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.

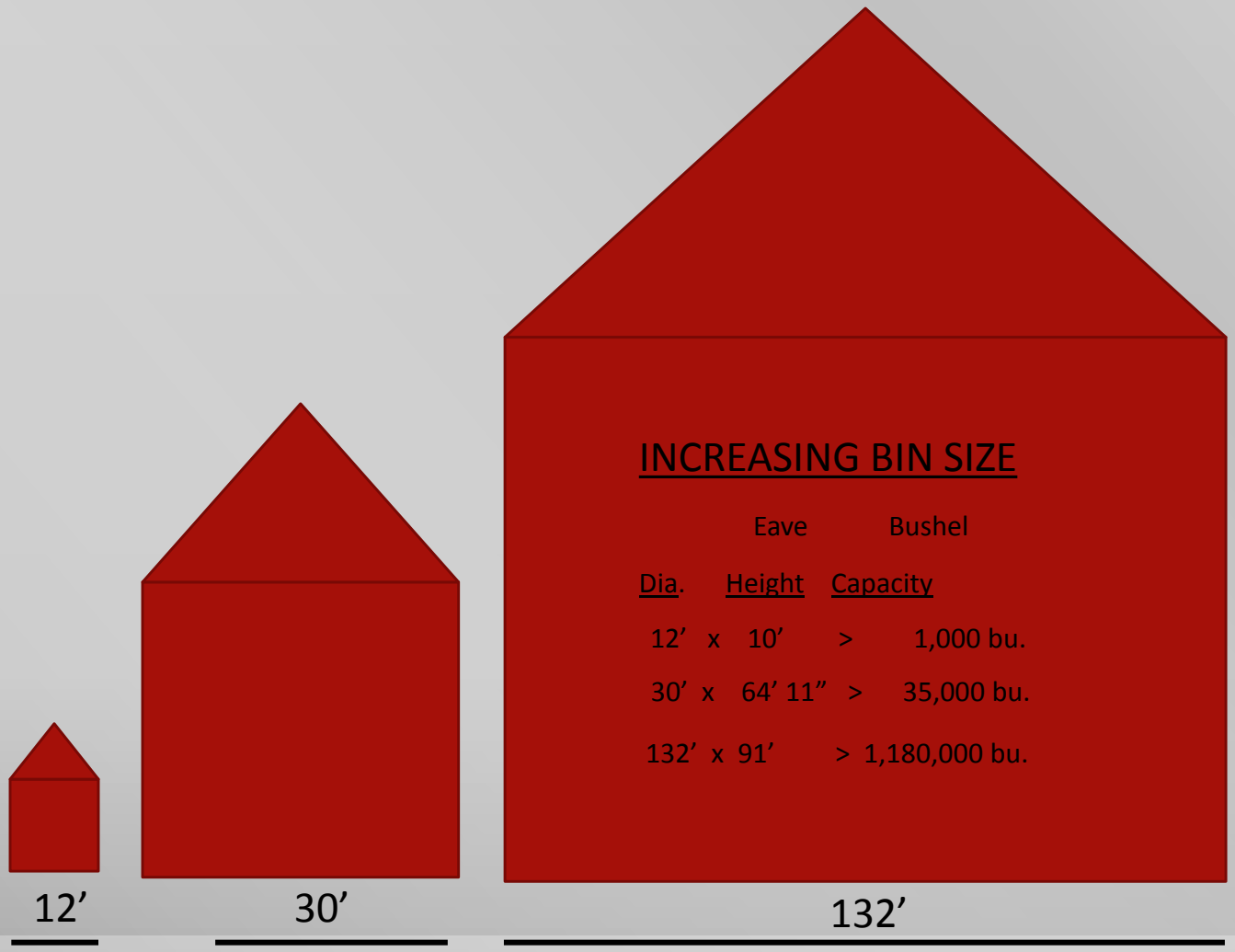
- 2015 > 24 billion Bu. (55% ON-Farm / 45% OFF-Farm)
- 2005 > 19.9 billion Bu.

Grain Entrapment Prevention

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



INCREASING BIN SIZE

Dia.	Eave Height	Bushel Capacity
12’	10’	1,000 bu.
30’	64’ 11”	35,000 bu.
132’	91’	1,180,000 bu.

Number of Grain Entrapments Reported & Fatalities

	# of Reported Grain Entrapments	Fatalities	
2015	35	14 =	40%
2014	38	18	
2013	33	13 =	39.4% of Entrapments
2012	20	8 =	40.0% of Ent
2011	32	11 =	34.4%
2010	59	31 =	52.5%
2009	44	19 =	43.2%

Version: 02/04/16

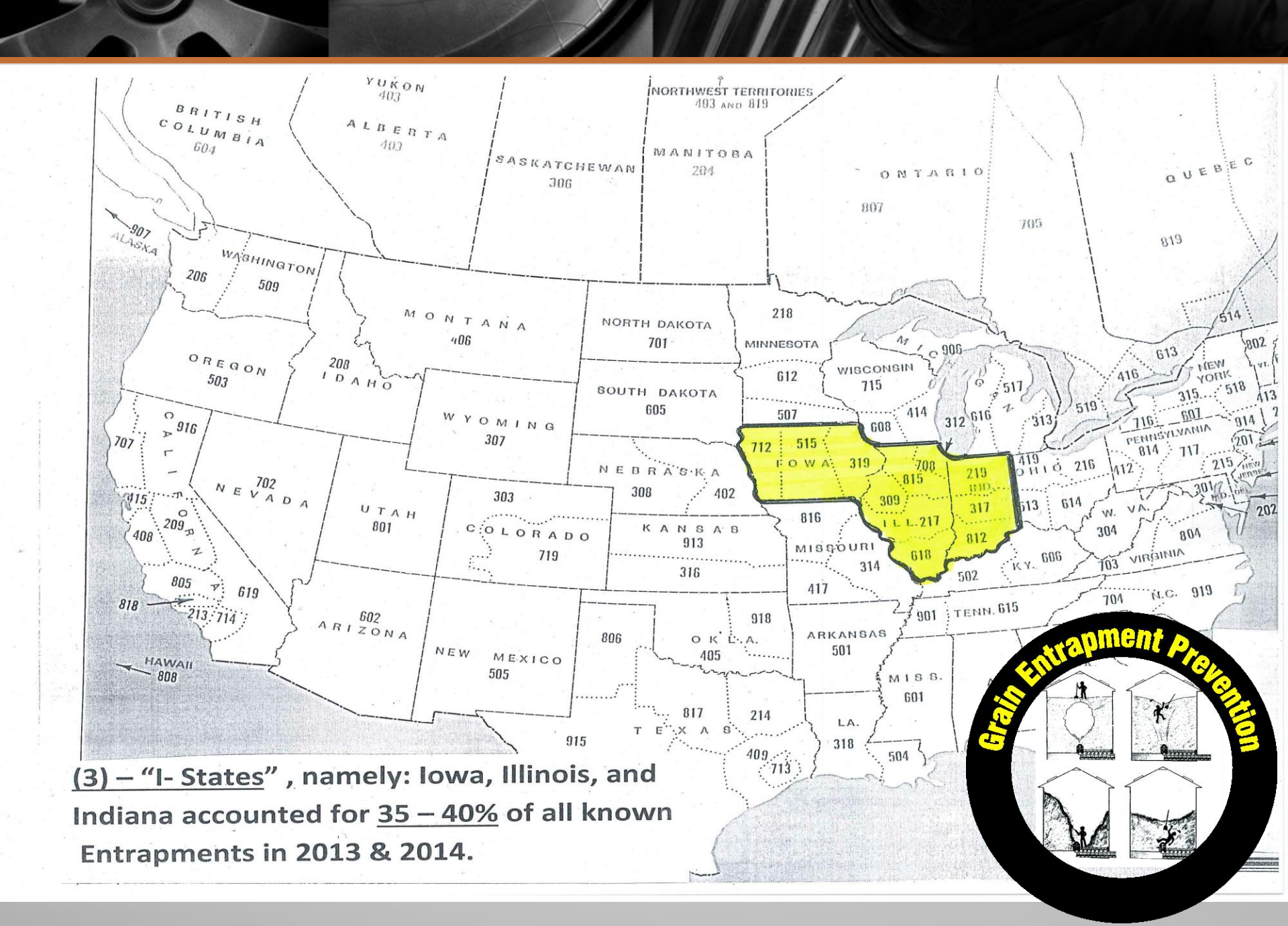
In the last (7) Years we have averaged over 36 reported entrapments & 16 deaths / Yr.

