GRAIN ENTRAPMENT PREVENTION SYSTEMS

Wayne Bauer, Star of the West Milling & Emergency Services Rescue Training (ESRT)

“Grain Entrapment Prevention”
Historical Timeline for Grain Industry

**Before 1860** Flathouses or warehouses with 2,000 – 5,000 bu. capacity were used for storing grain in 100 lb. bags and flour in barrels

**1860-1890** Wood-crib type elevators were designed & built for storage of bulk grain

**1899** A single experimental concrete grain tank (20’ dia.) was built for Peavey Grain Co. in Minneapolis

**1908** Butler built first steel bins for government storage

**1910** Zeleny Thermometer Co. developed the thermocouple cable for reading grain temperatures
Original Farm Usage
Original Farm Usage
Older Style Bins
Storage Systems Keep Changing
Grain Storage Capacity in U.S.

- 2015 > 24 billion Bu. (55% ON-Farm / 45% OFF-Farm)
- 2005 > 19.9 billion Bu.
How do storage types compare?

- ________________ - Concrete silos
- ________________ - Steel Bins
- ________________ - Wood crib bins
- ________________ - Flat Storage

23.0 - - **Bln. Bu.** - - **Total Permanent** Storage

3.2 - 4.4 - - **Bln. Bu. ---Temporary Outside Piles** (est.)
Bins Keep Getting Wider & Higher

<table>
<thead>
<tr>
<th>Eave</th>
<th>Bushel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dia.</td>
<td>Height</td>
</tr>
<tr>
<td>12’</td>
<td>10’</td>
</tr>
<tr>
<td>30’</td>
<td>64’ 11”</td>
</tr>
<tr>
<td>132’</td>
<td>91’</td>
</tr>
</tbody>
</table>

Grain Entrapment Prevention
## Number of Grain Entrapments Reported & Fatalities

<table>
<thead>
<tr>
<th>Year</th>
<th># of Reported Grain Entrapments</th>
<th>Fatalities</th>
<th>Percentage of Entrapments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>35</td>
<td>14</td>
<td>40%</td>
</tr>
<tr>
<td>2014</td>
<td>38</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>33</td>
<td>13</td>
<td>39.4%</td>
</tr>
<tr>
<td>2012</td>
<td>20</td>
<td>8</td>
<td>40.0%</td>
</tr>
<tr>
<td>2011</td>
<td>32</td>
<td>11</td>
<td>34.4%</td>
</tr>
<tr>
<td>2010</td>
<td>59</td>
<td>31</td>
<td>52.5%</td>
</tr>
<tr>
<td>2009</td>
<td>44</td>
<td>19</td>
<td>43.2%</td>
</tr>
</tbody>
</table>

Version: 02/04/16
In the last (7) Years we have averaged over 36 reported entrapments & 16 deaths / Yr.

- However, in the **first month of 2015** we have experienced (4) deaths already:
  - **01/24/15** – 71 year old man South of Lacon, IL.
  - **01/21/15** – 50 year old man in Taylor County, KY.
  - **01/10/15** – Farmer in Union City, S.C.
  - **01/04/15** – 21 year old man near Friona, TX.
Where do these incidents happen, according to Purdue University?

“When the incident location was known”:

- Historically, **70% ON-Farm**, however, **over 80% took place ON-Farms in 2014**
- **68% happen around steel bins . . .** over 47 yrs. (1964-2011)
- **63% involved CORN** in 2011, smaller (%) in 2013.
(3) – "I-States", namely: Iowa, Illinois, and Indiana accounted for 35 – 40% of all known Entrapments in 2013 & 2014.
The (5) states of Iowa, ILL., NE., Minn., and IN. produce 64 – 66% of the total corn crop in the U.S.
These (10) states in the Northern Mid-West accounted for 70 – 75% of the known entrapments in 2013 & 2014. States involved: ILL., IA., IN., Minn., MI., Neb., OH., Wisc., N.D., and S.D.
Transformation of Bin Designs

Wood

Concrete

Steel
Transformation of Bin Designs

Wood

Concrete

Steel

How does the – (R) Factor and resultant Convection Currents in the structures above compare?
### Bin Sizes Keep Increasing

<table>
<thead>
<tr>
<th>Year</th>
<th>Diameter</th>
<th>Sidewall Height</th>
<th>Capacity (bu.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1908</td>
<td>12’</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Mid 1960’s</td>
<td>36’</td>
<td>50’</td>
<td>10,000</td>
</tr>
<tr>
<td></td>
<td>48’</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 - 75’</td>
<td>60’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90’</td>
<td>75’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>105’</td>
<td>80’ - 84’</td>
<td>750,000</td>
</tr>
<tr>
<td>Today</td>
<td>132 - 156’</td>
<td>84 - 94’</td>
<td>1,000,000 - 1,340,000</td>
</tr>
</tbody>
</table>

During the past 100 years bin sizes moved from 500 bu. to 1,340,000 bu./bin.
Residual or Non-Reclaim Grain

10 - 22,000 bu.  20 - 50,000 bu.  85 - 130,000 bu.

