Exempt facility** – used to describe an agricultural facility that employs less than 11 employees or does not operate a work camp that is not required to follow the OSHA Permit-Required Confined Space or Grain Handling Facility Standards. It is customarily used to describe a family owned or operated farm.
Findings

- Frequency
- Geographic distribution
- Severity
- Facilities Involved
  - Grain Storage Facilities
  - Agricultural Transport Vehicles
- Contributing Factors
Total Agricultural Confined Space Cases, by Agent Category
1964 - 2010 (n=1255)

Majority are grain related

- Grain Storage Facilities: 891 cases
- Manure Storage Structures: 132 cases
- Ag Transport Vehicles: 115 cases
- Forage Storage Structures: 72 cases
- Other: 44 cases
- Food Processing & Storage Facility: 1 case
Geographic Distribution
Fatal vs. Non-fatal Cases per Age Range Involving Grain Storage, Handling and Transport Equipment 1964-2010 (n=1004)
Grain Storage, Handling and Transport Cases by Type of Incident: 1964-2010 n=1004

- Entrained / Engulfed in FAM: 2.1%
- Falls: 11.1%
- Equipment Entanglements: 6.7%
- Toxic Fumes: 0.5%
- Struck by Falling Equipment: 0.5%
- Unknown: 79.2%
Annual Frequency of Grain Entrapment & Engulfment Cases (1964 – 2010)
U.S. Grain Entrapments
2001-2011 n=321

Annual

5-yr Average

Year

2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

0 10 20 30 40

Annual

5-yr avg

U.S. Grain Entrapments
2001-2011 n=321
Breakdown by Classification of Facility Status (OSHA Exempt vs. Non-exempt) Involving FAM Engulfments and Entrapments 2009 - 2010 (n=89)
Breakdown of Grain Storage & Handling Facilities and Transport Vehicles Involved with Entrapments and Engulfments 1964-2010 (n=795)
Type of Ag Transport Vehicles Involved with Entrapments and Engulfments 1964-2010 (n=112)
Ag Transport Vehicles Involved with Entrapments and Engulfments
Age Distribution by Gender and Fatal vs. Non-Fatal
1964-2010 (n=112)

Male - Fatal
Male - Non-Fatal
Female - Fatal
Female - Non-Fatal

Age Range

0-15: 46
16-19: 6
20-29: 5
30-39: 2
40-49: 2
50-59: 2
60-69: 1
70-79: 1
UNK: 4

Total: 112
Contributing Factors

- Improper post-harvest drying (Excessive M.C.)
- Excessive fines and foreign material
- Out-of-Condition Grain
- Energized unloading equipment
- Working alone
- Unsupervised children in exempt workplaces
- Increased on-farm storage
- Unfamiliarity with extrication strategies by first responders
Factors Contributing to Increase Rate of Survival

• Increased emphasis on safer confined space entry procedures – use of outside observer
• Increased emphasis on first responder training
• More representative data including non-fatal incidents
Use of Commercial Grain Rescue Tubes

- Two documented incidents in 2010
- Three cases in 2011
- Three cases so far in 2012
Conclusions

• Poor quality grain a key problem
• Victims are mostly males → over 97%
• Average age of known cases → 39 years old
  – 1/5th of cases where age is known are under the age of 16
• Corn Belt region issue
• Historically, incidents occur primarily on OSHA exempt (farm) facilities → 70±%
• Primary medium (when known) is out-of-condition corn → 45%
  – Likely higher, as corn accounts for approximately 2/3rds of typical FAM crops by yield (NASS, 2011)
Conclusions (Cont.)

- Corrugated metal grain bins are most frequently involved → 68%
- Unloading equipment was typically energized at the time of the incident
- Suffocation occurred in over 60% of entrapment cases
- Frequency of incidents is increasing
Relative Risk of Grain Entrapment and Grain Dust Explosions

- 1970 – 2010 USDOL reported 600 airborne grain dust explosions
  - 250+ fatalities
  - 1000+ injuries

- 1964 – 2011 Purdue documented 900+ grain entrapments
  - 550± fatalities
  - 350± injuries/successful rescues
Increased Level of OSHA Enforcement

<table>
<thead>
<tr>
<th>Year</th>
<th>OSHA Proposed Fine</th>
<th>Number of Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>$1,83 million</td>
<td>3</td>
</tr>
<tr>
<td>2010</td>
<td>$2,77 million</td>
<td>4</td>
</tr>
<tr>
<td>2011</td>
<td>$4,18 million</td>
<td>19</td>
</tr>
</tbody>
</table>
Recommendations

• There is a need to:
  – Adopt a comprehensive, consensus definition for agricultural confined spaces and related terminology
  – Continue the current surveillance and documentation program
  – Develop a mutually agreeable set of processes and procedures for exempt facilities to follow that
    • do not unduly burden the producer
    • focus on farm family members under the age of 16
Recommendations

• There is a need to:
  – Develop appropriate engineering and practice standards to enhance the safety of grain storage and handling facilities
  – Continue promoting public awareness of grain handling hazards, especially when out-of-condition grain is present
  – Develop evidence-based grain handling safety curricula for high-risk operations
  – Develop evidence-based first response strategies for grain entrapment
Ongoing Research Efforts

1. Estimating the cost of bringing currently exempt facilities into compliance.

2. Summarizing the impact of grain entrapments on youth under 16.

3. Exploring the potential of entrapment while using grain vacuum machines.

4. Investigating victim extrication strategies.

5. Summarizing data on sweep and unload auger entanglements.
Questions?