- **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?

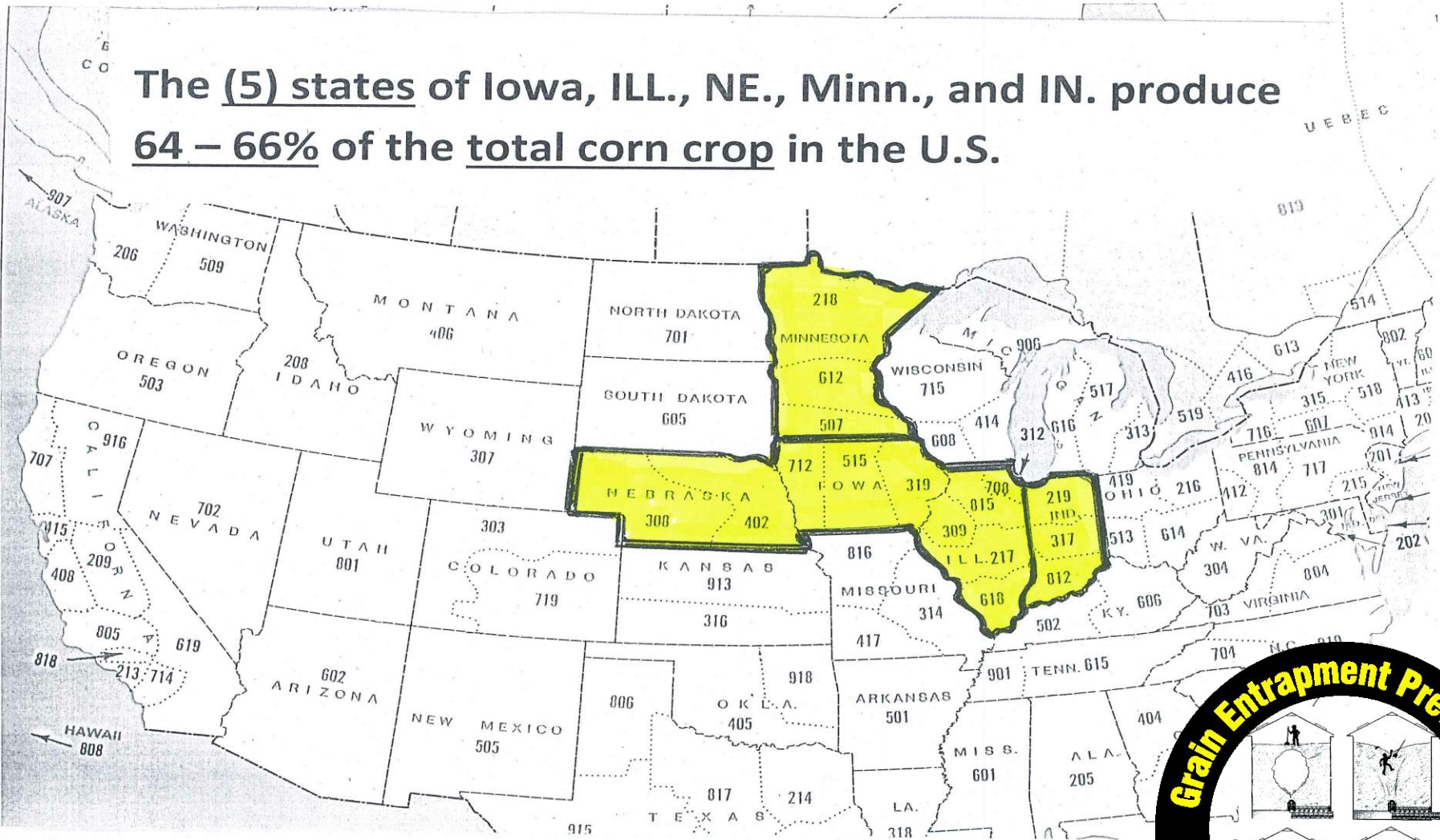
"When the incident location was known":

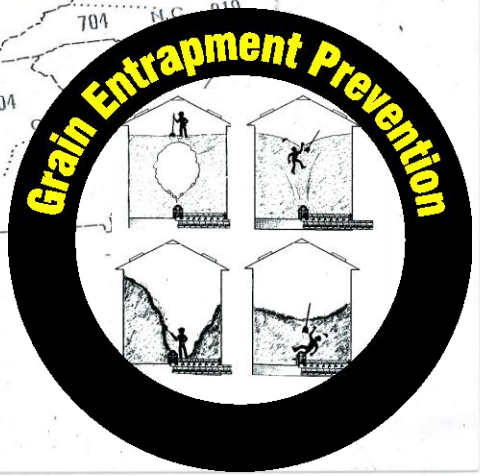
- Historically, **70% ON-Farm,** however, **over 80% took place ON-Farms in 2014**
- **68% happen around steel bins . . .** over 47 yrs. (1964-2011)
- **63% involved CORN** in 2011, smaller (%) in 2013.

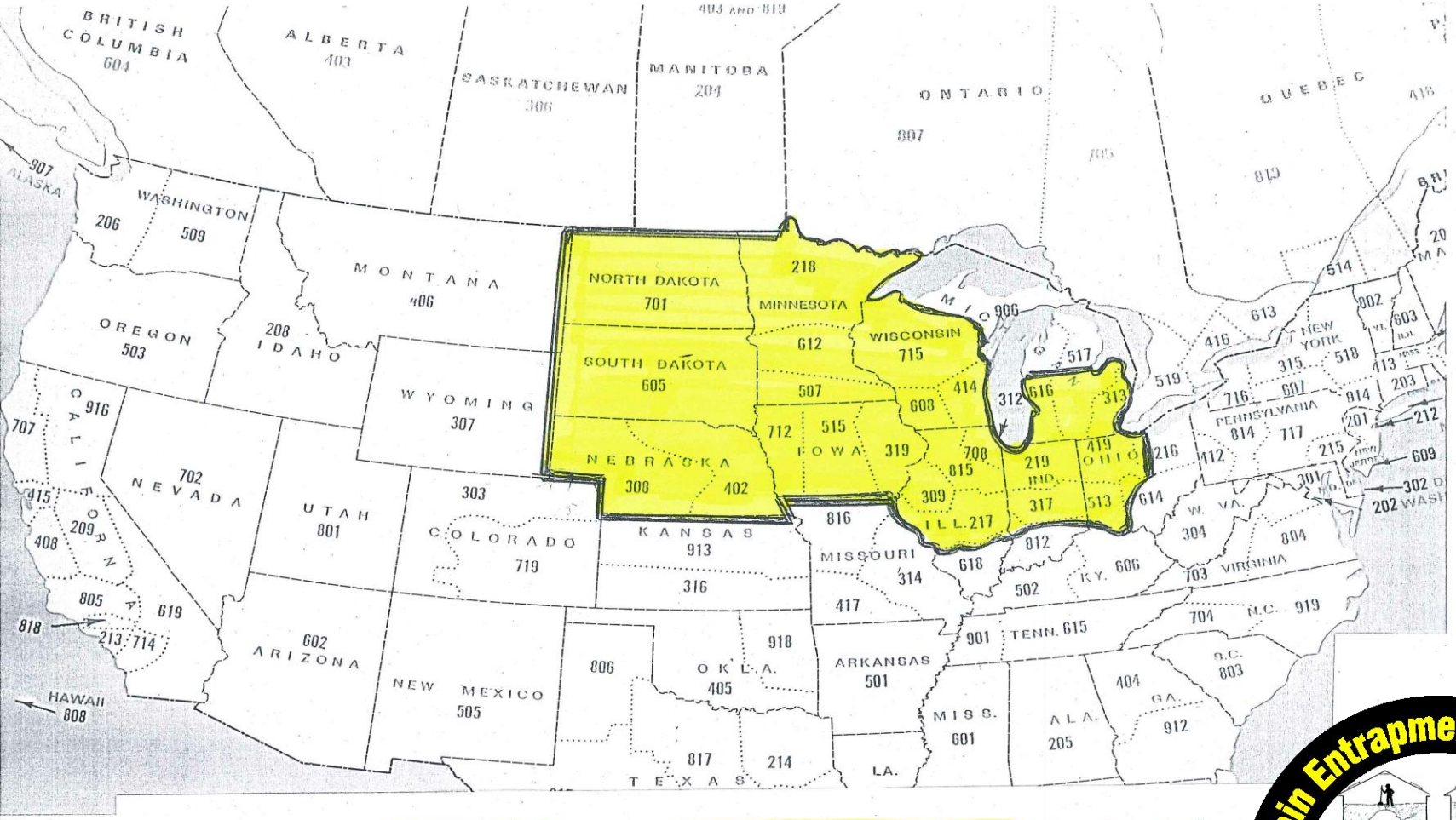


(3) – "I- States" , namely: Iowa, Illinois, and Indiana accounted for 35 – 40% of all known Entrapments in 2013 & 2014.

The (5) states of Iowa, ILL., NE., Minn., and IN. produce 64 – 66% of the total corn crop in the U.S.





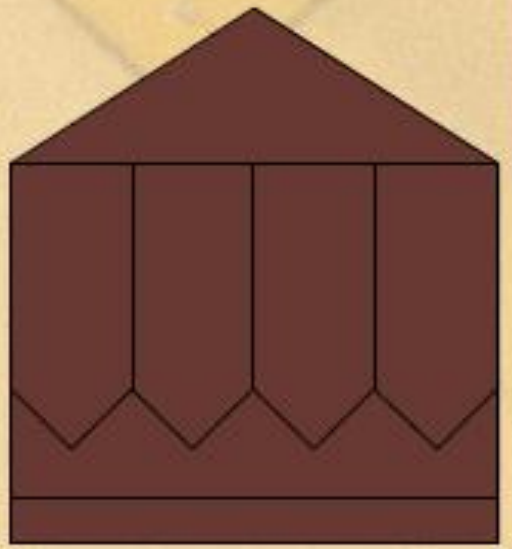


These (10) states in the Northern Mid-West accounted for 70 – 75% of the known entrapments in 2013 & 2014.

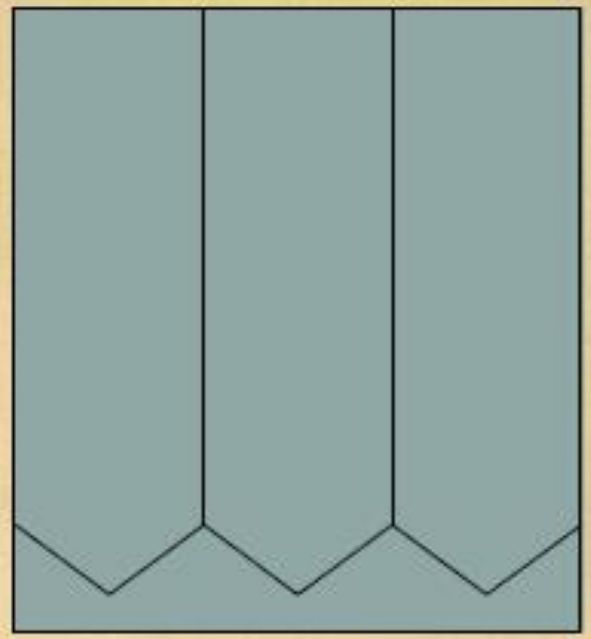
States involved: ILL., IA., IN., Minn., MI., Neb., OH., Wisc., N.D. , and S.D.

Transformation of Bin Designs

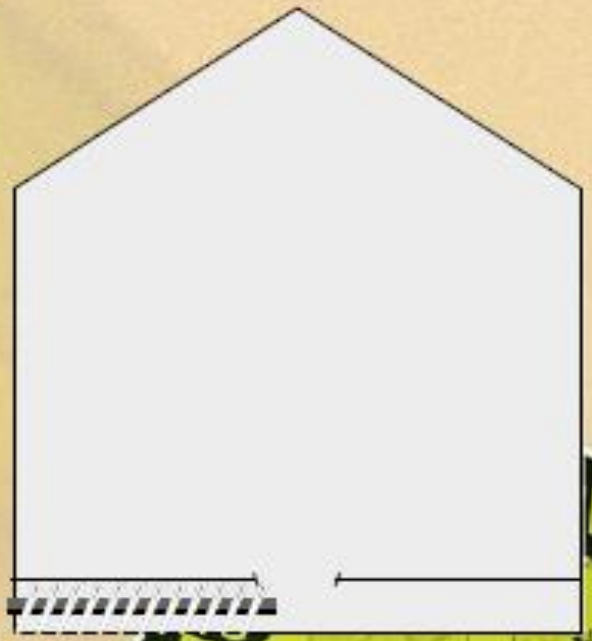
Wood

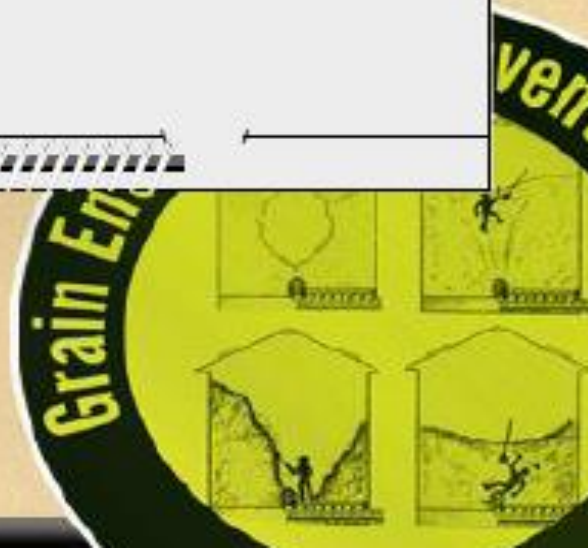


Concrete



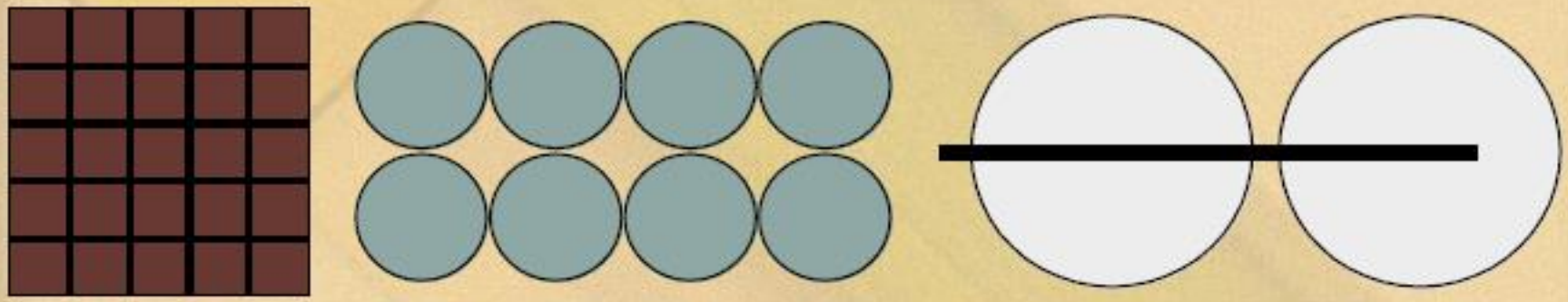
Steel





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

	Diameter	Sidewall Height	Capacity (bu.)
1908	12’		500
Mid 1960’s	36’		10,000
	48	50’	
	60 - 75’	60’	
	90’	75’	
	105’	80’ - 84’	750,000
Today	**132 - 156’**	**84 - 94’**	**1,000,000 - 1,340,000**

During the past 100 years bin sizes moved from 500 bu. to 1,340,000 bu./bin.

Residual or Non-Reclaim Grain

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

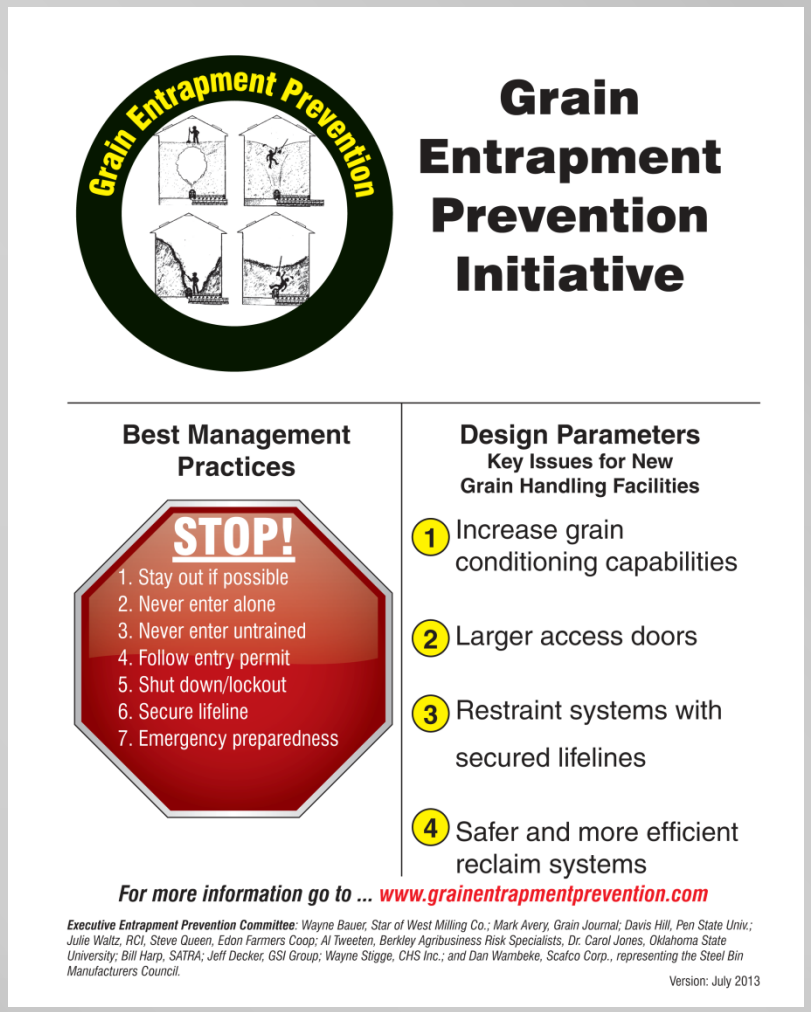
We Produce More Corn

- **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



www.grainentrapmentprevention.com

“Zero Entry Mentality”

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

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

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."*


#75-90
#90-120
Industrial 1 'D'
Full Body Harness
Industrial 3 'D'
Full Body Harness


#320
#205
UL
UL
Technical Rescue Harness
Heavy Rescue Harness


Prevention

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**.

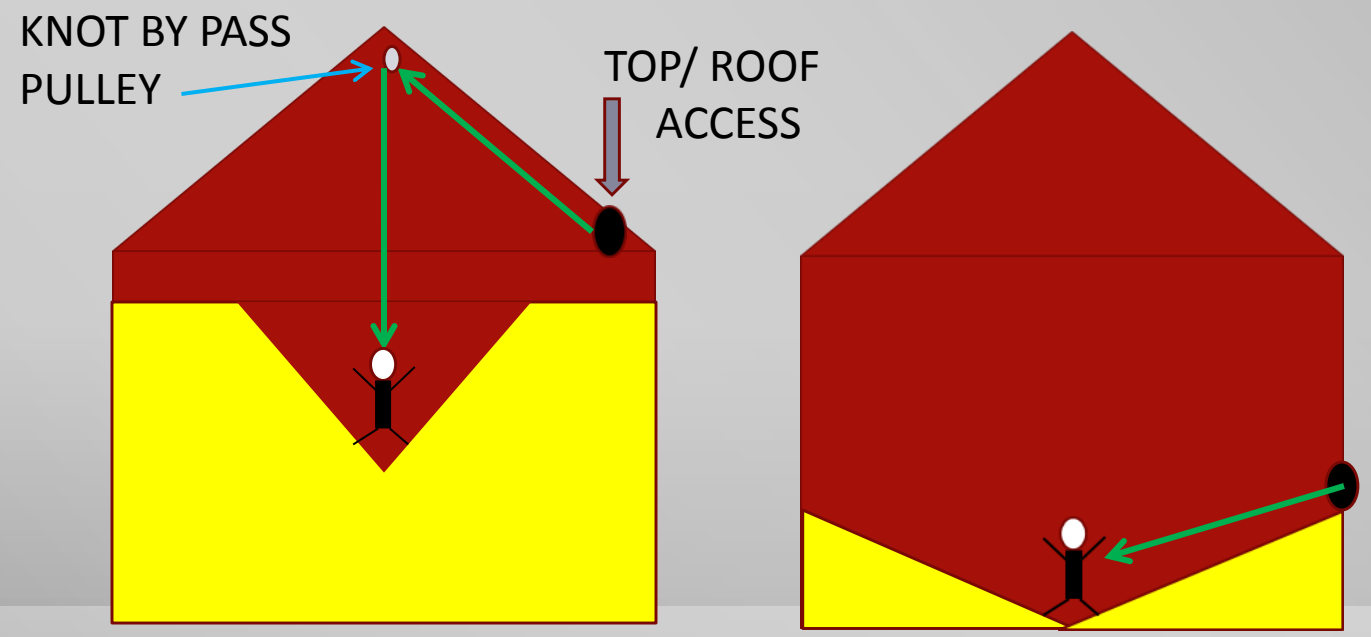
Fall Restraint:

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.

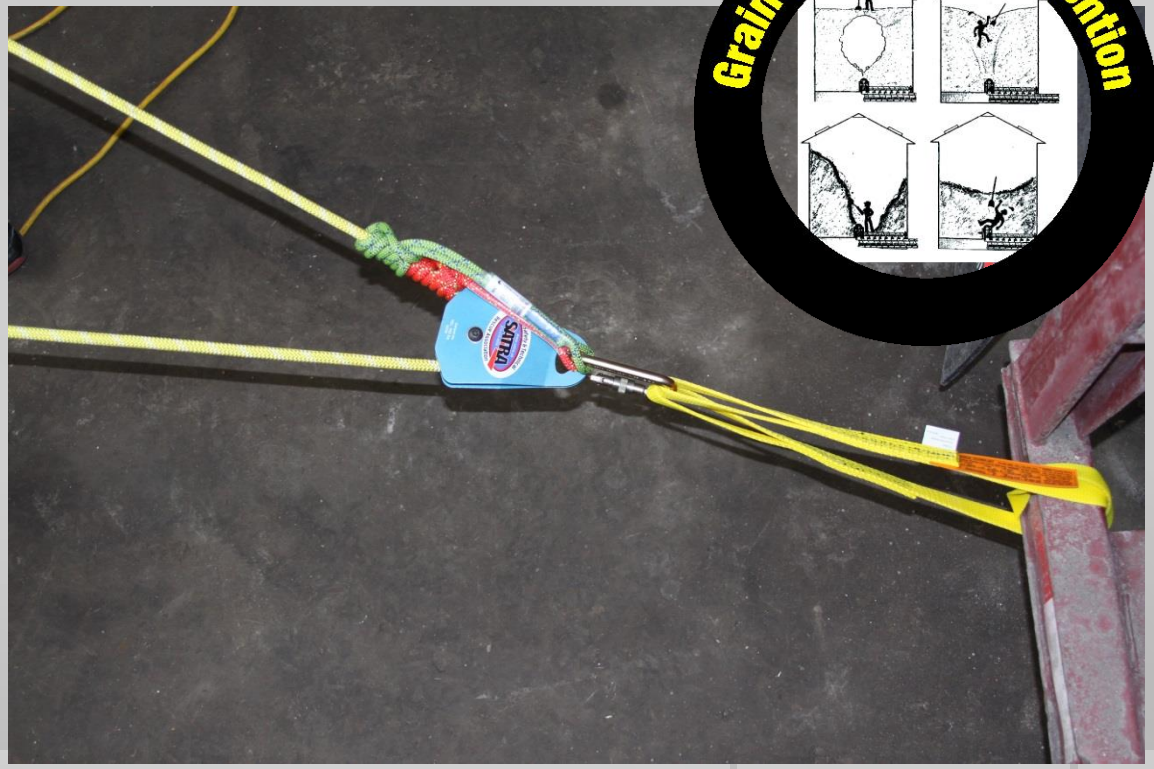
Fall Protection – vs - Prevention

- **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.

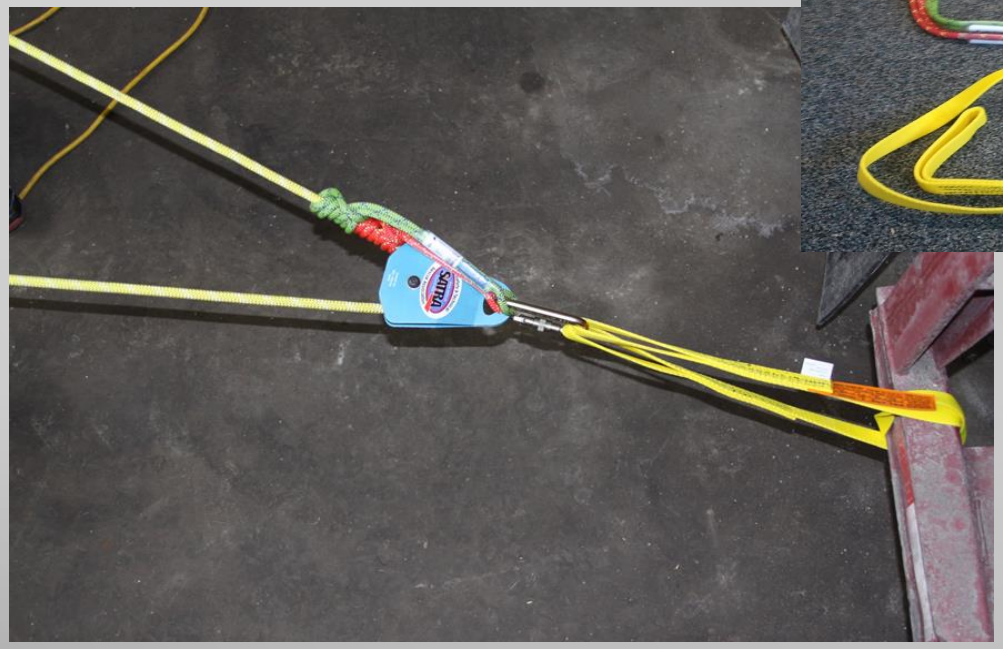


Fall Restraint Systems
Grain Bin Entry Lifeline
Bin-Entry-Kit attached to a suitable anchor



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



Grain Entrapment Prevention

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

ASABE

American Society of
Agricultural and Biological Engineers

(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.)

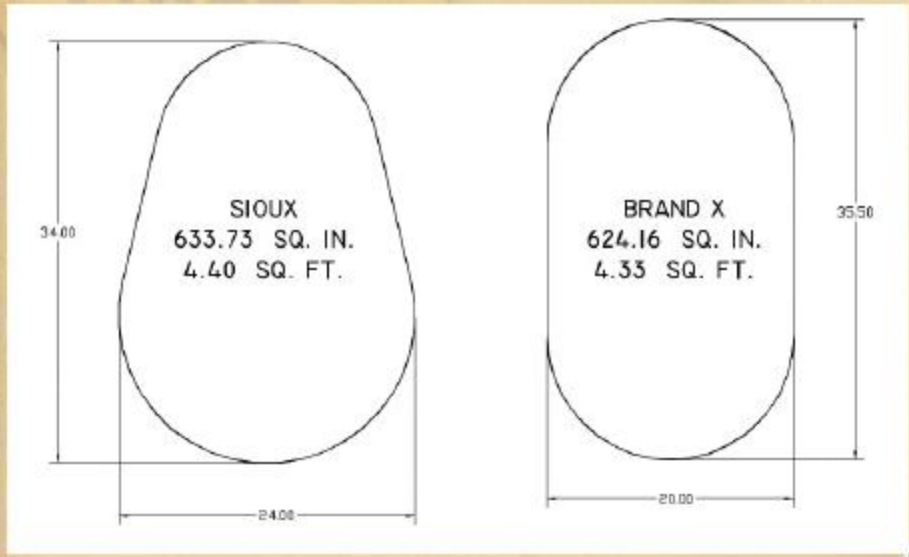
ACCESS DOORS OR ENTRY POINTS

Issues

- Size
- Configuration
- Shape
- Placement

Top Access Holes

Top Bin Entry Doors



Sketches furnished by Sioux Steel Company

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

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.

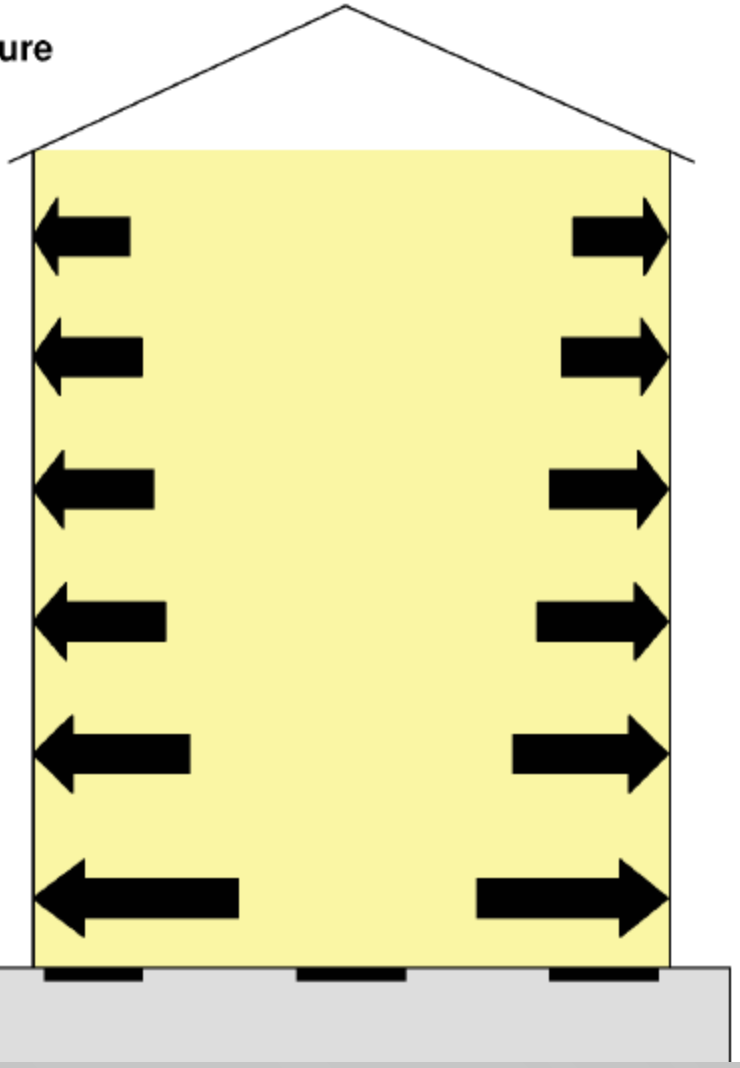
Reclaim Systems

We must give more attention to all components:

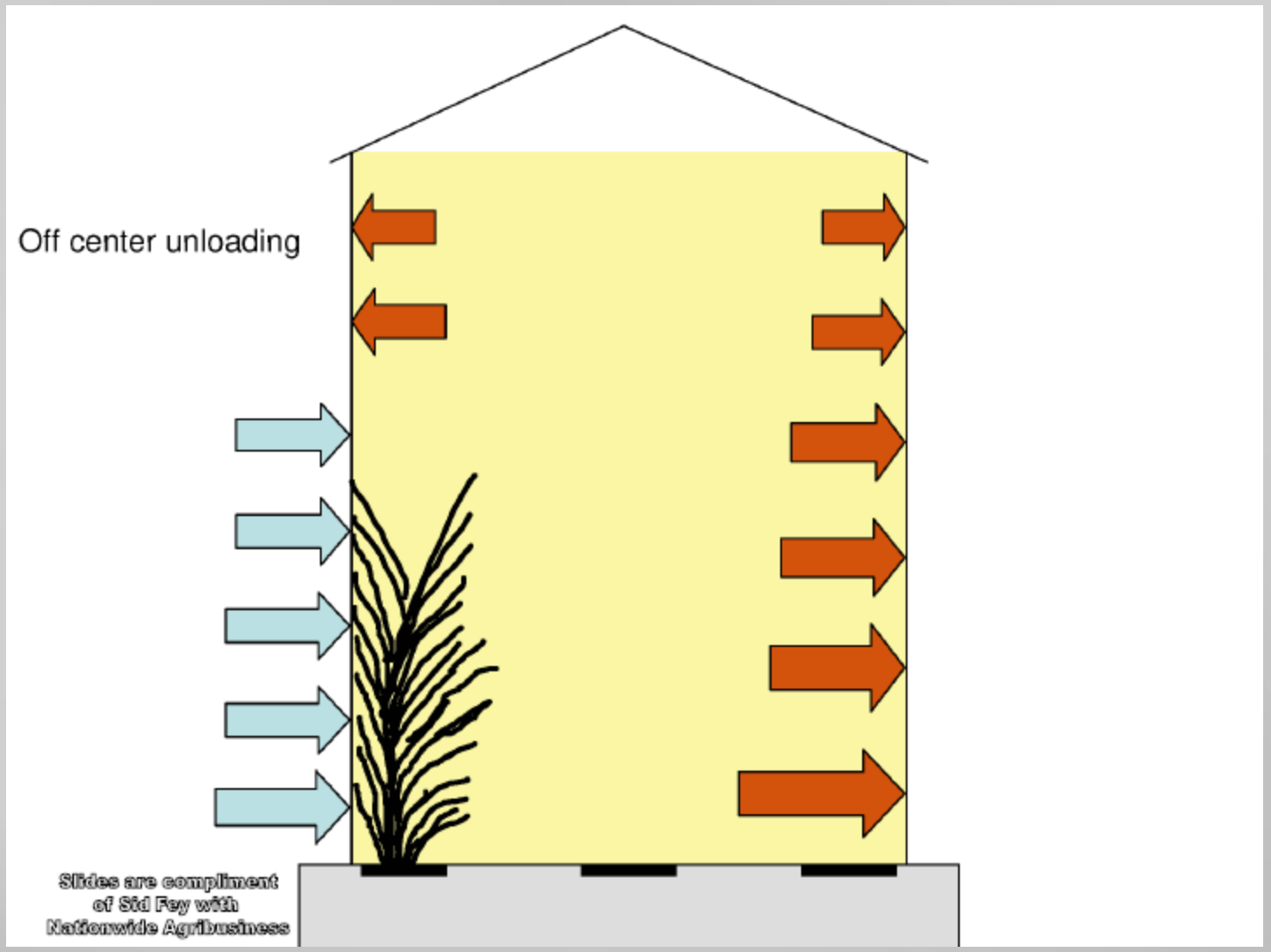
- Size and spacing of the discharge sump holes
- Sweep Auger which are safer and more efficient
- Unloading conveyer beneath the floor

Older/Inadequate Reclaim Systems

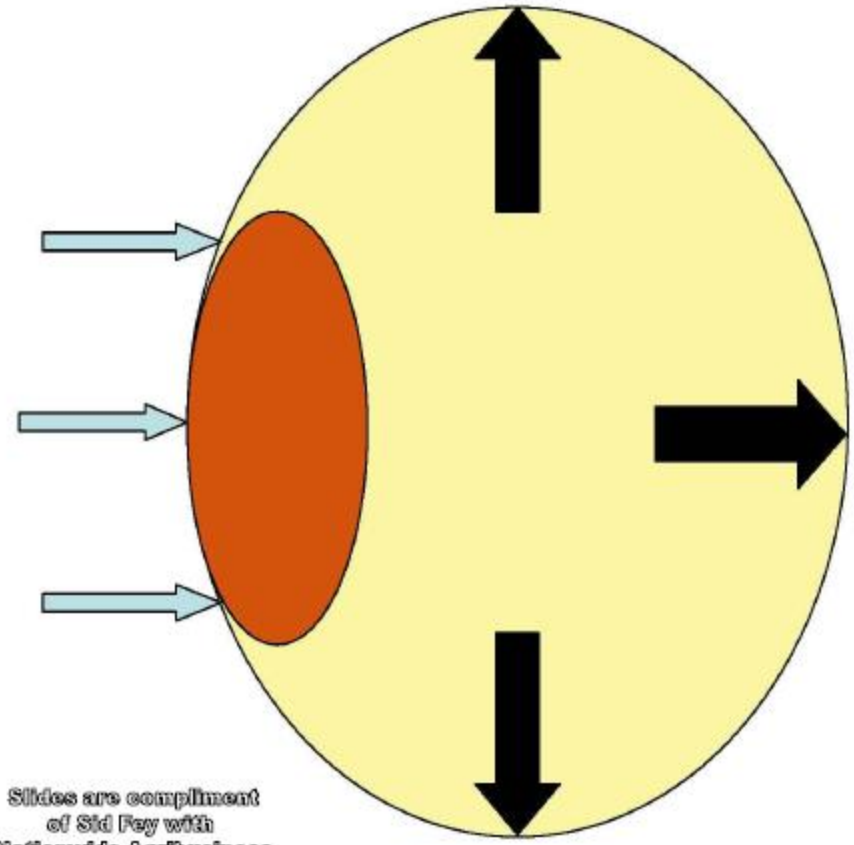
Equal grain pressure



Slides are compliment of Sid Fey with Nationwide Agribusiness


Off center unloading
Slides are compliment of Sid Fey with Nationwide Agribusiness

Unequal side wall pressure with off center unloading



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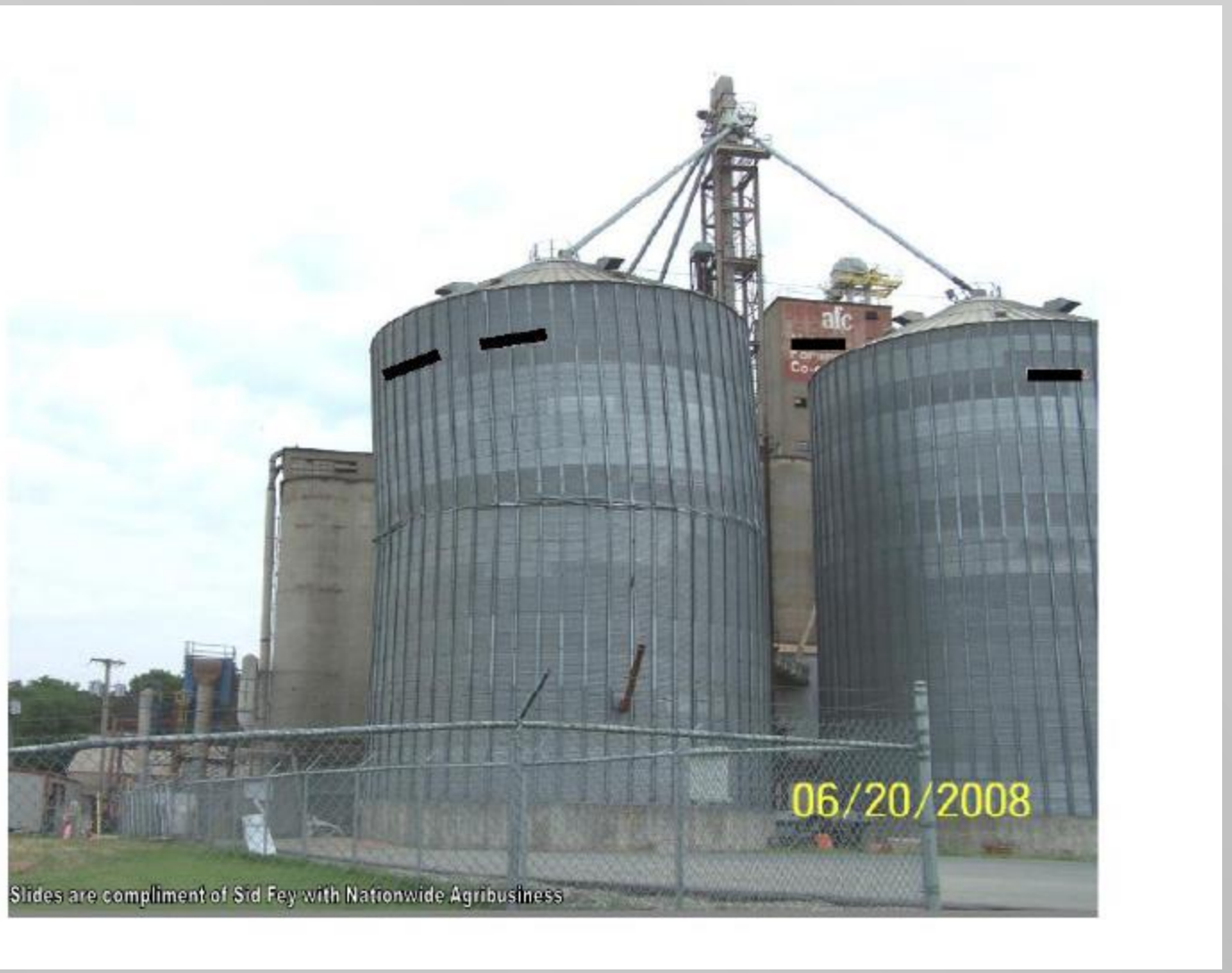
Nationwide Agribusiness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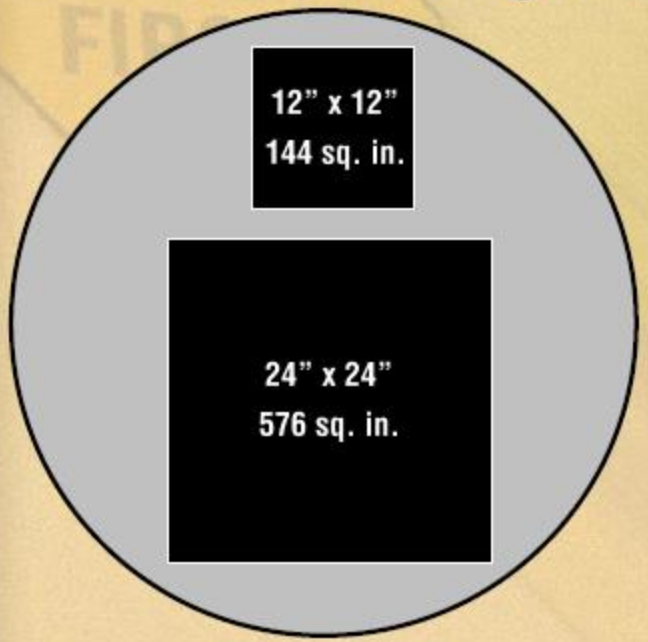
Discharge Sump Holes



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.

Equipment Manuals

- **1) Construction**
  - a) Need better "**Communication**" and "**Quality Control**" and monitoring of activities during the construction process with everyone involved, including **sub-contractors.**

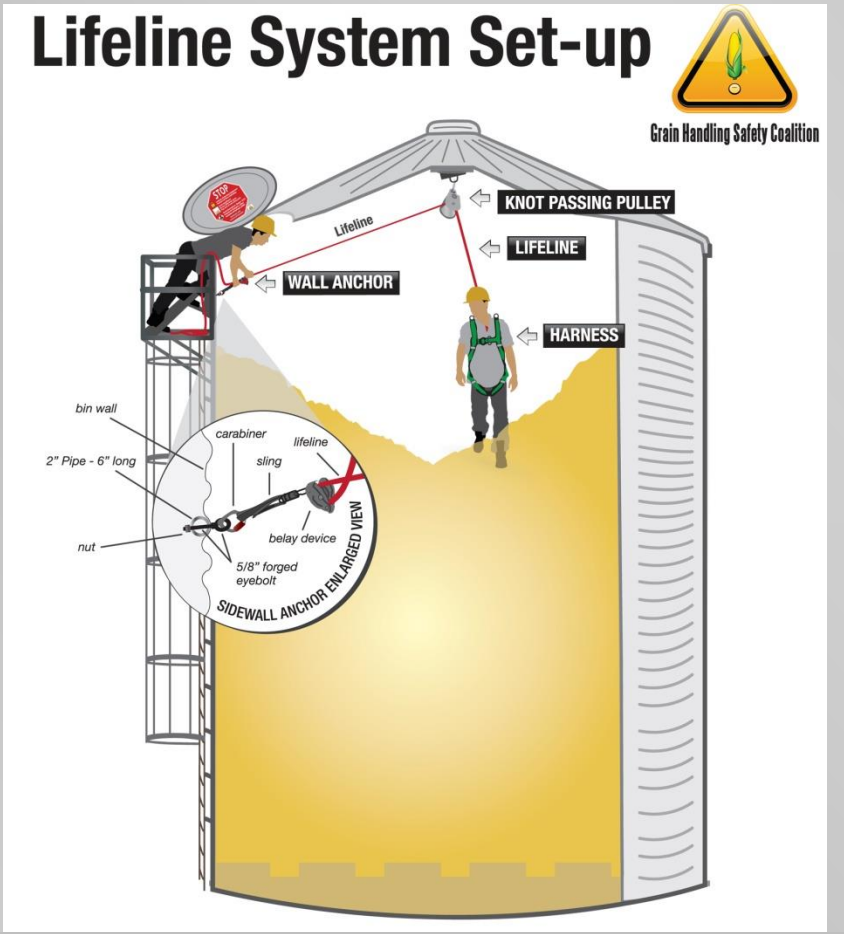
2) Operations

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

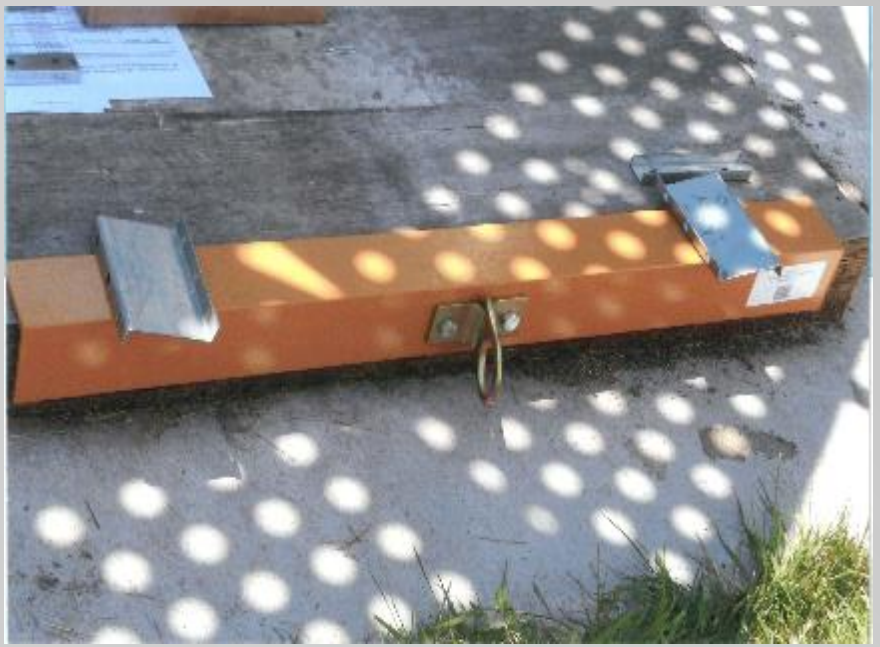
Fall Restraint System

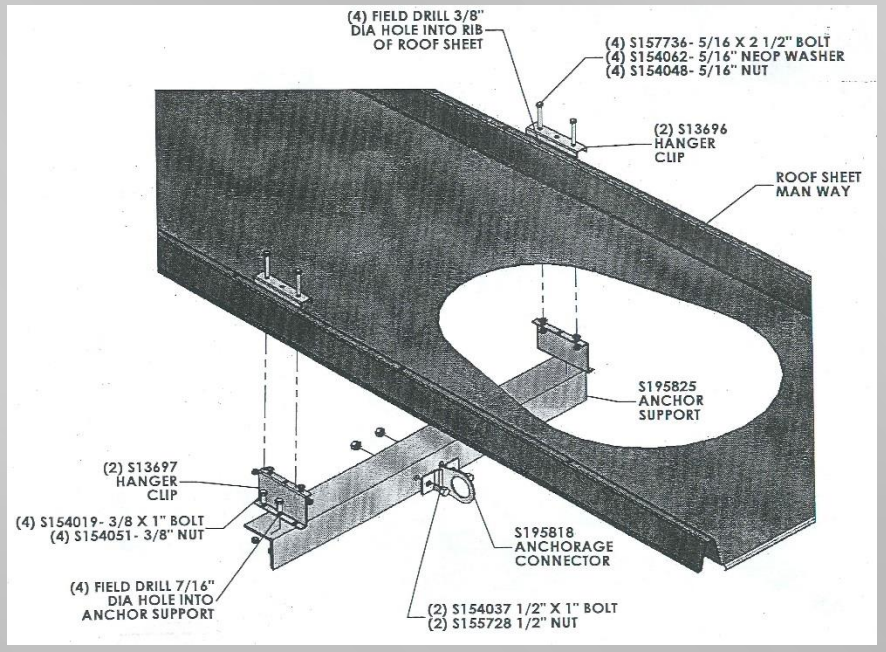
"Top Guard" - for use in 105' commercial bins

Not Fall Protection

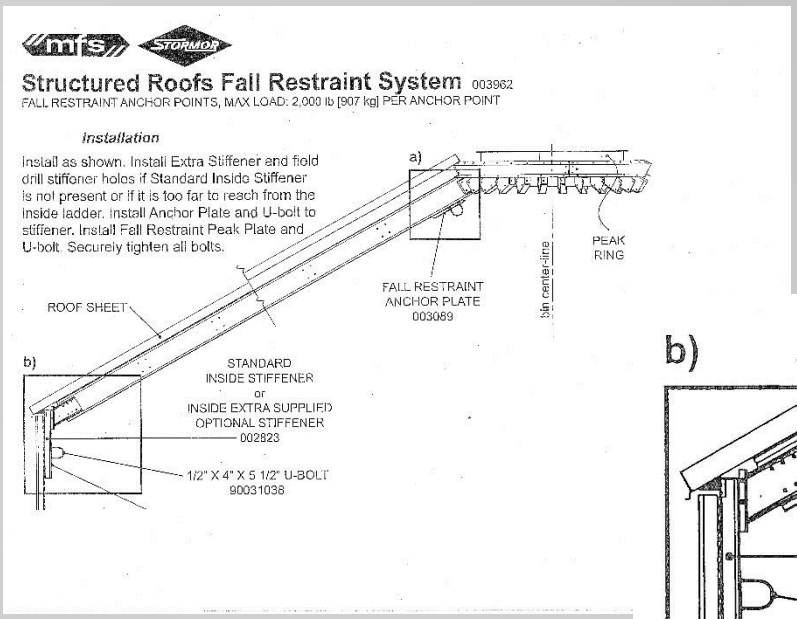
Photos courtesy of GSI Group

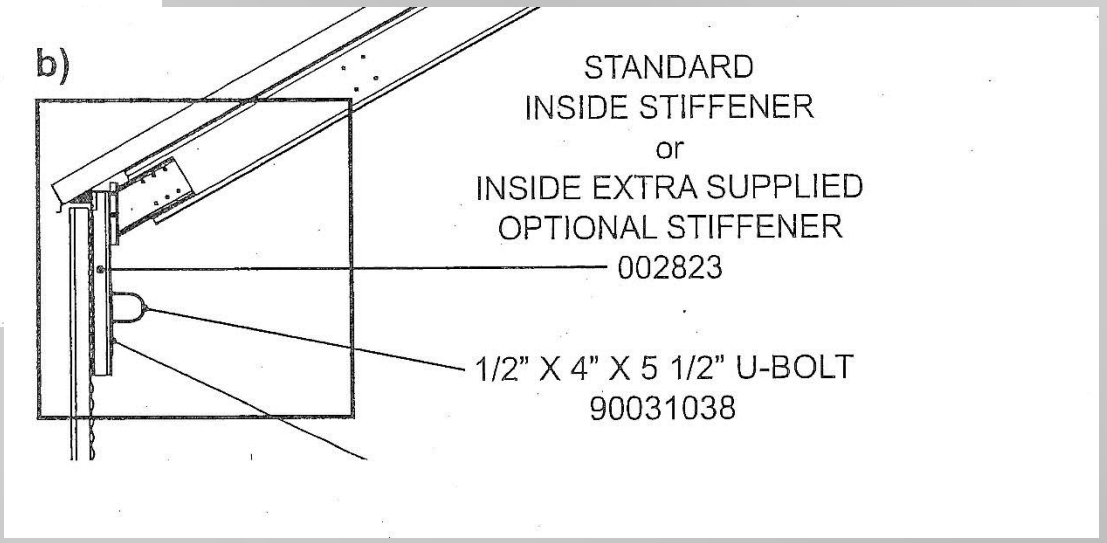
Sioux Steel




(4) FIELD DRILL 3/8" DIA HOLE INTO RIB OF ROOF SHEET
(4) S157736- 5/16 X 2 1/2" BOLT
(4) S154062- 5/16" NEOP WASHER
(4) S154048- 5/16" NUT
(2) S13696 HANGER CLIP
ROOF SHEET MAN WAY
S195825 ANCHOR SUPPORT
(2) S13697 HANGER CLIP
(4) S154019- 3/8 X 1" BOLT
(4) S154051- 3/8" NUT
S195818 ANCHORAGE CONNECTOR
(4) FIELD DRILL 7/16" DIA HOLE INTO ANCHOR SUPPORT
(2) S154037 1/2" X 1" BOLT
(2) S155728 1/2" NUT

Global Industries (MFS- Stormor)





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


Angle iron corner
Reinforcing Flange

Ag Safety & Rescue Initiative

- 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:

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- **Phone: 989 – 652 – 7026**
- **www.wayne.bauer@staroftheWest.com**