60'  80'  105'
What is the realistic lifespan of bin?

- Concrete: 50-70 years
- Steel: 25 – 30 years

Factors vary due to engineering design and cycles per year

Quality after 1980 improved, however cycles per year also increased.
Why Do These Incidents Keep Happening?

1. We are producing more corn (13+ billion bu.)
2. Holding corn for longer periods (4.5 billion bu. for ethanol)
3. We let the grain spoil or go out of condition
4. Bins are getting larger (up to 1.3 million bu.)
5. Reclaim systems are not adequate for 80’, 105’, or 156’ bins
6. No attention to restraint systems
7. People are not offered “Hands-On” training
8. We are not using progressive discipline
We Produce More Corn

- 13 billion bu. + is the norm today
- 3-4 billion was normal in 1960’s
- 2-3 billion bu. was the norm for 40 years between (1915-1955)
We let grain spoil or go out of condition
We need to…
- Clean it
- Dry it properly
- Cool it promptly
- Monitor temperature closely
- Keep air moving under the roof with exhausters
Grain Entrapment Prevention Initiative

Best Management Practices

Key Issues for New Grain Handling Facilities

1. Increase grain conditioning capabilities
2. Larger access doors
3. Restraint systems with secured lifelines
4. Safer and more efficient reclaim systems

STOP!
1. Stay out if possible
2. Never enter alone
3. Never enter untrained
4. Follow entry permit
5. Shut down/lockout
6. Secure lifeline
7. Emergency preparedness

For more information go to ... www.grainentrapmentprevention.com

Grain Entrapment Prevention

Design Parameters

1. Increase grain conditioning capabilities
2. Access doors
3. Restraint systems
4. Reclalm systems

2012 Grain Entrapment Prevention Symposium
March 21-23 • Marriott Airport Hotel • St. Louis, MO

Videos of Conference Presentations
Wayne Bauer: Welcome and Introduction - Video Part 1 / Part 2

www.grainentrapmentprevention.com
“Zero Entry Mentality”

- **Grain Conditioning** - Aeration & temp systems
- **Reclaim Systems** - Discharge sump holes, sweeps, service tunnels

**STOP!**

1. Stay out if possible
2. Never enter alone
3. Never enter untrained
4. Follow entry permit
5. Shut down/lockout
6. Secure lifeline
7. Emergency preparedness
Too many facilities are still not providing adequate training

- Did you provide **REAL “Hands-On”** training in the past 12 months?
- Should be providing **Annual** (2-4 hrs.) Awareness Level training
- **Hands-On** with equipment
- Identify hazards & demonstrate use of lifeline in your confined spaces
- Classify spaces
- Share information above with local emergency responders

STOP!
1. Stay out if possible
2. Never enter alone
3. **Never enter untrained**
4. Follow entry permit
5. Shut down/lockout
6. Secure lifeline
7. Emergency preparedness
29 CFR 1910.272(g)(2) has been quoted for the past 20 Years, but NO one has ever figured out how to do this. It has been an abstract concept that has been avoided and ultimately ignored.
29 CFR 1910.272(g)(2) – “The lifeline shall be so positioned, and of sufficient length, to prevent the employee from sinking further than waist deep in the grain.”
GRAIN ENTRAPMENT TERMS

Fall Protection:

CFR 29 Subpart M – Systems and procedures designed to prevent employees from falling off, onto, or through working levels and to protect employees from being struck by falling objects.

Fall Arrest:

The form of fall protection which involves the safe stopping of a person already falling.

Fall Restraint:

A fall protection system that prevents the user from falling any distance. The system is comprised of either a body belt or body harness, along with an anchorage, connectors and other necessary equipment. The other component typically includes a lanyard and also may include a lifeline.
Fall Protection – vs - Prevention

- Free Falling
  - Fall Protection
  - Fall Arrest
  - Prevention
  - Fall Restraint
  - Work-Positioning
  - Grain-Bin-Entry-Lifeline / Systems
In order to accomplish this feat, you need a **Grain Bin Entry Lifeline** used within a system that is attached to an **overhead anchor point**. The system must **minimize the slack** in the lifeline (12 – 18” max.) and be able to handle an **unexpected 500 – 800 lb. jerk** on the line.
Fall Restraint Systems
Grain Bin Entry Lifeline
Bin-Entry-Kit attached to a suitable anchor
Components for a Bin-Entry-Kit:

- Anchorage strap or piece of 1” webbing fastened to an anchor
- Connectors (Carabiners)
- Lifeline
- Tandem Prusiks
- Prusik Minding Pulley
Bin Entry Kits
The American Society of Agricultural and Biological Engineers (ASABE) is attempting to develop a new consensus standard referred to as (x624) – Design Parameters – for New Grain Bin Entry Design (initiated in 2012).

