Fire Service Guide Series

(5/88)

4/ *Handling Fires in Farm Silos*

INTRODUCTION

There is considerable concern in the fire service regarding the proper methods of extinguishing fires in farm silos due to the serious danger of explosion, hazardous operating conditions and difficulty in extinguishing fires in this specialized structure.

The local fire department must be prepared to handle problems presented by a silo fire and successfully extinguish it without causing unnecessary property loss. By following basic firefighting principals and manufacturer's recommendations, silo fires will be safely extinguished with a few firefighters and minimum amount of agent.

Generally, a silo will contain materials not considered hazardous (hay, alfalfa, corn). However, during the fermentation of silage or as a result of fire, hazardous gases, such as carbon monoxide (CO), carbon dioxide (CO_2), nitric oxide (NO), nitrogen dioxide (NO_2) and nitrogen tetroxide (N_2O_4) will be generated. This warrants self-contained breathing apparatus to be mandatory for all silo fire or rescue situations.

Occasionally, chemicals may be added to silage to increase its nutritional value or prevent spoilage. Again, the farmer should be questioned during the preplanning phase to determine what, if any, products are used, their chemical make-up and possible hazards associated with the product. The county Cooperative Extension agent will be helpful in gathering product information.

Figure 1. Some characterisitics of a silo fire.

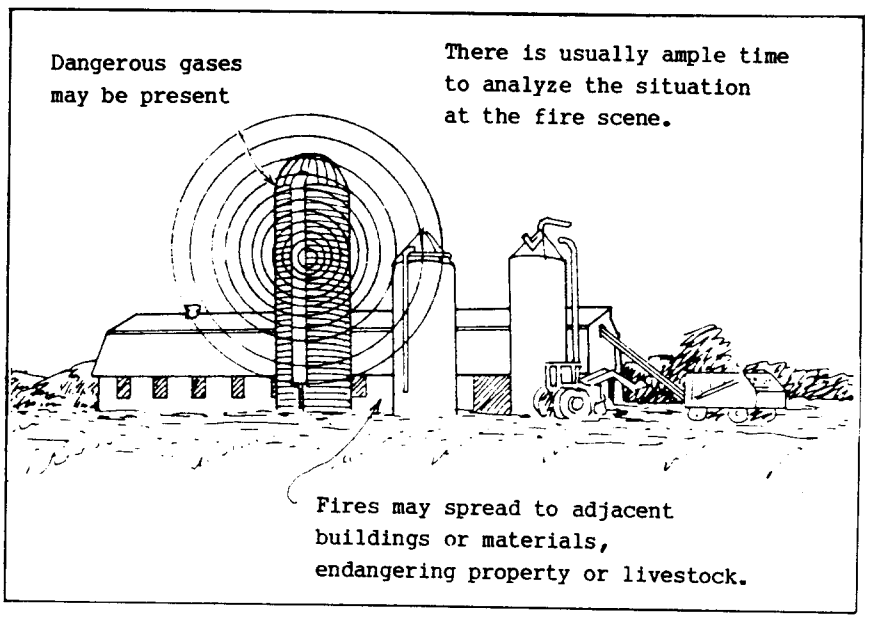


Table 1. Characteristics of dangerous gases that may be present in silos.

GAS	HEALTH EFFECTS		EXPOSURE LEVEL MAXIMUMS[1]			PHYSICAL PROPERTIES			FLAMMABLE PROPERTIES	
	Acute	Long Term	Immediately Dangerous to life & health	Short-term exposure[2]	8-hour work day	Density (Air=1)	Color	Odor	Explosive Limits[3]	Autoignition Temperature
Carbon Monoxide (CO)	Asphyxiant		1,500	400	50	.97	Colorless	Odorless	12.5-74.0	1128°F(609°C)
Carbon Dioxide (CO_2)	Asphyxiant		50,000	15,000	5,000	1.52	Colorless	Odorless	Nonflammable	
Nitrogen Dioxide (NO_2)	Respiratory Irritant	Permanent Lung Damage	50	No standard presently in effect	5	1.16	Reddish brown	Strong Pungent	Nonflammable but will support combustion	
Nitric Oxide (NO)	Asphyxiant		100	35	25	1.53	Colorless	Strong Pungent	Nonflammable but will support combustion	
Nitrogen Tetroxide (N_2O_4)	Respiratory Irritant	Permanent Lung Damage	50	No standard presently in effect	5	1.58	Yellow	Strong Pungent	Nonflammable but will support combustion	

[1]Numbers represent parts of gas permissible per million parts of air.

[2]Fifteen minute exposure, maximum 4 exposures per 8-hour day with 60 minute intervals between exposures.

[3]Percent of flammable vapor, by volume, when mixed with air that can cause an explosion.

SAFETY

Fire officers should use extreme caution when placing apparatus and committing personnel at the scene of a silo fire. The following general precautions apply to all such fires:

1. All personnel will be required to wear full protective clothing (turnout gear). Those directly involved with operations near the silo should wear self-contained breathing apparatus.
2. Apparatus should be placed a safe distance (200' minimum) from the silo to prevent damage or injury in the event of an explosion or collapse.
3. Personnel should never be placed on top of, or over the top of, a silo with ladders (aerial or ground).
4. Never allow personnel to enter a void in the silage. The material above and around the void may collapse and entrap them.
5. If necessary to enter a silo, full protective equipment should be worn (Item 1). Also, ladders or wood planks should be used to distribute weight over the silage. Life lines should be used at all times while working inside of a silo. The necessary equipment to effect a rescue should also be on hand.

PREPARATION

This guide recommends extinguishing procedures and suggests ways to plan your operations in advance so the fire service, and other agencies in your locality, will be prepared to work together in the event of a silo fire.

FIRE PREVENTION

Preventing a silo fire is much easier than extinguishing one. Generally, the cause of silo fires is spontaneous ignition of the stored material due to improper handling or failure to follow the silo manufacturer's recommended operating procedures.

Fire departments, county fire coordinators, Cooperative Extension agents and local farm bureau organizations are encouraged to sponsor agricultural fire prevention seminars. Details of proper fire prevention measures should be distributed at this time. A seminar will allow you to meet with the personnel and organiza- tions which may assist you at a silo fire.

SILOS

There are two main types of silos: the conventional open top silo and the oxygen limiting silo. The fire officers approach to a silo fire will vary according to type, particularly with respect to the degree they are oxygen-limiting. Both types are cylindrical in shape, varying greatly in diameter and height.

Conventional Silos: This type may be constructed of wood, poured concrete, concrete staves or metal. All but the poured concrete are held together by steel rods around the circumference with bolted or wedge-type connectors. The silo is enclosed on the bottom and sides with a dome or cone-shaped roof having openings allowing for air circulation.

The silage is usually unloaded with a mechanism resting on top of the material through small doors running vertically along the side of the silo. These doors are enclosed with what is commonly know as a silo chute. Access steps will be attached to the unloading doors and a ladder leading to the filling platform is generally located in close proximity to the silo chute. Some conventional silos unload from the bottom with access doors found at the base of the silo.

Oxygen-Limiting Silos: This type is usually constructed of vitreous enamel coated steel, with the most common example manufactured by A.O. Smith Havestore Products, Inc. These silos are often referred to as sealed silos but are oxygen limiting rather than totally sealed. Oxygen-limiting silos may be distinguished from the conventional type by the lack of a silo chute and access doors; unloading equipment located at the base of the silo; and a sealed roof. The only openings will be the unloader discharge door, drain cap at the base of the silo and the hatch cover and vent found at the top.

Figure 2. Typical top-unloading conventional silo.

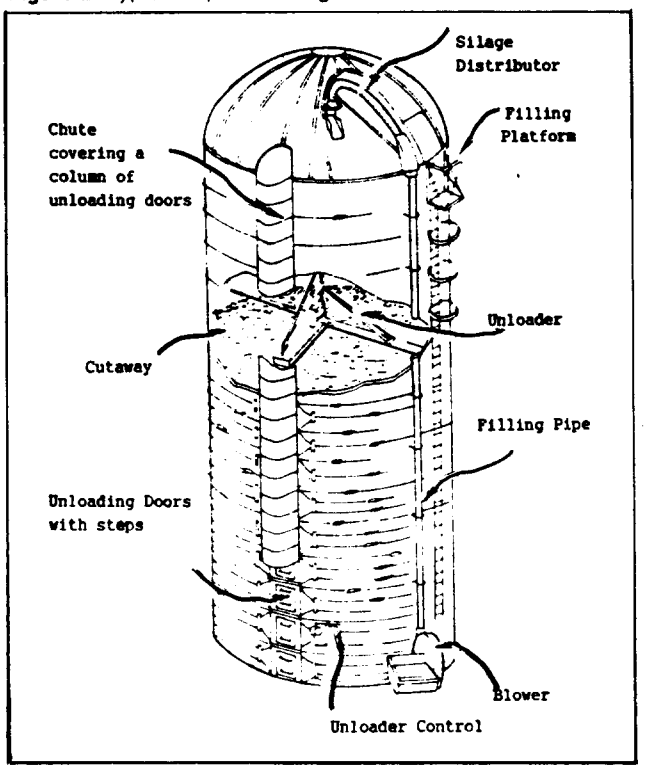
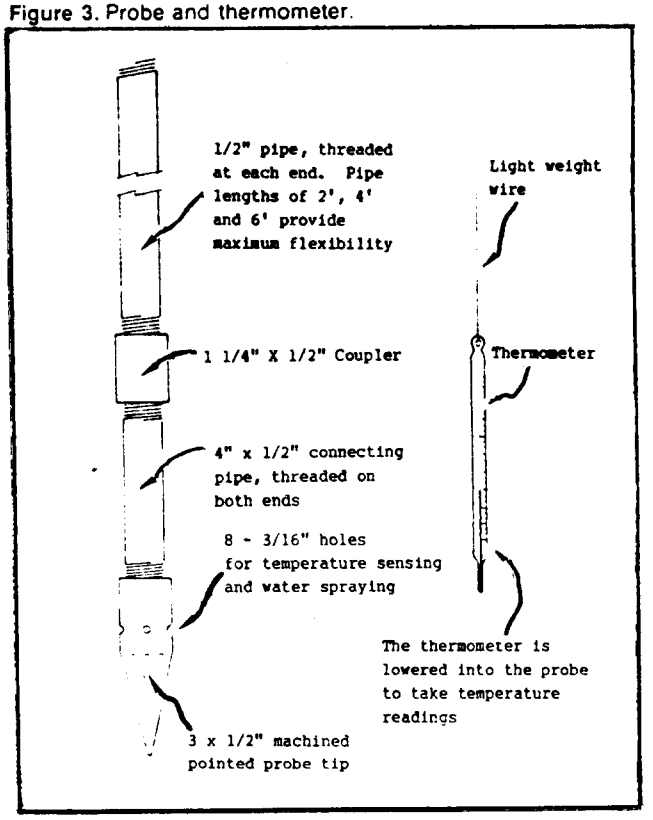


Figure 3. Probe and thermometer.



SILO CONTENTS

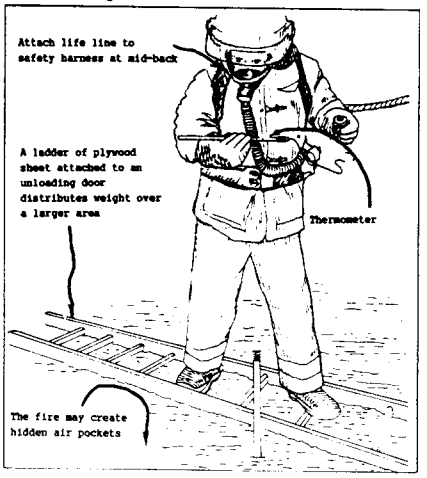
Fire officers should have a basic knowledge of the contents stored in all structures involved by fire. This is especially true with silos. Contents will vary with the type of farm operation and it is recommended that the stored material be determined during the pre-planning phase.

TEMPERATURE READINGS

One of the keys to extinguishing a conventional silo fire is to find the exact location of the fire. This can be done with an easily-made probe and a dairy thermometer.

Lower a dairy thermometer on a light-weight wire into the probe to obtain temperature readings.

Figure 4. Probing for a silo fire



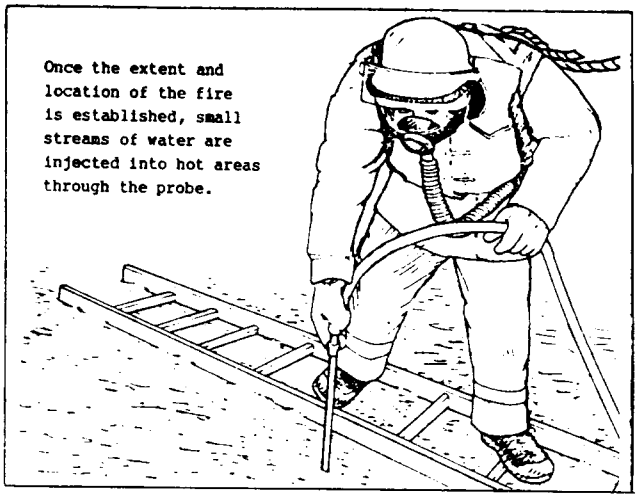
Several temperature readings should be made, starting near any obvious hot spots and gradually moving toward the silo walls. If a fire is caught in its earliest stages, there may be only one hot area. However, several hot spots may exist because the fire will follow air pockets to support itself. Consequently, several readings should be taken across the silage.

If temperature readings are near 180°F or higher, the material will eventually char, smolder or burn. Temperature readings at 140°F to 170°F could be misunderstood. Since heat moves slowly through silage on silo walls, readings in this range may indicate that the silage is heating or it may indicate residual heat from a hot spot that is conducted through the silage. Temperature readings every 2 or 3 hours at this stage are essential. Temperatures below 140°F indicate no particular heating problems.

Most case histories show that fires occur in the top 10 feet of silage. Fires within the top four to six feet occur most often but exceptions do occur.

How far a probe can be inserted into the silage mass depends upon the condition of the silage. A probe will go easily into a spot that has charred or burned, yet, it is difficult to push the probe more than four to six feet into good quality silage.

Figure 5. Water Injection



FIREFIGHTING

GENERAL

Contents of these silos and the basic fire problem should be considered. The "direct cut and store" method used for many years has created little, if any, fire problems. This is due mainly to the very high moisture content of the materials when put into the silo. It is the newer methods of partial crop dying before storage, that are creating the fire problem. These deal mostly with grass ensilage or "haylage" and not corn ensilage.

The newer methods call for reducing moisture content in the haylage to between 35-65 percent. In the conventional silos adapted for haylage, recommended moisture content is from 50-65 percent. But because a better quality feed can result with a lower moisture content, many farmers who own conventional type silos use a lower moisture content. This usually results in charring or burning of the contents.

In the sealed type silos, it may be recommen- ded to use a range of 35-50 percent moisture. This moisture content is very important, not only for obtaining a quality feed but also for preventing combustion occurring inside the silo.

The length of cut when chopping the crop is also important to storage and eliminating spontaneous combustion. By regulating the length of cut between 1/4 and 3/8's of an inch, along with good, even distribution and packing (along the silo wall especially), conditions inside the silo will be less susceptible to spontaneous combustion.

Information on most silo fires and explosions indicates mosture content as the major cause. Therefore, farmers are encouraged to maintain a safe moisture level of 40 percent or above when the crop is put into a sealed type silo; and 50 percent or above in a conventional silo. It is important that all the crop be at a safe moisture level because just one wagonload that is too dry can start the combustion problem within the silo.

In dealing with the actual fire and explosion problem, advice can be divided into two categories: conventional silos and sealed silos.

CONVENTIONAL SILOS

Because of the type of construction and the inability to effectively seal this type silo, danger of explosion is very small. In handling a fire in this type of silo, the following guidelines are offered:

1. Any open free-burning fire should be extinguished with water. These generally occur around the silo doors, in the silo chute, the silo roof and on top of the silage.
2. Never allow any fireman to get directly on top of the silage in the silo. There can be unseen holes or pockets burned out beneath the surface. It is best to work from fire department ladders over the top edge of the main wall structure or, when the chute and doors are safe, from this side. Usually the fill door in the roof can be opened to give access from the silage. REMEMBER opening a roof access door applies ONLY to the conventional silos.
3. The remaining fire within the silage is going to be, at best, difficult to extinguish. Depending on the situation, there are several ways to handle it.

   In some cases, it may be easiest to remove the silage

to a point below the burning area. This should be done under the protection of charged lines so any outbreak of burning fire may be quickly extinguished. Today, unloading in many silos may be quickly accomplished with the mechanical un- loader found in most silos. However, prolonged operation may cause the unloader motor to overheat and fail. The unloader must be shut down and allowed to cool off periodically. When, under special circumstances, it is deemed necessary for anyone to enter the silo, they should wear full protective clothing, a LIFE-LINE and self-contained breathing apparatus.

4. Cooling with water will probably be the most convenient method to extinguish a conventional silo fire. It will be extremely difficult to apply the water so it reaches the entire burning area and effectively cools it. There is no prescribed method that can generally be recommended. It will take trial and error application, persistence and local ingenuity to accomplish complete extinguishment.
5. The smothering of a fire in this type silo by using carbon dioxide or exhaust gases from an internal combustion engine (these methods will be discussed under "sealed" silos) is highly unlikely. This is because the structures cannot be effectively sealed to exclude oxygen or to hold these smothering agents inside. The use of any type of foam has little effect on extinguishment. "Wet waters" should not be used without consulting agricultural extension agents regarding the possible effect on the feeding value of the remaining silage.

SEALED SILOS

The tight construction of this type of silo and the bottom unloading (which creates an empty space above the silage where combustible gases can collect) is highly susceptible to explosion. For handling fires in sealed silos, the following recommendations are offered in addition to the general recommendations for silo fires.

1. NEVER open hatches or other openings in the roof structure. They are too small for effective ventilation and the oxygen that would enter when opened can be all that's needed to create an EXPLOSION or rapid burning. These openings should be properly fastened down and sealed.
2. Should any roof hatches be open, they should not be closed until the fire is out and the silo ready to be put back in service. Even then, the hatches should be closed, not secured, so the covers lift to relieve any sub- sequent buildup pressure.
3. Do not introduce water inside the silo, even at the bottom, except for application to any burning materials outside of the basic silo structure or in the area of the unloading equipment. Water combining with the products of combustion in a silo can form a certain amount of steam.
4. If the silo walls become hot, avoid trying to cool them by spraying with water. The structure may be damaged and any cooling of the contents will be minimal. Prolonged application of water to the exterior of the silo could cool the gases in the headspace to the extent that oxygen could be drawn through the roof openings.
5. The best method of extinguishing a fire in this type of silo is to put carbon dioxide into the silo at the unloading opening. The amount required will vary according to the size of the silo and the amount of contents. Once the carbon dioxide has been applied, the openings for unloading should be sealed as tight as possible. The silo should remain sealed until all outward signs indicate the fire has been extinguished. It might also be necessary to add additional carbon dioxide every day or two during this period. Although

this is the best and safest method of extinguishment, it is also the most expensive and time consuming.

6. Depending on exact conditions, it might be more feasible to unload the silo under the protection of charged hose lines. This may work well when the silo unloading equipment and any other structures can be protected from fire during the unloading process. When using this method, good adequate water supply must be provided. Remember to keep the top hatches and opening seals closed and check the vent valve to see that it is functioning properly.
7. There are instances where the exhaust gases from a gasoline engine have been used in place of carbon dioxide. Although less expensive to use, there is an element of danger involved. It is impossible to determine the exact conditions inside a silo where charring or burning is taking place. Therefore, inducing exhaust gases which are mostly carbon monoxide could create an explosive atmosphere or an explosion in the silo. It's use cannot be safely recommended.
8. Due to the limited occurrence of this type of fire in New York State, it is suggested that outside advice and assistance be sought in order to ensure a fairly accurate size-up of the situation.

CONCLUSION

Fires in farm silos are difficult to extinguish and require a certain degree of precaution in order to adequately protect life and property. Be alert to the problems and, if necessary, seek advice in handling them.