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In this issue:

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Agricultural Environmental Health Hazards

There are a wide range of environmental health hazards associated with agriculture. Farm workers may not be aware of these hazards or may not have had adequate training to protect themselves.

Silo Gas

Silage is a common feed in dairy and beef cattle operations. It is formed from the fermentation of green plant materials such as corn and alfalfa. This fermentation process uses up oxygen and produces carbon dioxide and oxides of nitrogen. When silage is stored in enclosed silos, these gases are confined and produce hazardous atmospheres within the silos.

Shortly after green plant material is placed in a silo, the nitrates in the plant material are released as nitric oxide (NO). Oxygen within the enclosure combines with the nitric oxide to produces nitrogen dioxide. Nitrogen dioxide (NO_2) causes coughing, difficulty breathing and nausea at low levels but at higher concentrations causes the lungs to fill with fluids which can cause serious lung injuries and even death to humans as well as livestock.

The highest nitrogen dioxide concentrations occur within 60 hours after the green plant material has been added to the silo and may be present for the next four weeks. Nitrogen dioxide is heavier than air and collects in a layer at the bottom of the silo and may travel down silo chutes and drain at the base of the silo where it collects in the silo room and moves through the barn. Presence of the gas in often indicated by dead birds or flies under the silo chute.

Nitrogen dioxide has a bleach-like odor. Farmers should be on the lookout for these odors or yellowish-brown fumes near the silo. A buildup of the gas may be reduced by keeping the silo chute doors open to the silage level. A space between the bottom of the door and silage level can create low spots where nitrogen dioxide can collect. Workers entering these low spots or bending over to pick up tools or a shovel can inhale fatal concentrations of the gas. If a silo must be entered within the first few days after silage has been added, confined space entry procedures must be implemented. Employees and farm workers should never work alone. The silage blower or ventilation fans should be run for 15-20 minutes to ventilate the chute and then the chute doors should be removed down to the level of the settled silage. The blower or fans should be run for 30 minutes before the silo is entered and then continuously when someone is inside.

It is important to ventilate the silo room and keep the door between the silo room and the barn closed for four weeks after the silos have been filled to protect farm workers as well prevent death of livestock from exposure to nitrogen dioxide. The windows and outside door to the silo room can be left open and fans can be used to ventilate the silo room during this period.

Manure Pits

Manure pits and lagoons are another type of confined space entry hazard associated with livestock operations which have been the cause of numerous fatalities in agriculture. In most incidences two or more workers die because of rescue attempts by untrained and unprepared workers. Manure pits can be above ground or below ground. Most are located outside but they can also be located within structures or below barns and buildings.

Inside the pit or lagoon, manure undergoes anaerobic digestive fermentation. This process uses up available oxygen and produces:

- Methane
- Hydrogen sulfide
- Carbon dioxide
- Ammonia

All of these gases can displace oxygen and conditions within the pit can become oxygen deficient.

Methane is highly flammable and is lighter than air. It usually forms during hot weather and accumulates in poorly ventilated storage facilities or buildings and at the top of the pits.

Hydrogen sulfide is the most dangerous toxic gas produced in manure pits and lagoons. It is heavier than air and smells like rotten eggs. It settles near the bottom of manure pits and causes dizziness, headache nausea and respiratory irritation at low concentrations. At high concentrations it causes unconsciousness, respirator fatigue and death within minutes.

Carbon dioxide is colorless and odorless and is heavier than air. It settles at the bottom of the pits and displaces oxygen.

Ammonia has a sharp pungent odor and is lighter than air. It can cause severe burns to the eyes, throat and lungs.

It is important to note that dangerous atmospheric conditions may exist intermittently at manure pits. Stirring and agitating manure may release large amounts of manure gases. Previous uneventful entries may lead to complacency. Studies show that the most fatalities occur during hot weather when microbial activity in the pits is highest. Deaths have occurred in the U.S. from April through September with the highest number in August. Although summer poses the highest danger, hazardous atmospheres can occur at any time and it is essential that necessary controls be implemented to prevent injuries and deaths.

The CDC (Center for Disease Control) recommends:

- Manure pits should be ventilated.
- The atmosphere in the pit should be tested before entry.
- A standby person should be available.
- A harness and lifeline and mechanical lifting device should be used during entry.

An SCBA (self contained breathing apparatus) should be worn by individuals entering the pit if oxygen deficient or toxic atmospheres are detected. Other control measures include:

- Provide training and information on the hazards of manure pits to all farm workers.
- Never enter a manure pit unless it is absolutely necessary and only when all the safeguards have been taken.
- Post warning signs on all manure pits. Signs may have to be in other languages as necessary.
- Provide continuous fresh air ventilation when entering the pit.
- Equipment must be explosion proof.
- Never enter a manure pit without a standby person.
- Always wear a safety harness and lifeline and use a mechanical emergency lift device for rescue.
- Standby personal are never to enter the pit for rescue.
- Eliminate the need for entry by designing equipment and systems so maintenance can be done from outside the pit.
- Pumping equipment should be corrosion resistant to eliminate frequent repairs.

In addition to these controls, manure pits should be fenced to restrict access.

Grain Bins

In addition to silos and manure pits there may be other confined space entry hazards at agricultural operations. These include pits, vaults, sumps and other confined spaces. Probably the most common confined space situation that is encountered involves grain storage bins. Suffocation in grain bins has consistently been a leading cause of fatalities in farming operations.

A confined space is defined as a space large enough for an employee to enter, has limited means of entry and egress and is not designed for human occupancy. A permit-required confined space has these same characteristics but additionally contains or potentially contains a hazardous atmosphere, contains material that can engulf anyone who enters the space, has inwardly converging walls that might trap or asphyxiate an entrant or has any other recognized serious health hazard. By these definitions all grain bins containing materials are considered permit required confined spaces because there is an engulfment hazard. In addition, some bins may have converging walls and pose a confined space hazard even when empty. One other important point to remember is that if any stored grain has become wet or has spoiled, microbial activity may have created an oxygen deficient environment since oxygen is converted to carbon dioxide by the metabolism of the microbes.

Engulfment and suffocation can occur in two different ways. The first is when an employee enters the bin while it is being emptied. Most bins have systems that empty the grain from the bottom. As the grain is removed a person entering the bin is quickly drawn toward the center and is pulled under the column of grain. The grain flows like quicksand making escape impossible. In 10 seconds or less someone is thigh deep and is completely buried in less than a minute. The second way someone entering a grain bin is suffocated and buried is when there is caked or frozen grain in the bin. When a bin has a crust and some of the material has been removed, a void is created under the crust. Someone walking on the crust can cause the crust to collapse and the person to fall through and become buried.

To prevent engulfment and suffocation, grain bins should never be entered when they are being filled or unloaded. Some grains such as flax and millet cannot support a person even when the grain is not being unloaded and bins containing these types of very small loose grains should never be entered. Lock-out/tagout procedures should be in place whenever grain bins are entered. All loading and unloading electrical control boxes should be locked out. Permanent ladders can be installed inside of bins. The ladders make access to the bins easier and allow a means of escape. Frozen or encrusted materials should be broken apart from the outside of the bin using wooden poles. Metal poles should not be used since they may come in contact with power lines near the bin.

If a grain bin must be entered, it first should be ventilated. The fan should be turned on and the bin should be ventilated continuously while the person is in the bin. All power to the loading and unloading equipment should be locked-out. Three persons are required when entering the bin. The person entering the bin should wear a harness attached to a lifeline. The second person should remain at the bin entrance to watch the person inside the bin and keep tension on the lifeline. The third person should remain on the ground outside the bin to assist and to contact help in an emergency.

Pesticides

A wide variety of pesticides are used in agriculture. Pesticides include agents such as insecticides, herbicides, fungicides, algaecides and rodenticides. Pesticides can vary in toxicity to humans and the general environment and some may persist in the environment for years while others break down soon after application. Pesticides are regulated by the EPA (U.S. Environmental Protection Agency) according to FIFRA (The Federal Insecticide, Fungicide and Rodenticide Act). The law requires manufacturers to register their products with the EPA as either general use pesticides or restricted use pesticides. Restricted use pesticides can only be used by certified applicators. General use pesticides can be used by anyone as long as they follow the directions on the label. The EPA has authorized the states to certify and train restricted use pesticide applicators. Each state may have slightly different requirements but generally they include a completed training course, an examination and payment of a license fee.

There are two types of certified applicators- private applicators and commercial applicators.
It is important to understand the differences between private applicators and commercial applicators since different rules apply. Private applicators are certified applicators who use or supervise the use of restricted use pesticides on property they own or rent, on an employer's property or on another person's property if there is no compensation other than trading of personal services. A commercial applicator is any person who uses or supervises the use of restricted use pesticides for a fee.

Pesticides will have MSDSs similar to those for any industrial chemical but in addition they are required to have

labels meeting EPA requirements that are different from OSHA requirements. These labels are more like an MSDS and contain important information pertaining to proper use along with precautions and protective measures that must be used. The pesticide label is a legal document and it is against federal law to use pesticides outside of the label requirements. Pesticide labels are required to contain:

- Brand and Trade Name
- Ingredients
- % of Active Ingredients
- Net Weight
- Name and Address of Manufacturer
- EPA Registration Number
- Environmental Hazards
- Classification of Pesticide
- Directions for use
- Re-entry Information
- Harvesting and Grazing Restrictions
- Storage and Disposal Directions

Re-entry information pertains to the amount of time after application before employees are allowed back in the treatment area. This is especially important is greenhouses, nurseries, and fruit and vegetable operations where there are typically more hand laborers.

The use classification information identifies the material as a restricted use or general use pesticide.

One last very important piece of information on pesticide labels are the Agricultural Use Requirements. Some pesticides will have a statement that says that the product is to be only used in accordance with the Worker Protection Standard, 40 CFR part 170. The Worker Protection Standard is similar to an OSHA standard in that it pertains to employee safety. The standard applies to pesticides used for production of agricultural plants on farms, forests, nurseries and greenhouses.

Owners and members of their families are exempt from some of these Worker Protection Standard requirements. EPA encourages families to comply with the requirements however. Any hired workers are covered by the standard which classifies employees into two categories – Workers and Pesticide Handlers. The standard also applies to owners who contract out pesticide application as well as all commercial applicators.

The standard requires employers to provide information to both Workers and Handlers to ensure employees are informed about pesticide exposure. This includes:

- Training
- Display a pesticide safety poster
- Access to label information
- Access to information pertaining to location of pesticide treatment

Employers are also required to provide protection for employees. This includes:

- Prohibit handlers from applying a pesticide in a way that will expose workers or other persons
- Exclude workers from areas being treated with pesticides
- Exclude workers from areas that remain under restricted-entry
- Protect early-entry workers who are doing permitted tasks in treated areas
- Notify workers about treated areas so they can avoid inadvertent exposures
- Protect handlers during handling tasks, including monitoring while handling highly toxic pesticides, and duties related to correct use of PPE

Employers are also supposed to provide measures to mitigate exposures that employees may receive. This includes providing decontamination supplies including soap and water and emergency assistance in case a worker or handler is exposed to a pesticide.

Employees classified as Workers should be prevented from entering areas where pesticides are being or have been applied through notices, warnings, and signs. Whenever restricted use pesticides are applied special precautions are required to prevent contact with potentially contaminated surfaces.

Employees classified as Handlers need more extensive training. This includes information on specific application procedures and equipment. These employees also must be provided with training on the use, care and disposal of PPE (personal protective equipment), instruction for cleaning and re-using PPE and use or respiratory protection.

Pesticide labels will refer to chemical resistance categories A through H. This corresponds to the type of personal protective glove that is to be used in the EPA's Chemical Resistance Category Chart in Appendix B of the Worker Protection Standard.

Respiratory Diseases

Agricultural activities expose workers to a number of dusts that can lead to respiratory disease. Organic dusts are the most common type of airborne exposure in agriculture. These dusts are associated with grain, straw, silage, hay and animal waste in confinement buildings. The toxic components of these dusts are related to bacteria and fungi. The cell walls of gram-negative bacteria contain toxins known as endotoxin. Gram negative bacteria are found in manure and animal confinement areas. Fungi produce mycotoxins and compounds known as glucans. These toxins can cause a condition known as organic dust toxic syndrome or ODTS. The condition is sometimes called Silo Unloaders Syndrome. Symptoms of ODTS include cough, fever, chills, body

aches and fatigue. Symptoms appear four to twelve hours after exposure to high levels of dust and conditions can last up to seven days. Many times ODTS is mistaken for the flu.

Exposures to certain molds known as thermophilic actinomycetes associated with moldy hay cause a condition known as Farmer's Lung. Farmer's Lung belongs to a group of allergic disorders collectively called hypersensitivity pneumonitis (HP). This disease can occur in a number of settings where there is dust and fungi exposure but is called Farmer's Lung in an agricultural setting. Other forms of the disease include grain handler's disease, mushroom worker's lung, coffee worker's lung, cheese washer's lung and there are many more. The names are associated with the occupations where the disease develops but all are a type IV immune response. Type IV immune responses are characterized by cell mediated immunity without antibodies. Asthma by comparison is a type I immune response with the body releasing immunoglobulin to react with the foreign antibodies. HP has similar symptoms as ODTS and the two conditions are often confused.

The main differences are that ODTS can occur from a single high dust exposure while HP is a progressive condition resulting from prolonged exposures to dusts and mold. Chest x-rays are normal for ODTS while diffuse infiltrates are found in HP. The other main difference is that ODTS patients recover in a few days while HP can be a recurrent and progressive disease resulting in permanent lung impairment. Once HP develops, avoidance of further exposure is the main treatment. Usually this is not easy and can be difficult in a farm environment.

Since HP is associated with moldy hay, the highest incidence of the disease is in areas with large amounts of alfalfa and forage crops. These include the upper Midwest and Northeast especially where there are large numbers of dairy operations. The condition is especially prevalent in dairy farmers with the highest rates in the U.S. in Wisconsin and Vermont. HP diagnosis is most common in the winter and spring. This corresponds to when farm work is largely confined in barns and hay, bedding and silage that is moldy is handled. The molds also have had a chance to develop in enclosed storage areas.

Control of ODTS and HP involves management practices that reduce potential exposure to molds and dusts. Mold inhibitors can be added when bailing hay, ensiling crops and during harvest of grains. Storing crops and grains with the recommended moisture content will also prevent mold growth. Mechanical and automated feeding systems reduce exposure since workers are isolated from potential dusts. Enclosed equipment and tractor with climate controlled cabs also isolate the operators from dust exposure. Bedding can be wetted down before chopping and spreading. Grain storage areas should also be wetted down during cleaning operations as a means of dust suppression. Use of air hoses for cleaning should be prohibited. Respiratory protection is also an important control method. Type N95 disposable respirators should be available and used whenever dusty situations are encountered.