- Formal consensus standard versus
- General acknowledgment of features that should be offered in a “White Paper”
  - Top & Side Access Doors
  - Anchors to fasten – Grain Bin Entry Lifelines to
(x624) New – Design Parameters for Grain Bin Entry

- 1) Anchors
- 2) Access Doors
- 3) Work-platforms
- 4) Reclaim Systems
- 5) Lockout / Tag-out (LO/TO) accommodations
- 6) Ladders
- 7) Signage & Labels
- 8) Aeration & Exhaust Systems
- 9) Equipment Manuals
Anchors inside any new steel bins built after 2013

1) Offer a means to properly secure bin entry lifelines.

2) Initially - Some questions regarding whether anchors should be labeled for 1,800 / 3,000 or 5,000 lbs. ?? (Settling on 2,000 lbs.)
ACCESS DOORS OR ENTRY POINTS

Issues

- Size
- Configuration
- Shape
- Placement
Top Bin Entry Doors

SIoux
633.73 SQ. IN.
4.40 SQ. FT.

BRAND X
624.16 SQ. IN.
4.33 SQ. FT.

Sketches furnished by Sioux Steel Company

Grain Entrapment Prevention
Top Entry Doors

Consider moving doors for rescue purposes.
Side Access Doors

1. Use Minimum 5’ Door
2. 18” Step NOT Acceptable
3. Use minimum 3’ x 3’ work platform with handrails
Side Access Doors

1. Avoid Use of 24” Round
2. Use Minimum 5’ Door
3. Recommended Access Door is offset from unloading auger

Grain Entrapment Prevention
Work-platforms

1) Should meet current ANSI standards

2) Anything over 4 feet from ground (or next level) must have a platform & appropriate hand-rails.
Reclaim Systems

We must give more attention to all components:

- Size and spacing of the discharge sump holes
- Sweep Auger which are safer and more efficient
- Unloading conveyor beneath the floor
Older/Inadequate Reclaim Systems
Equal grain pressure
Off center unloading
Unequal side wall pressure with off center unloading
Discharge Sump Holes

12” x 12”
144 sq. in.

24” x 24”
576 sq. in.

What would it cost to increase the size of your discharge sump hole by 4 times?
Reclaim Systems

1) Need **larger discharge sump holes** (not 12” x 12”)

2) Placed *(8 – 10’) apart*, depending upon diameter of bin.

3) Floor wells / sumps need appropriate **guards**.

4) **Zero Entry** Bin Sweeps.
Lockout / Tag-out (LO/TO) accommodations

1) Most systems have NO easy way to lockout reclaim systems.

2) Proximity of controls to equipment & access points.

3) Controls need to be easily accessible.
Signage & Labels

1) Appropriate signage that addresses critical hazards

2) Warnings on each access / hatch opening.
1) Construction
   a) Need better “Communication” and “Quality Control” and monitoring of activities during the construction process with everyone involved, including sub-contractors.

2) Operations
   a) Offer better instructions on using temp., aeration & reclaim systems
   b) Emphasize hazards of flowing grain, nature of flowing grain, and other precautionary measures.
   c) Safety information on appropriate steps to take for dealing with a plugged reclaim system.
Whatever system you use with your Grain Bin Entry Lifeline, you need a substantial anchor.
Knot-Passing-Pulleys (KPP)
Passing Pulley in a 48’ dia. Tank
Passing Pulley in a 72’ dia. Tank
Fall Restraint System
"Top Guard" - for use in 105' commercial bins

Photos courtesy of GSI Group
Sioux Steel
Global Industries (MFS- Stormor)

Structured Roofs Fall Restraint System

Installation

1. Install as shown. Install Extra Stiffener and fold drill stiffener holes if Standard Inside Stiffener is not present or it is too far to reach from the inside ladder. Install Anchor Plate and U-bolt to stiffener. Install Fall Restraint Plate and U-bolt. Securely tighten all bolts.

b) STANDARD INSIDE STIFFENER
or INSIDE EXTRA SUPPLIED OPTIONAL STIFFENER 002823

1/2" X 4" X 5 1/2" U-BOLT 90031038
Anchor Plates Installed by Steve Queen
KC Supply
Aspen Lift under development at OSU
Home Grown Cofferdams

- Aluminum – 4-H Club in Ontario
- Baltic Birch Plywood
We are currently offering a wide range of ag safety & rescue training classes to (3) separate audiences:

- Youth - “First on the Scene”
- Farm Families - Hazard Assessments
- Emergency Responders - modules on (15) Farm related Emergencies
For further information on any of these training topics, please contact me:

- Wayne Bauer
- Phone: 989 – 652 – 7026
- www.wayne.bauer@starofthewest.com