



MECHANICAL HAZARDS

HOSTA Task Sheet 3.1

Core

NATIONAL SAFE TRACTOR AND MACHINERY OPERATOR PROGRAM

Introduction

There are many hazards in agriculture associated with mechanical equipment. Knowing every hazard of every machine is very difficult. For this reason, agricultural safety and health professionals group them in ways that help the operator recognize the different types of hazards regardless of the machine.

Your ability to recognize these hazardous components is the first step in being safe.

This task sheet identifies groups of hazards, what the danger is, where the hazards may be found, and gives instruction for avoiding them.

Pinch, Wrap and Shear Points

A **pinch point** hazard is formed when two machine parts move together and at least one of the parts moves in a circle (Figure 3.1.a). These types of hazards are often found in power transmission systems such as belt drives, chain drives and gear drives. *Avoid pinch points by keeping machine guards in place.*

Any type of rotating machine component can be considered a **wrap point**. The rotating components are often shafts such as the PTO. Individuals can be caught in a wrap point by their

loose clothing or long hair. *Guards can protect the operator from wrap points. Attention to dress and care of long hair is important as well.*

A **shear point** occurs when the edges of two machine parts move across or close enough to each other to cut a relatively soft material. One of the two objects can be stationary or moving while the second is moving. Hedge trimmers are a good example of a shear point.

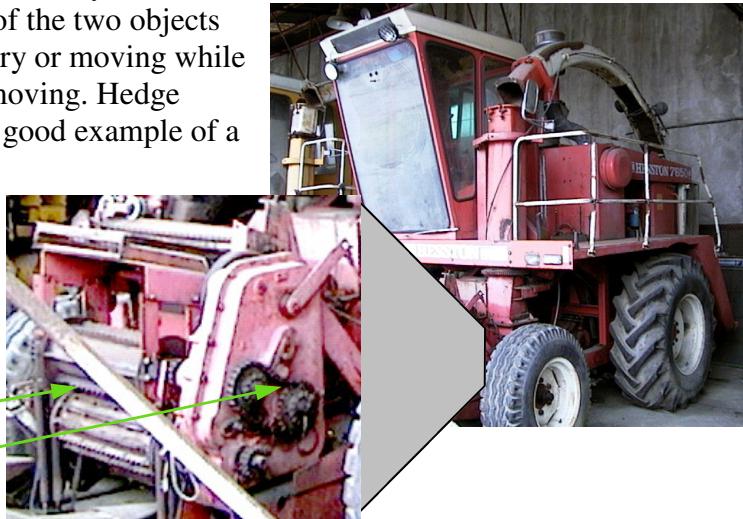


Figure 3.1.a. Pinch points can be found on most machines.

Shielding the worker from the shear point is difficult on many agricultural machines. *The best precaution to take for preventing injury is to shut off the machine before making repairs or adjustments.*

Learning Goals

- To identify the mechanical hazards associated with agricultural machinery
- To avoid mechanical hazards

Related Task Sheets:

Reaction Time	2.3
Hazard Warning Signs	2.8
Making PTO Connections	5.4
Using Power Take-Off (PTO) Implements	5.4.1

PTO Stub

- Transfers power from the tractor to the machine
- Rotates at 540 rpm (9 times/sec.) or at 1,000 rpm (16.6 times/sec.)
- Some tractors have a stub shaft guard that screws onto the PTO stub.

Master Shield

- Protects the operator from the PTO stub
- Is often damaged or removed and never replaced.



Figure 3.1.b. A PTO stub and a master shield on a tractor. A PTO is a wrap point hazard that causes countless injuries and deaths each year.

Crush, Pull-in and Burn Points

Crush points are formed when two objects are moving toward each other, or when one object is moving toward a stationary object, and the gap between the two is decreasing. The most common example of a crush point is formed when an implement is attached to a tractor's drawbar. Most often the tractor is moving toward a stationary implement, and the gap between the tractor's drawbar and the implements hitch is decreasing. *Do not permit another person to stand between the tractor and implement while hitching.*

Pull-in points occur most often where crops are fed into harvesting machinery. Rotating parts that come in close contact with each other, such as feed rolls, often form pull-in points. Pull-in points can also be formed by moving components, such as feed

chambers on square balers. *To avoid being pulled into a machine, shut down the engine and the PTO before making repairs or adjustments.*

Hot mufflers, engine blocks, pipes, and fluids (fuel, oils, chemicals) are all examples of possible **burn points** on tractors, self-propelled machinery, and pulled machinery. Machine inspection, servicing, and maintenance are the most common types of activities that may result in exposure to a burn point hazard. *To avoid being burned, do not touch the engine or machine parts you are inspecting. Place your hand near the surface of the part to determine if heating has occurred.*

**Awareness is
the best
protection
from hazards
that cannot
be eliminated
or shielded.**



Figure 3.1.c. Pull-in points are found on harvesting machinery.

Freewheeling Parts

When parts of a machine continue to move after the power to the machine has been turned off, they are called *freewheeling parts*. These hazards exist because many machines require a large amount of rotational force to keep them running smoothly under irregular loading. Bringing this rotational force to a sudden stop is almost impossible. A baler is an example of the freewheeling hazard.

To avoid injury from freewheeling parts, stop the tractor engine, disengage the PTO, and wait for the machine to stop completely before making repairs or adjustments.



Figure 3.1.d. The flywheel on a small square baler is an example of a freewheeling part. The flywheel keeps the baler running smoothly if a large amount of hay is suddenly taken into the bale chamber. Notice that part of the PTO driveline is unguarded.

Thrown Objects

Thrown object hazards occur as normal machine operations discharge materials into the surrounding environment. These hazards are formed by rotating fan or knife blades that are used to cut, grind or chop materials. The blades can throw small or large objects, such as glass, metal, rocks, sticks or other vegetation. A common example of a thrown object hazard is the material that it discharged from a rotary mower.

To avoid injury from thrown objects, be sure the machine is at a complete stop before nearing the discharge area. Keep the work area clear of bystanders. Wear eye protection when working with this type of hazard.



Figure 3.1.e. Mowers are a frequent source of thrown objects.

Stored Energy

Stored energy hazards occur when energy that is confined is released unexpectedly. This hazard is present in pressurized systems and their components. Examples include springs, hydraulic, pneumatic, and electrical systems.

Avoid the hazard of stored energy by knowing which parts which may be spring loaded. Relieve hydraulic system pressure when the job is completed. Ask for a demonstration of where you might encounter this potential hazard.

The ability to identify hazards is the first step in avoiding them.



Figure 3.1.f. Hydraulic systems often have stored energy.

Safety Activities

1. Draw a line from the Mechanical Hazard to the correct definition.

- Pinch Point ·
 - Hot mufflers, engine blocks, pipes, and fluids (fuel, oils, chemicals) are all examples of this type of hazard on tractors, self-propelled machinery, and pulled machinery.

- Freewheeling Part ·
 - A hazard formed when two machine parts move together and at least one of the parts moves in a circle.

- Pull-in Point ·
 - This type of hazard occurs when machine parts continue to move after the power to the machine is turned off.

- Shear Point ·
 - Any type of rotating machine component can be considered this type of hazard.

- Crush Point ·
 - These types of hazards occur when a machine discharges materials into its surrounding environment.

- Stored Energy ·
 - A hazard formed when the edges of two objects move across or close enough to each other to cut a relatively soft material.

- Burn Point ·
 - These hazards are caused by energy that is confined and then released.

- Wrap Point ·
 - A hazard formed when two objects are moving toward each other or when one object is moving toward a stationary object, and the gap between the two is decreasing.

- Thrown Objects ·
 - Rotating parts that come in close contact with each other, such as feed rolls, often form these points. They can also be formed by moving components, such as feed chambers on square balers.

2. Find an old and a new machine on your farm or at a local dealership, and identify as many mechanical hazards as you can. Compare the two machines.

References

1. Farm and Ranch Safety Management, John Deere Publishing, 2009.
2. Murphy, D.J. 1992. *Safety and Health for Production Agriculture*. St. Joseph, MI: ASAE.
3. American Society of Agricultural and Biological Engineers, ANSI/ASABE S318 Safety for Agricultural Equipment, St. Joseph, MI.

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NOISE HAZARDS AND HEARING PROTECTION

HOSTA Task Sheet 3.2

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Farm equipment can generate high noise levels. High sound levels pose serious health risks to the people who work long hours around this equipment. Hearing damage seldom occurs with one loud noise. Hearing damage results from an exposure to loud noises over an extended period of time.

This task sheet will examine the problem of noise hazards and how to protect your hearing.

What Is Noise?

Sound is created by anything that causes pressure waves in the air. Different wave sizes, or frequencies, are formed by different levels of shock to the air. Unwanted sound is called "noise."

All sound, including noise, is measured in *decibels*. The unit of measurement is shown by the designation dB(A). A decibel meter is a tool that measures the dB level. The "A" represents the sound scale used for the measurement.

Not all sound levels are a hazard. Knowing typical sound levels of various sources of sounds helps us understand if the sound level is unsafe. Consider the following decibel level information.

Decibel Level Chart	
dB(A) Level	Sound Source
15	A whisper
50	Gentle breeze or babbling brook
60	Normal talk level
85	Tractor at idle engine speed
90	Chopping silage (no cab) or lawnmower at full throttle
100	Tractor at work or table saw in use
110	Stereo with headphones set at mid-volume
120	Bad muffler or rock concert
140	Shotgun blast or jet engine

Sound levels that cause hearing loss begin at about 85 dB(A). Hearing loss occurs more quickly with louder noise. See Table 3.2 for time exposure to various sound levels which can lead to hearing loss.

OSHA standards consider sound measured at 85 decibels or higher as damaging to the eardrum and therefore a risk to hearing.



Figure 3.2.a. A straight pipe used for the exhaust or a worn-out muffler will increase noise levels coming from the engine. Muffler condition should be part of a safety audit.

You don't adapt to
loud noise; you
lose your ability
to hear loud
noise.

Learning Goals

- To recognize when sound levels can become a threat to hearing
- To use correct hearing protection devices

Related Task Sheets:

The Work Environment	1.1
Personal Dress	2.7

Permissible Noise Exposures:

<u>Duration Per Day (hours)</u>	<u>Sound Level, dB(A)</u>
8	90
6	92
4	95
2	100
1	105
1/2	110
1/4	115

Table 3.2. Exposure time limits to sound levels decrease as the db(A) level increases. Use the chart on page 1 to answer the following questions. What is the sound level at your high school dance or at a rock concert? How long should you be exposed to that intensity of sound pressure level?

How Does Hearing Loss Occur?

Is loud music or farm equipment causing you to lose your hearing?

Sound waves have pressure. High frequency sound waves have greater pressure than lower frequency sound waves. This pressure pushes on the ear drum.

Hearing loss occurs over a period of time. Deafness and loss of hearing usually occur with the high frequency sounds and not the lower frequency sounds.

Hearing is lost as auditory nerve endings are exposed to the same frequency of sound for extended time periods. The nerves lose their ability to recover from that hostile frequency. The ability to hear that sound frequency is then decreased forever.

Sound levels may be nearing the danger point for hearing loss if you notice any of these:

- Ears ringing
- Noises in your head
- Your own speech sounds muffled
- You have to shout to be heard by someone working next to you

By the time you recognize any of these events, some hearing loss has occurred.

Hearing loss accumulates over time and cannot be reversed. Hearing aid assistance may be necessary. Many older farmers have developed hearing problems over time. Hearing loss in the young also occurs. With the knowledge gained from this task sheet, the younger farm worker should avoid unnecessary hearing loss.

Protection of Hearing

Reduction of excessive noise is the first step to hearing protection. Hearing protection starts in the farm shop by keeping the exhaust and muffler system of the tractor in good repair. Machine parts that are not well-lubricated or adjusted also cause loud noises.

What farm tasks have you encountered that require hearing protection?

Reduction of excess noise levels may require a sound proofing barrier between the ear and the source of the noise. Sound-proof tractor cabs are designed to reduce sound levels. Compressor rooms may need to be sound-proofed as well. Sound-insulating building materials can reduce noise levels.

Where on your farm is the highest noise level likely to be found?

Types of Ear Protection

Commercially available hearing protection devices are recommended. There are two devices to use. They are:

- Acoustical Muffs
- Ear Plugs

Acoustical Muffs

Acoustical muffs, or ear muffs, are effective in reducing sound level at the ear. They cover the ear and ear canal to provide a barrier to sound. They do not block out all sounds, therefore, conversation for information and safety purposes is readily heard.

Ear Plugs

Ear plugs are made to fit into the ear opening. A snug, tight fit is necessary for effective sound reduction. Ear plugs can be a source of ear infection; so they must be kept clean and sanitized. Do not share ear plugs with others as ear infection can be spread in this way.

There are two types of ear plugs:

- Formable Plugs

These plugs are compressed before inserting into the ear. They expand to fill the ear canal. One size fits all.

- Preformed Plugs

These plugs come in many sizes and must be fitted to the individual's ear. They usually have a cord attached between each plug making them more difficult to lose.

Ear-protection devices are ranked by their Noise Reduction Rating (NRR). An NRR31 rating signifies that noise will be reduced by as much as 31 decibels under ideal conditions. For example, in a 100 dB(A) work area, a device with a NRR of 31dB would reduce the effective sound level to 69dB.

Be sure that the hearing-protection device reduces sound to a safe level. Typical ratings are shown.

Device	dB NRR
Ear Muffs	21-31
Ear Plugs	26-33
Combined	Add 3-5 db



Figure 3.2.b. Acoustical ear muffs offer the greatest level of hearing protection because they cover the entire ear and ear canal.

**Cotton
stuffed into
the ears
does not
offer hearing
protection!**



Figure 3.2.c. Ear plugs offer hearing protection, but not as much as full-ear coverage protection devices. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses*, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Safety Activities

1. Obtain a decibel meter (available at electronics stores if your school or club does not have one), measure and record the decibel levels of the following farming operations:
 - A. Tractor being used to agitate liquid manure
 - B. Tractor being used to operate ensilage blower
 - C. Chain saw in use
 - D. Milk-cooling equipment compressor
2. Using a supply catalog, such as Gempler's or NASCO, make a list of the various ear-protection devices, their NRR, and their costs.
3. Call a hearing-protection salesperson and a hearing-aid dealer and request hearing-protection literature, or invite them to make a presentation to your group, family, or coworkers.
4. Have a hearing test done as a baseline test to compare your hearing results on an annual basis.
5. Make arrangements with the school nurse or a volunteer nurse to conduct hearing tests for local farmers.

References

1. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.
2. www.gemplers.com/ Type in search box key word(s), hearing protection/Choose a site.
3. www.howstuffworks.com/ Type in search box key word decibel/Choose a site.
4. www.osha.gov.

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RESPIRATORY HAZARDS

HOSTA Task Sheet 3.3

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

The daily activities of farming generate dust and dirt. Working with crops, livestock, and equipment creates more dust and dirt. The worker is placed in conditions perfect for the growth of microorganisms, such as fungi and molds. The worker is often exposed to hazardous gases and vapors. Farm shop work can create respiratory hazards as well. Oxygen-deficient areas present the risk of death.

Continual exposure to breathing hazards creates long-term health problems. Farm workers can suffer from breathing difficulties, such as asthma, "farmers lung," and organic dust toxicity syndrome (ODTS).

This task sheet discusses the problem of respiratory hazards. Respiratory-protection equipment and practices will be discussed in Task Sheet 3.3.1.

Dusts, Mists, and Fumes

Particulates are airborne particles of material that can be measured. Dusts, mists, and fumes make up a group of various-sized particles. They are measured in microns. A micron is 1/25,400th of an inch (50 micron-size particles are visible). Particle sizes over 5 microns are heavy enough to settle quickly without posing a respiration hazard. Finer materials are the

major concern to lung health.

Dusts—Dusts include the solid particles (0.1– 25 microns in size) created by handling, crushing, grinding, and moving materials such as rock, metal, wood, and crops.

Crop production exposes the worker to dust particles from the crop, spores from microorganisms growing on the crop, and the fine, airborne particles of soil stirred by field work. Many particle sizes are produced. Fine chopped crop particles can be inhaled into the lungs (respirable dust). As plant materials break down, molds and fungus are also inhaled.

Livestock production exposes the worker to dirt, dust, mites, fungus, and the dry scaly skin found on or around the animal or bird or in its housing area. Antibiotics added to livestock feeds can also pose a respiration hazard.

Mists—Liquid droplets suspended in the air represent mists as a respiration hazard. Paint sprays and cutting oil become airborne breathing hazards.

Fumes—Material that becomes airborne during welding (metal, welding rod, and flux) are examples of fumes. See page 2 for a discussion of toxic gases and vapors.

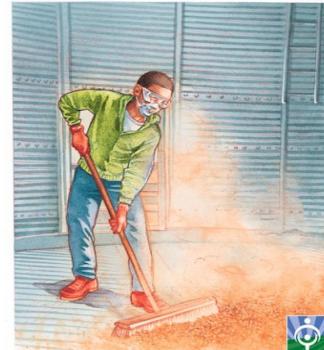


Figure 3.3.a. Dust from agricultural work can lead to eye and lung irritation. Respiratory protection, such as filter masks, are discussed in Task Sheet 3.3.1.

Coal miners can get “black lung” from breathing coal dust.
Farmers can get “green lung.”

Learning Goals

- To recognize respiratory hazards associated with agriculture

Related Task Sheets:

The Work Environment	1.1
State Agricultural Safety and Health Resources	1.4
Personal Protective Equipment	2.10
First Aid and Rescue	2.11
Silos	3.9
Grain Bins	3.10
Manure Storage	3.11
Anhydrous Ammonia	3.12

Carbon monoxide vapors from engines can kill. This gas is colorless and odorless.

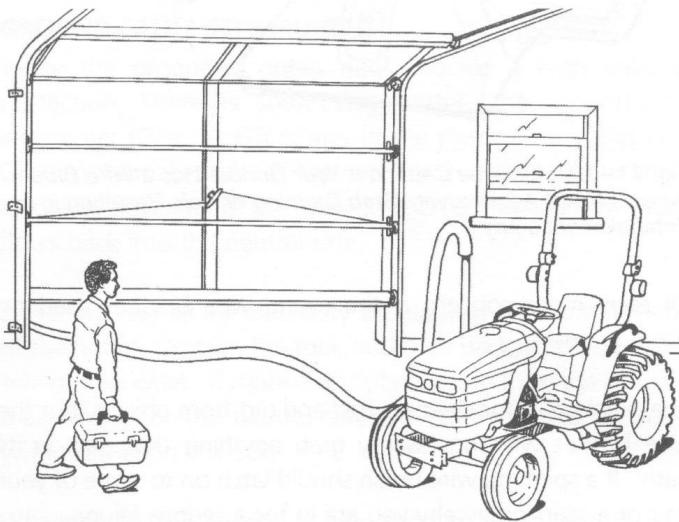


Figure 3.3.b. Internal-combustion engines produce carbon monoxide gas in the exhaust. This colorless, odorless gas can asphyxiate or suffocate a person working on the engine in an enclosed area. Be sure to ventilate the exhaust gases to the outside of the building, or work with plenty of air flow into the building. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses*, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Gases and Vapors

Manure Gases

Manure breaks down chemically when held in storage pits. Hydrogen sulfide, carbon dioxide, ammonia, and methane gases are produced in the manure. These gases intensify in their concentration and are trapped in the manure. The oxygen level of the storage pit or tank becomes too low to support life.

To move the manure from storage to field application, the manure must be agitated and pumped to a spreader unit. The gases are then released into the air.

With equipment breakdowns, unsuspecting farm workers, co-workers, and family members have entered the unventilated, low-oxygen level, confined areas and have been killed by suffocation. Oftentimes multiple fatalities have occurred attempting a rescue.

Stay out of manure storage facilities!

Manure gases can cause asphyxiation, eye and nose irritation, or can be explosive (methane). See Task Sheet 3.11 for more details.

Silo Gases

The silage fermentation process produces deadly nitrogen dioxide gas. This yellow brown gas is heavier than air and settles to a low point in the silo or feed room. Workers entering unventilated silos are often overcome with this gas. A few survive the exposure with lung damage, but many victims perish. See Task Sheet 3.9 for further discussion on silo safety.

Farm Shop Gases

The farm shop exposes workers to respiratory hazards during jobs such as welding, painting, and engine repair. Ventilation is needed for each of these tasks.

Check with the owner of the shop as to what safety procedures to follow to activate ventilation fans.

Welding

Ventilation is necessary during all welding processes. Galvanized metal emits zinc smoke fumes during welding. These fumes can be fatal to inhale. Weld gases such as acetylene can be explosive in high concentrations. The arcing of a light switch can cause acetylene vapors to explode.

Engines

Engines produce deadly carbon monoxide gas. This colorless, odorless gas can asphyxiate the worker who operates an engine in an enclosed area. Do not operate an internal combustion engine inside a closed building!

Solvents and Paint Thinners

Vapors from paint thinners or solvents are released into the air and can be explosive. Paint thinners also produce symptoms of nausea when inhaled. Skin damage is possible. Read the labels on solvents and thinners to learn about ventilation requirements.

Lung Disease

Inhalation of dusts, mists, fumes, vapors, gases, and smoke causes irritation to the respiratory system. Repeated, prolonged exposure can cause more severe problems. Two of the problems are described here.

Farmer's Lung— Farmer's Lung is an allergic reaction caused by inhaling moldy hay, straw, and grain. When the lungs cannot remove the material, an allergy can develop. Repeated exposure further increases lung tissue damage and allergic reaction. Symptoms are similar to those of pneumonia.

Organic Dust Toxicity Syndrome (ODTS)— ODTD is caused by a reaction to inhaling molds from spoiling grain and forage. ODTD usually does not cause permanent lung damage. Symptoms include cough, fever, chills, body aches, and fatigue. Symptoms can last 1-7 days.

Asthma

Do you know someone who has asthma? They probably use an inhalant (medicine in an aerosol tube) to provide breathing relief. National statistics show an increase in the number of persons suffering from asthma.

What is asthma? Asthma is a disease of the respiratory system. It is not known how people develop asthma. The small air tubes of the lungs tend to make more mucous than normal. The air tubes tend to swell, and the muscles around the air tubes tighten when an asthma attack occurs.

Asthma can be triggered by several causes. Some of them are:

- Allergies
- Infection (colds and bronchitis)
- Weather changes
- Smoke
- Physical exercise

Allergies such as exposure to dusts, mists, fumes, vapors, and gases irritate the lungs and can bring on an asthma attack. All of these irritants can be found in agriculture. Weather changes can lead to colds and bronchitis. Hot, humid weather as well as winter cold is a factor in asthma.

Cigarette smoking or standing in the smoke of a burning fire is an irritant to the lungs also. Sports activities and physical work can also trigger an asthma attack.

If you are an asthma sufferer, there are two recommendations.

1. Avoid those factors that trigger an asthma attack.
2. Follow your doctor's advice and prescription program.

Since repeated exposure to lung irritants reduces respiratory health, asthma can develop. Take the necessary precautions to protect your lungs from developing asthma and other respiratory problems.

Respiratory-protection devices will be discussed in Task Sheet 3.3.1. Be sure to use the knowledge from this task sheet to select the proper respiratory protection for the materials with which you are working.



Figure 3.3.c. Welding produces fumes. As the metal melts, and the welding rod and flux covering is burned, fumes are produced. These fumes can cause irritation to the nose and lungs.

***When you can't
breathe,
nothing else
matters.®***
**American Lung
Association**



Figure 3.3.d. Silo gas can leave a person unconscious or dead. It is difficult to rescue a victim from inside of a farm silo.

Safety Activities

1. Visit the American Lung Association website (www.lungusa.org) to learn more about lung disease.
2. Invite a respiratory therapist to speak to you, your 4-H club, or FFA chapter about lung disease and its prevention.
3. Visit the website www.gemplers.com. Locate the respiratory-protective devices for the following situations, and then make a chart of the device, use, and price:

Device	Used For:	Price Range	NIOSH Rating
_____	Welding Respirator	_____	_____
_____	Dust/Mist Respirator	_____	_____
_____	Nuisance Odor Respirator (livestock odors)	_____	_____
_____	Full-Face Respirator	_____	_____

4. Interview older farmers in the community about their experiences with “farmers lung” and ODTs, then write a news article to submit to an agricultural publication or newspaper in your state.
5. Interview people in your community who are welders. Ask them what they do to protect their lungs.

References

1. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.
2. Any Internet search engine. Type in asthma. Scroll to various sites to learn about asthma.
3. www.gemplers.com.
4. www.lungusa.org

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RESPIRATORY PROTECTION

HOSTA Task Sheet 3.3.1

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Many people think that farming means working in the clean, fresh air. Farming, however, has many respiratory (breathing) hazards. Some air will be dirty. Some air can be lethal (deadly) to breathe.

This task sheet discusses respiratory-protection devices to be used in agricultural work. Specific devices must be used with the correct work hazard to reduce lung damage. Failure to use the correct device can be the same as having no protection at all.

Breathing Hazards

The first step in selecting a respirator is to determine what the hazard is. Three categories of respiratory hazards can be found on the farm. They are:

- Particulates (dusts, mists, fumes)
- Gases and vapors
- Oxygen-deficient atmospheres

Particulates

Particulates are airborne particles of sizes that can be measured. Dusts, mists, and fumes are the types of these various-sized particles. Dusts are the largest-size particles. Dust may be dirt, but also can be spores from moldy hay, silage, or grain. Mists are suspended liquid droplets held in the air from mixing, cleaning, and spraying operations. Fumes are

particles of airborne solid evaporated metals such as from welding tasks.

Gases and Vapors

Chemical reactions of materials with the air produce gases and vapors. Gases are released from chemical reactions, such as manure decomposition, silage fermentation, and the exhausts of internal combustion engines. The gaseous products of these reactions exist during normal temperatures of the reaction.

Vapors are gases from substances that are normally solid or liquid. Evaporation from liquids, such as pesticides, paints, adhesives, and solvents become vapors. These become airborne breathing hazards.

Oxygen-Deficient Atmospheres

The air we breathe normally contains about 21% oxygen.

Some agricultural storage areas are oxygen-free by design or by the chemical reaction going on inside of them.

- Sealed silos are kept free of oxygen to keep certain bacteria from spoiling the silage.
- Controlled Atmosphere (CA) storages of fruit and vegetables lower the oxygen levels to maintain food quality and storage times.
- Manure storage, especially covered pits, become oxygen-deficient due to manure decomposition depleting the oxygen supply.

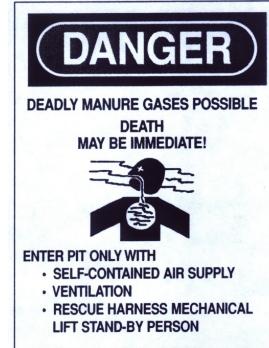


Figure 3.3.1.a. Safety signs warn us of immediate danger. This sign tells us that respiratory protection is required. What other safety practices does this warning sign recommend?

Try a different work practice to reduce breathing hazards. If you are still at risk, use a respirator.

Learning Goals

- To be able to select the correct respiratory protection for use in specific agricultural work

Related Task Sheets:

The Work Environment	1.1
Worker Protection Standards	1.2.4
Personal Protective Equipment	2.10
Common Respiratory Hazards	3.3
Agricultural Pesticides	3.5
Confined Spaces	3.8
Silos	3.9
Grain Bins	3.10
Manure Storage	3.11
Anhydrous Ammonia	3.12

Poor air environments can be immediately dangerous to life and health.

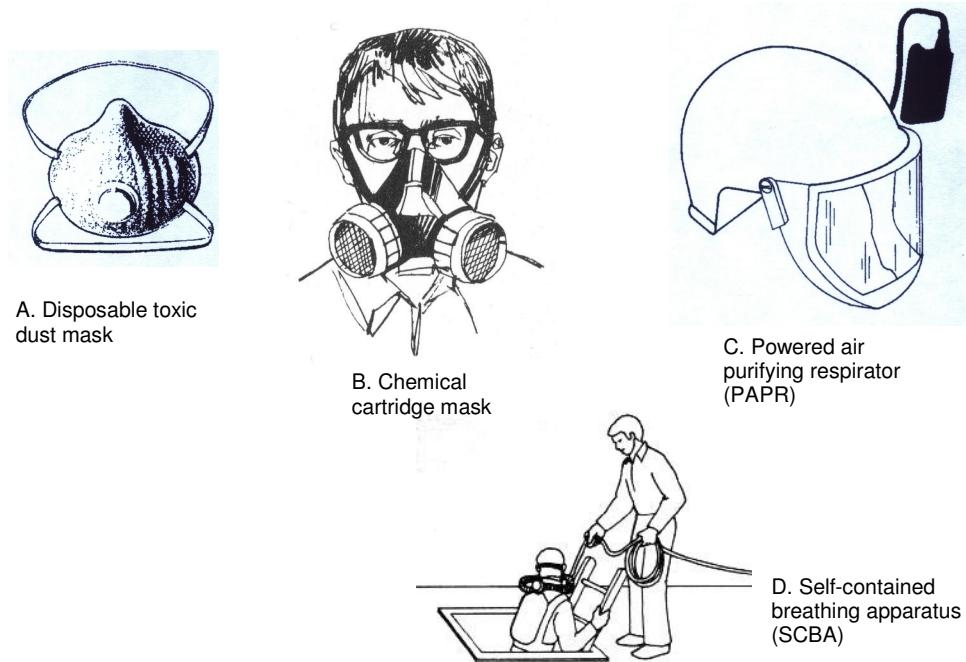


Figure 3.3.1.b. Respirators are available in two main categories. Air-purifying respirators such as the disposable toxic dust mask (A), the chemical cartridge mask (B), and the powered air-purifying respirator (PAPR), (C) shown above. Air-supplying respirators or self-contained breathing apparatus (SCBA), (D) provide clean fresh air from an outside source.

Types of Respirators

There is no such thing as an all-purpose respirator. Specific respirators are used for specific contaminants. A disposable dust mask will not filter chemicals. A self-contained breathing apparatus (SCBA) is not needed to load hay on a wagon.

Respirators can be placed in two categories:

- Air-purifying respirators
- Supplied-air respirators

See Figure 3.3.1.b.

Air-purifying respirators are equipped with filters. The user breathes through these filters. The respirator filters may be disposable or may be replaced according to the material to be filtered (Figures 3.3.1.c and 3.3.1.d.).

Replacement-filter respirators

should have filters replaced when your breathing becomes labored, the mask loses its shape or no longer fits your face, or you taste or smell the substance. A mechanical filter for particulates is not a replacement for a chemical-replacement filter.

Gas masks filter chemicals through a cartridge canister filter system. They have a full-face piece. Do not use the gas mask-type respirator in an oxygen limited area as they do not supply oxygen to the user.

Powered Air Purifying Respirators (PAPR) have a motorized blower to force air through a filter to the wearer. A constant stream of air is placed over the user's head and face. They have the appearance of a hard hat with a face shield.

Air-supplying respirators bring an outside source of air to the wearer.

These respirators are used in those areas where the oxygen levels are so low that they are considered immediately dangerous to life or health (IDLH).

Air-supplying respirators are of two types:

- Air-line respirator
- Self-contained breathing apparatus (SCBA)

Air-line respirators supply air to a respirator face piece through a hose connected to an air pump or tank.

Self-Contained Breathing Apparatus (SCBA) devices have a portable air tank that must be carried on the back like those worn by scuba divers and firefighters. Air-supplying respirators are expensive, and the user must learn and practice how to use them.

Use and Care of a Respirator

Respirators must be properly cared for if they are to protect your lungs. The device must snugly fit your face to provide lung protection. The respirator must not expose you to harmful residues either. The respirator must be cleaned. Filters must be changed often.

A properly fitted respirator will make an air-tight seal around your mouth and nose but still allow you to breathe. Poorly fitted respirators provide little or no protection. Dirty filters will prevent you from breathing normally.

Respirators must be clean before use. Clean the respirator body with warm soapy water and rinse thoroughly. Change the filters also. Clean the straps as well.

Use disposable filter masks just one time; then dispose of them.

Selecting a Respirator

Approved respiratory protection equipment should have NIOSH (National Institute for Occupational Safety and Health) shown on the device. Letter and number designations can be found. Look for the designation to be sure that the respirator is approved. Older labels will show the MSHA/NIOSH TC# or approval number. For example, a TC-23C respirator is used for pesticides. There may be older respiratory-protection devices to be found where you are employed.

Newer labels on respirators will

show the NIOSH approval number and describe the new NIOSH-approved respirator. An example would be the NIOSH TC-23C dual-cartridge half mask with disposable filter used for pesticides and ammonia.

Under current standards, air-filtering masks or respirators are rated according to the filter's efficiency in reducing solid particles of dust, mists, and fumes. Respirators are rated as being 95%, 99%, and 99.97 percent effective at filtering dust particles.

Filters are also rated according to time-use limitations in using the filter for protection against oil-based chemicals or pesticides in the atmosphere. The following designations are found:

N= Not resistant to airborne oils.
Becomes plugged quickly.

R= Resistant to airborne oils for up to 8 hours

P= Oil proof– Possibly resistant to airborne oils for more than 8 hours. Change filters after 40 hours of use or every 30 days, whichever is first.

The air-purifying disposable filter mask in Figure 3.3.1.c. could have a N95 rating. The filter respirator in Figure 3.3.d. may have a N99.97 NIOSH rating. This assures you that the filter offers 99.97% protection from exposure to particulates. There are no 100% filters in theory.

The work situation dictates the respirator to be used; not what happens to be hanging on the shop wall.

Use a respirator for its intended use only, and take proper care of the respirator as well.

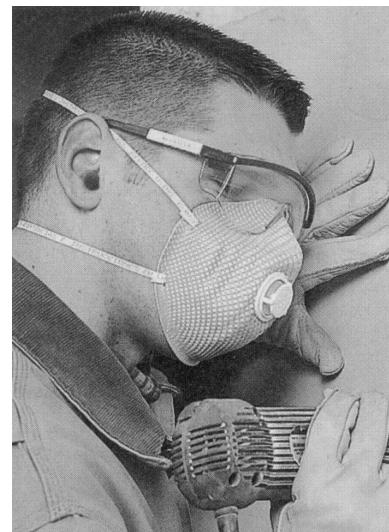


Figure 3.3.1.c. A double-strap respirator provides for a snug fit over the mouth and nose. If a respiratory protective device does not fit snugly, it cannot offer effective respiratory protection from small particles that can damage your lungs. A beard may cause the respirator to fit improperly.



Figure 3.3.1.d. The chemical cartridge respirator mask has a replaceable filter to trap dust, chaff, and larger particles. These respirators do not supply oxygen. These respirators do not filter toxic dust and vapor materials.



**A handkerchief
over the nose
will not filter
gases, fumes, or
small particles!**

Figure 3.3.1.e. The nuisance dust mask is the simplest form of protection. These devices do not filter out small particles of dust that cause respiratory disease. You can identify a nuisance mask by its single strap. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses*, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Safety Activities

1. During a farm visit, list as many places as you can that are oxygen-limited structures or locations.
2. Are all silos oxygen-limiting? Why or why not?
3. Visit a local orchard to find out more about controlled atmosphere (CA) storage of apples. Write a report on CA storage.
4. Using a vendor's catalog such as GEMPLERS, Inc, locate the respiratory-protective devices, and make a chart including the efficiency rating (95, 99, 99.97) and the respirator's rating for exposure to oils in the atmosphere (N, R, P) for each of the devices.
5. Match the recommended respirator type with the situation where that respirator would be used.

A. _____ Air-purifying filter mask with double straps	1. Oxygen-limited area, such as a manure pit.
B. _____ Chemical cartridge face shield and respirator	2. Nuisance dust areas, such as sweeping a shop.
C. _____ SCBA	3. Pesticide mixing and filling area.

References

1. www.cdc.gov/niosh (Search the site for respirator use information)
2. www.gemplers.com.
3. Farm Respiratory Protection, Fact Sheet E-36, College of Agricultural Sciences, Department of Agricultural and Biological Engineering, Dennis J. Murphy and Cathleen M. LaCross.
4. Farm and Ranch Safety Management, John Deere Publishing, 2009

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WORKING WITH LIVESTOCK

HOSTA Task Sheet 3.4

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

Working with livestock can be pleasurable and rewarding. To observe a litter of piglets being born, to assist with the birth of a dairy calf, or to train a young horse to lead by halter can be very satisfying. Working with animals is a major task in farming.

Working with livestock can also be dangerous. Animals have their own patterns of behavior. How well you understand animal behavior will be important to working safely with livestock.

This task sheet discusses what you will need to know to safely work with livestock.

Working With Livestock

Farm youth learn to work at an early age. Small children are routinely assigned to feed calves, heifers, pigs, and poultry. Junior livestock programs in rural counties help youth learn how to feed, care for, and market their animal project. Responsibility, confidence, and animal handling skills are gained by doing this work.

Statistics show us that working with livestock is also hazardous. Study these injury facts.

- In 2006 over 23,000 youth injuries occurred on farms with

39% being work-related.

- Falls, animals, and off-road vehicle use were three major sources of injury.
- Livestock and dairy farms led the injury list followed by crops farms.

Working with livestock does expose the youthful farm worker to an increased risk of injury.

Livestock hazards are also recognized as part of the Hazardous Occupations Order in Agriculture (HOOA). In these regulations, youth under age 16 are prohibited from working in a yard, pen, or stall with:

- Cows with newborn calves
- Bulls, boars, or stud horses kept for breeding purposes
- Sows with nursing pigs

Not all livestock jobs are hazardous for young people. Caring for poultry, milking cows, cleaning barns and equipment storage buildings, and riding, driving, or exercising horses are considered acceptable tasks, depending on the age and experience of the youth. Adult supervision of small children doing these tasks is recommended under North American Guidelines for Children's Agricultural Tasks (NAGCAT).

If you are employed by a local farmer to work with livestock, the expectation is that you will be trained and supervised by that person to safely do that work.



Figure 3.4.a. A cow with a newborn calf is usually protective of her offspring.

Livestock are linked to one in every five injuries on the farm.

Learning Goals

- To recognize hazards associated with caring for livestock
- To learn how to work with livestock

Related Task Sheets:

Injuries Involving Youth	2.1
Age-Appropriate Tasks	2.4
Personal Dress	2.7

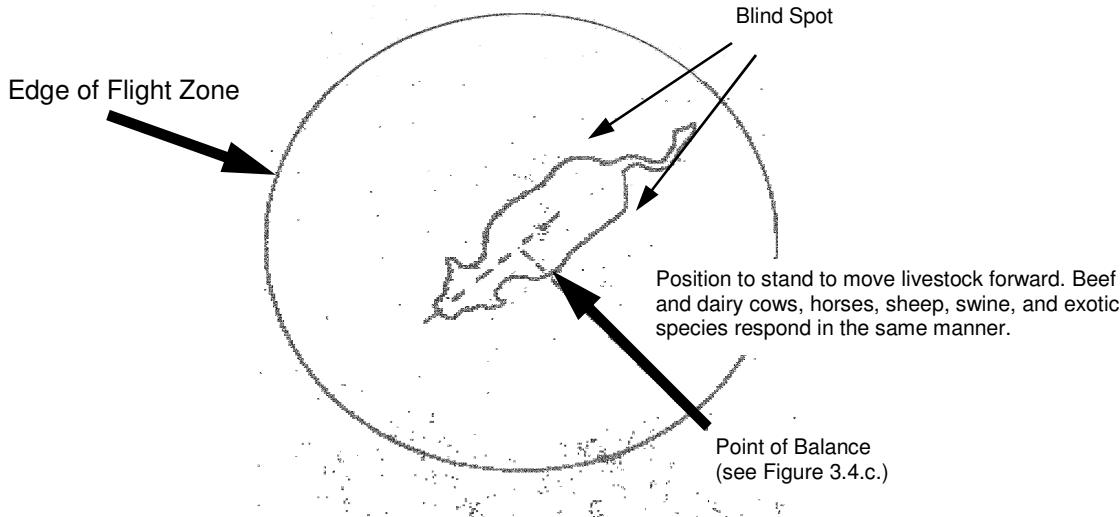


Figure 3.4.b. Flight Zone. Animals have a “personal” space. That space varies with how tame or wild the animal is. An excited animal has a larger flight zone. When you enter the flight zone, livestock turn to move away. If you surprise an animal by entering the blind spot of the flight zone from the rear, you may be kicked.

Roy's mother thought it was cute to teach the feeder calf to butt her hand with its head. When the FFA steer project weighed 1200 lbs., the animal still liked to butt his head. But that wasn't fun any longer.

Animal Behavior Facts

Animals have certain patterns of behavior which are instinctive and other behaviors that develop from habit. Cattle are “creatures of habit.” Milking time finds cows lining up at the holding pen. The sound of feeding equipment being started is enough to bring animals to the feeder.

Understanding animal behavior is the first step in working safely with animals. Here are some animal behavior facts.

- Female species are maternal. They will try to protect their young from danger.
- Older male animals are more aggressive and unpredictable. Male hormones cause this.
- Animals tend to group together for safety. Single animals are more dangerous and difficult to handle.
- Animals are territorial. They

may challenge an intruder that comes into their space.

- Animals tend to follow a leader when being moved. If no animal makes a move, the group tends not to move.
- Animals become acclimated to particular locations, sights, smells, and sounds. When moved to new and strange surroundings, livestock will react tentatively.
- Animals have a zone of comfort within which they will behave normally. Intrusion into that space will cause the animals to move to re-establish the comfort zone.
- Animals have poor depth perception and cannot see behind them. They will turn to keep you within their sight.

Moving Animals

Getting livestock to move is a matter of understanding the animals “flight zone” and “point of balance.” Animals will move easily if these two ideas are used with calm movement and the least amount of confusing noise.

Animals have a personal space just like people. The size of that space depends upon the animal’s tameness, the excitement level, and the angle that you approach the animal. If you move into the animal’s *flight zone* (Figure 3.4.b.), the animal will turn to move away from you. If you move outside the flight zone, the animal will turn to look at you. If the animal feels trapped in a corner and has limited vision, the animal will kick to warn you to stay away.

The animal will move according to your position at its *point of balance* (Figure 3.4.c.). The point of balance is the animal’s shoulder. All species of animals will move forward if the person is behind the point of balance. All animals will back up or turn away if the person is in front of the point of balance.

Using the point of balance works for moving larger groups of animals as well. Use this knowledge to move animals without prods, “hot-shots,” or shouting and screaming. People are smarter than animals and should use their thinking skills in working with livestock. *Hint:* Watch a livestock show. The leader will move in front and to the back of the point of balance to move his or her animal easily.

Precautions to Take

Livestock chores are not hazardous if the animal’s behavior is understood. There are precautions to follow to assure that the work is a pleasant experience free of injury.

Plan to use these safety measures when working with livestock.

- Plan for an escape route when working with livestock. Pens and corrals should have people pass-through openings for escape purposes.
- Wear steel-toed, nonskid shoes—not sandals or sneakers—when working with livestock.
- Avoid the hind legs of animals.
- Use squeeze chutes to hold animals securely for veterinarian procedures.
- Approach livestock so that they can see you coming.
- Move cattle in well-lighted areas, not shadowy places.
- Avoid quick movements and loud noises.
- Be patient.
- Keep animal-handling facilities in good repair with no sharp projections.
- Ask for help to move or work with an animal if the animal is excited or nervous.
- If the animal becomes nervous and agitated, wait 30 minutes before attempting to work with the animal again.

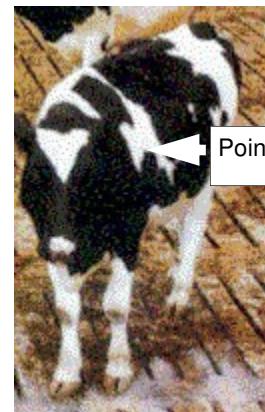


Figure 3.4.c. The animal’s shoulder is the point of balance for movement. Stand behind the shoulder, the animal moves forward. Stand in front of the shoulder, the animal stops moving forward.

**When
working with
animals, give
yourself a
route of
escape. Do
not corner
the animal.**



Figure 3.4.d. In days gone by, milking a cow was a different chore than it is today. What might be unsafe about this scene?

Safety Activities

1. Use a basketball and a tennis ball to represent an animal and a person respectively. Roll the tennis ball against the basketball to determine if the larger ball can be moved easily. Then roll the basketball against the tennis ball to determine if the tennis ball can stop the basketball. What did you observe?
2. Most animals are territorial. What does this mean? Make a list of incidences you have observed where an animal exhibited territorial habits and how they acted/reacted.
3. Use the Internet to locate your state's Land Grant University, College of Agriculture website. Search this site for any information you can find on how to construct animal-handling facilities for moving animals (chutes) and holding animals (squeezes). Make a sketch of the plans with dimensions.
4. Inspect a farm's facilities for handling livestock. How many pass-through gates are available?
5. Ask a friend who has a halter-broke animal to exhibit at the county fair. Ask your friend to show you how easily an animal will move backward or forward based on a person's slight movement front or back of the point of balance.
6. Practice moving a group of animals slowly and quietly by using knowledge of flight zone and point of balance.
7. Make a poster of the flight zone of a beef animal, a dairy cow, a hog, or a horse to show others how to safely move around animals.
8. Inspect all animal pens and alleyways where you will work for sharp obstructions (nails, sheet metal, etc), broken boards, and damaged gates. Report your findings to the owner. Suggest to the owner that they be repaired. Perhaps this is something that you can do as an employee of that farm.

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1. Injuries to Youth on Farms and Safety Recommendations, Farm Youth Injuries 2006, cdc.gov/niosh/docs/2009-117, August 31, 2010
2. www.nagcat.org/Click on guidelines>Select category, December 2010.
3. Cooperative Extension Service publications of your State Land Grant University.
4. www.necasag.org/library/facts/Search for Livestock Handling Fact Sheet, April 2009.

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AGRICULTURAL PESTICIDES

HOSTA Task Sheet 3.5

Core

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Modern farming relies on many chemicals to produce and preserve an abundance of high-quality food. Fertilizers, pesticides, cleaners and sanitizers, crop preservatives, fuels and solvents are chemicals. Each of these chemicals poses a hazard. Youth younger than age 16 are prohibited from using many agricultural pesticides.

This task sheet discusses agricultural chemicals from a youth information standpoint. Older workers can be called upon to handle and apply most chemicals. *If asked to work with restricted use (Category I and II) agricultural chemicals, tell your employer that you are under age 16 and are prohibited by law from doing so. See Task Sheet 1.2.2.*

Pesticide Use

Restrictions

At age 15, you have been hired to work at the neighboring farm. You have passed the safe tractor and machinery certification program. On your first day of work, the farmer has assigned you to rinse pesticide containers for return to the dealer and to burn pesticide bags. This may sound like a safe job for you to do, but is the job actually safe?

Hazardous Occupations Order in Agriculture regulations cover more than just tractor and machinery

operation activities.

The agricultural chemical portion of the regulation clearly states, "Youth workers under the age of 16 are prohibited from handling or applying (including cleaning or decontaminating equipment, disposal or return of empty containers, or serving as a flagman for aircraft) agricultural chemicals classified as Category I of toxicity (identified by the word "poison" and the "skull and crossbones" on the label) or Category II of toxicity (identified by the word "warning" on the label). Categories of chemical toxicity and their signal words will be explained on page 2 of this task sheet.

Effects of Pesticides on People

Agricultural pesticides may come in dust form, granular particles, liquid concentrates, or solutions. They appear innocent and safe, but they are complex chemical compounds with very serious effects on humans.

Exposure to pesticides produces a variety of symptoms. Symptoms may include headache, nausea, stomach cramps, diarrhea, chills, fever, fainting, and possibly paralysis and/or death. Some persons mistake pesticide poisoning for what they call the "summer flu."

Ag chemical exposure can lead to a variety of symptoms—including paralysis and/or death.

Learning Goals

- To understand that 14- and 15-year-old workers cannot use some agricultural chemicals
- To understand the warning signs and symbols used on agricultural pesticides

Related Task Sheets:

Hazardous Occupations Order in Agriculture	1.2.1
Worker Protection Standards	1.2.4
Personal Dress	2.7
Personal Protective Equipment	2.10
Lead Acid Batteries	4.6.2

KEEP OUT OF REACH OF CHILDREN



DANGER POISON



PELIGRO

Figure 3.5.a. The most toxic of chemicals will display the signal words “danger-poison,” along with the skull and crossbones. Peligro is Spanish for danger. Young farm workers are prohibited from working with or being exposed to these chemicals.

**Learn the
signal
words used
on pesticide
containers.**

TOXIC

Figure 3.5.b. The word toxic means deadly. Toxic materials can produce illness-like effects, or they may be deadly.

Signal Words and Categories

Every chemical label must display signal words. These industry standard words tell the user the toxicity of the product. Toxicity means how deadly the product is to people.

Signal words found on agricultural chemicals include:

- Danger-Poison (skull and crossbones included)
- Danger
- Warning
- Caution

These words and symbols indicate the product’s potential risk to the user.

Danger-Poison

Category I chemicals show the “Danger-Poison” signal word. A skull and crossbones is included on the label. These chemicals may be corrosive (can burn) to the eyes and skin and lungs. Less than a teaspoon of the chemical can kill a 150-pound person. Most of these chemicals are “restricted use” materials due to increased risk to

human health and/or the environment. They require certification to purchase and use.

Danger

These Category I chemicals can cause severe skin irritation and eye damage.

Warning

Category II chemicals use the signal word “Warning.” Skin and eye irritations that could last longer than one week can result from exposure to these products. A tablespoon of some Category II chemicals can be fatal. These pesticides are considered as restricted-use pesticides.

Caution

Chemical labels using the signal word “Caution” are much less toxic products to use. Mild skin and eye irritation results from exposure to these chemicals. Nearly one pint of the material would have to be swallowed to be fatal to a 150-pound person. Pesticides sold over-the-counter to consumers use the signal word Caution.

Ag Pesticide Exposure

Exposure to agricultural chemicals is not necessarily a harmful event, but exposure over time can be harmful. