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PAgricultural Rescue Training

- Agricultural Emergencies Awareness
- Emergency Rescue in An Agricultural Environment
 - Tractor & Machinery Emergencies
 - Managing Ag Chemical Emergencies
 - Agricultural Confined Spaces- Awareness/Operations
- Animal Emergencies in an Agricultural Environment
- Introduction to Feed Mill and Grain Elevator Fires
- *Farm Confined Spaces - Technical Level (in development)*

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Course Goals

- Understand what farm silos are used for and how fires in silos can start.
- Understand the differences in silo types and how fire management is different by type of silo.
- Describe how silos are used in non farm settings.
- Recite OSHA confined space standards in relation to silo emergencies.

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Objectives-you will be able to:

- Describe the importance of pre-planning for various silo related emergencies in your area.
- Develop and enforce SOG's/SOP's for silo related emergencies.
- Recite the hazards associated with all types of silos.
- Describe why silos are considered confined spaces and what that means to emergency personnel.

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Objectives continued

- Describe the importance and role of a safety officer at a silo emergency.
- Describe community wide efforts that can lead to fewer farm confined space incidents.

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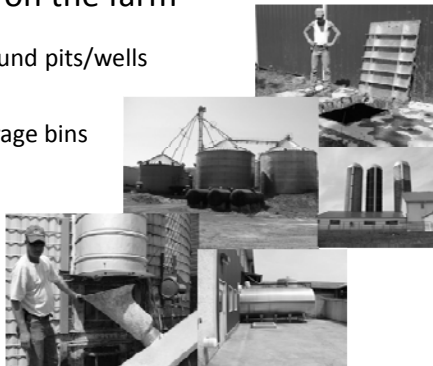
Confined Space Defined

1. Limited or restricted means of entry or exit
2. Large enough to enter
3. Not designed for continuous occupancy



Examples on the farm

- Underground pits/wells
- Tanks
- Grain storage bins
- Pits
- Silos



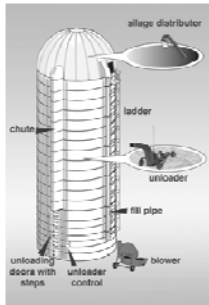
Farm Silos

A farm silo is container that is used to allow forage or grain material to ferment and be held until used as animal feed.

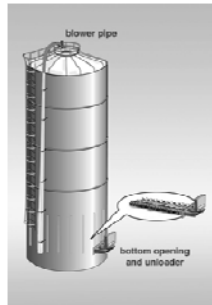
- **Vertical Silos**
 - Conventional
 - Oxygen limiting
 - Modified oxygen limiting
- **Horizontal Silos**
 - Bunker
 - Trench or pit
 - Bags



Vertical Silo Types



Conventional



Oxygen limiting

Vertical Silo Types



Silo conversions





Fire Hazards

- Causes
 - **Spontaneous combustion**
 - Aerobic respiration consumes oxygen
 - Anaerobic fermentation produces heat & acids
 - Water conducts heat away from silage mass
 - If too dry, heat is not conducted away
 - **Electrical short or overheating motor**
 - On dry material-may burn down
 - Inside silo or in chute

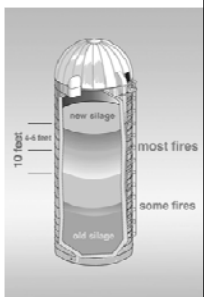


Spontaneous combustion

- Pocket of dry material during filling
 - Air that is trapped allows excessive heating
- Air penetrates from sides of silo, especially around silo doors. Dries silage and allows for moisture to be absorbed.
 - Air is trapped and begins to heat (fermentation process begins again)
- Fresh silage is put on top of old silage that has been allowed to dry out.
 - Silo that has not been used will have dry material on top

Fire behavior/location

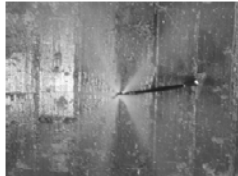
- Heating silage during fermentation
 - Normal 140-160° F
 - Combustion takes place at 180° F
- Incomplete combustion slowly spreads in pocket
- Localized to that one area-usually close to area that let air in
- Within 10 feet of silage level



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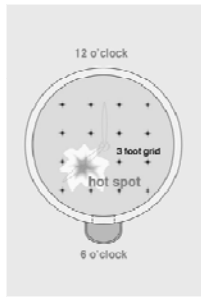
Fire management

- **Locate the hot spots (pockets)**
 - Probing
 - This is a confined space procedure
 - Thermal imaging
- **Small amounts of water**
- **Flooding not effective**
 - Will not reach pocket
 - Will ruin the good silage
 - May have a negative impact on integrity of silo



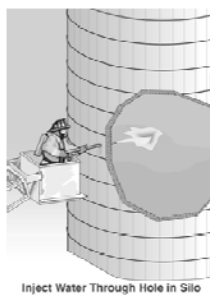
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Temperature Probing

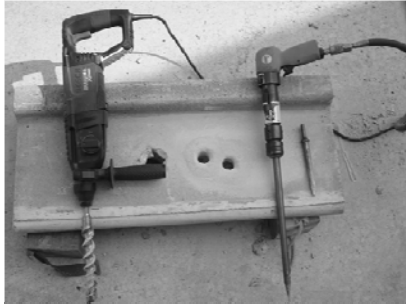


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Fire management

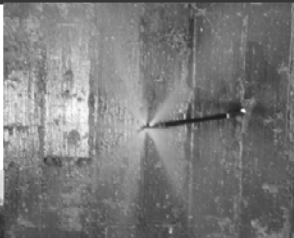


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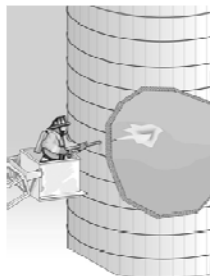
Probing



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Probing into burning pockets

- Potential buildup of CO
- Adding water will add oxygen
- Steam explosion possible
- Go in dry, pull out wet



Inject Water Through Hole in Silo

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Wash out chute



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Flames observed on silage surface from filling platform or aerial?



- Raise & secure silo unloader
- Direct water stream at flames and heavily smoking areas of silage surface with straight tip nozzle.

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Heavy Smoke observed coming from silage surface?



- Raise & secure silo unloader
- Direct water stream at flames and heavily smoking areas of silage surface with straight tip nozzle.

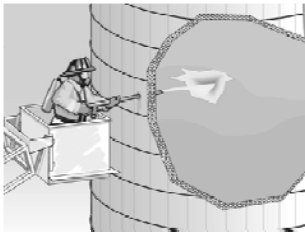
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Thermal imaging camera available?



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Use piercing nozzle from outside the silo into hot zones



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Will farm operator unload silo to below suspected hot area?



Prepare for flare ups. Observe from loading platform and bottom of chute with charged lines.

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From bottom of silo chute, are any silo doors burned through?



Direct water "spurts" via straight tip nozzle or via probe through burned out doors from the chute. Water on withdrawer of probe to allow steam to escape.

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Still can't locate it or stop it?

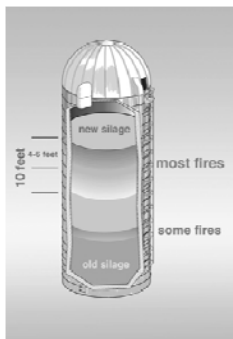
- Allow to burn
- Await **confined space trained** silo team



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Unload Silo

- To below burned area
- Prepare for flare ups
 - Observe from loading platform & bottom of chute



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Oxygen limiting silos

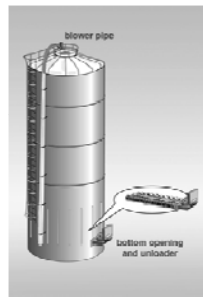
- Construction
 - Glass lined steel panels bolted together
 - Poured concrete
- Atmosphere controlled through a breather bag in top or in adjacent structure (barn)
- Designed to keep air out
 - Normal environment is 4% O₂
- Unloader normally on bottom, unless modified then on top



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**Oxygen limiting silos
Filling and unloading**

- Filled with outside fill pipe-to center of roof
- Unloader usually on bottom unless modified, then on top



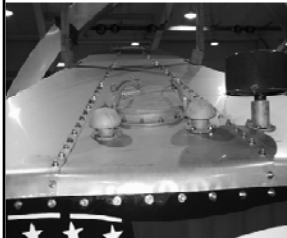
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**Oxygen limiting silo
Normal practice**

- Open and close top hatch for fill pipe
- No need to enter
 - Unless tool or object is dropped from top hatch
- Open and close bottom hatch for unloader
 - Occasionally must crawl in unloader space to service unloader



Oxygen limiting silo



Top showing entry portal & air vents



Air vents connected to air bag inside silo or adjacent building

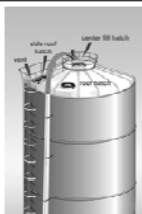
Oxygen limiting silo Fires

- Caused by too dry material forming a dry “pocket”
 - Excessive heating
 - No air to feed it so just smolders
 - Produces CO—Flammable range 12-74%
 - Pyrolysis reactions
- Also note seals around steel panels crack with time, allowing air to penetrate
 - Silos unused for 10 years have caught fire

Oxygen limiting silos

Firefighting strategies

- Do nothing to introduce O₂
 - Close top and bottom hatch
 - **STAY OFF SILO TO ACHIEVE**
 - No water or foam
 - **Remember: because of incomplete combustion there is a buildup of CO and pyrolysis reactions. Adding O₂ will cause an explosive environment!**
 - Wait 2 weeks
 - Can consider injection of inert gas to displace any O₂



Signage on silos



Result of spontaneous combustion

- Tight structure
- Incomplete combustion created a vacuum causing an implosion
- Panel seals broke allowed air to enter, causing explosion.

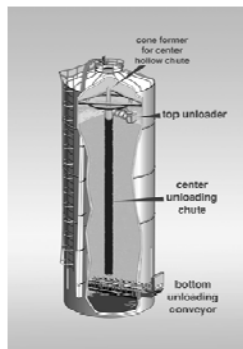


Modified Oxygen Limiting Silo

- Unloader has been installed to top
 - Conventional unloader
 - “Big Jim” unloader
- Dilemma-is it now a conventional silo?
 - It should be treated as oxygen limiting for firefighting purposes
 - Determine O₂ and CO levels prior to management



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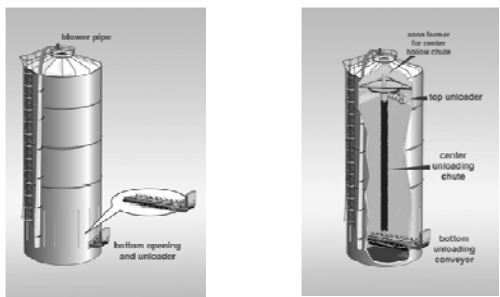
Oxygen Limiting and Modified Oxygen Limiting Silo Fire Decision Tree



- DEFINITIONS AND NOTES:**
- 1. MODIFIED OXYGEN LIMITING SILO: A SILO WITH A CENTER UNLOADING CHUTE OR UNLOADING CONVEYOR.
 - 2. OXYGEN LIMITING SILO: A SILO WITH A CENTER UNLOADING CHUTE OR UNLOADING CONVEYOR.
 - 3. MODIFIED OXYGEN LIMITING SILO: A SILO WITH A CENTER UNLOADING CHUTE OR UNLOADING CONVEYOR.
 - 4. OXYGEN LIMITING SILO: A SILO WITH A CENTER UNLOADING CHUTE OR UNLOADING CONVEYOR.
 - 5. MODIFIED OXYGEN LIMITING SILO: A SILO WITH A CENTER UNLOADING CHUTE OR UNLOADING CONVEYOR.
 - 6. OXYGEN LIMITING SILO: A SILO WITH A CENTER UNLOADING CHUTE OR UNLOADING CONVEYOR.

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Confirm Oxygen limiting or Modified Oxygen limiting silo



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Modified Silos

- If silo was constructed as oxygen limiting, treat it like oxygen limiting.
- Ask farm operator if silo has been modified.

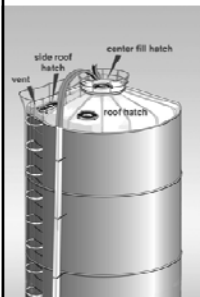
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Close and latch silo unloader chute door



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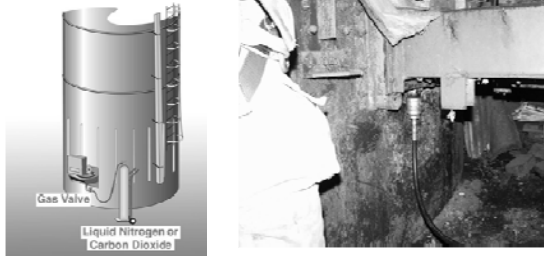
Heavy smoke and/or rumbling observed at silo, and/or side of silo hot to touch? STAY AWAY!



Wait 2-3 weeks.

Is smoke or heat still present?

Injecting Gas into a Sealed Silo



Summary

- Review, revise & enforce SOG's/SOP's regarding silo fires/silo rescues.
- Train all personnel on hazards and tactics regarding silos.
- Jurisdictional pre-incident planning regarding silos—also mutual aid especially if your resources will be requested.
- Work with farm community to place warnings and placards on silos.

Break Time



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Silo Fire Case Studies- Do you measure up?



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Mifflin County 2011



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Berrysburg

- Dauphin County



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Churchtown -
Caernarvon Township
• Lancaster County









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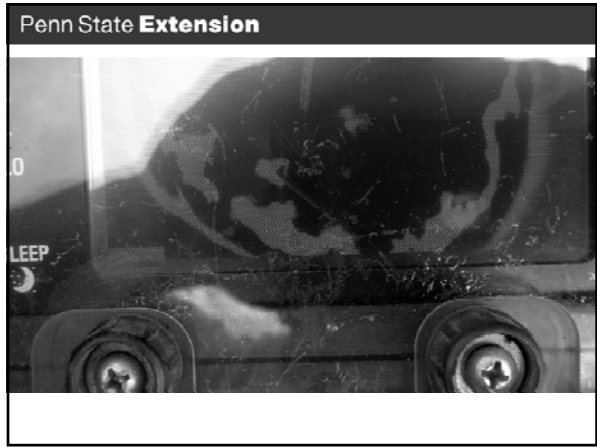
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Selinsgrove Snyder County 2011

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Pitman –
Eldred Township
• Schuylkill County



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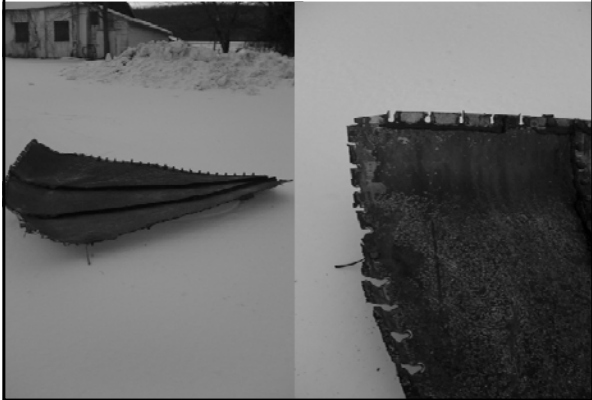
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New Tripoli Silo Fire-Lehigh County



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Size Up-Confirm Pre-plan
Oxygen limiting or Conventional?



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Assure top hatches are closed



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Assure bottom hatches are closed



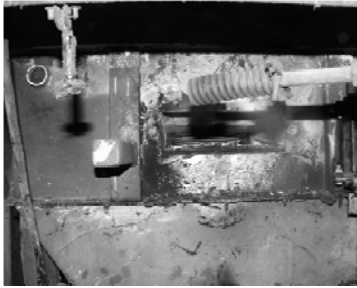
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Inspect for physical damage



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Back side of unloader—no way to close



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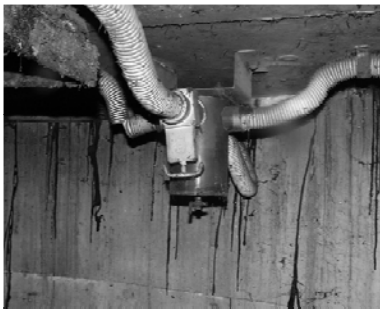
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Notice melted breather pipes



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Notice tar on walls



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Breather tubes



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Breather tube connected to
breather bag



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Breather tube connection to fill
pipe



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Gas injection port



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Burned bearing from heat of fire



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Structural compromise?



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Ascertain temperature



Seek technical advice



List options with farm owner



Options

- Close silo and wait 2 weeks
- Inject Carbon Dioxide gas

Bracing up the silo floor



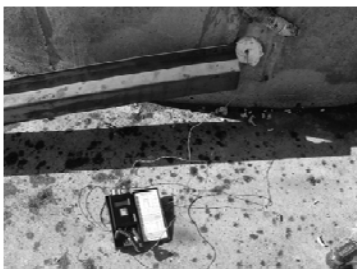
Sealing the tunnel



Now air is nearly blocked, fire should cool down

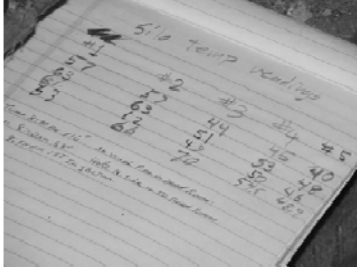


Block all air entrances



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Keep record of temperature readings



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Carbon Dioxide gassing



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Ground tanks from static electricity



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Continue to monitor over next
several days



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A happy ending



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Newport-PA Perry County 2010



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Confirm silo type



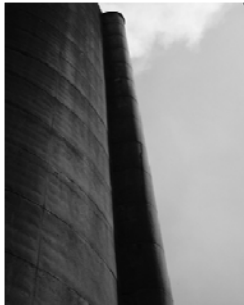
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Size up



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Size up-establish safety officer



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Lock out-tag out hazards



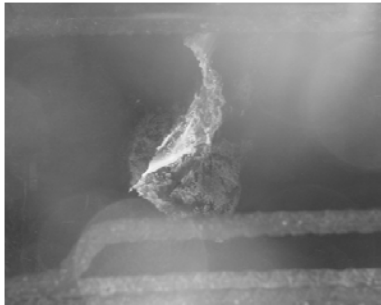
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Size up



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Further size up



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Discuss options with farmer



Let it burn
Slow down and let burn

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Flooding with water-what goes in
needs to come out.



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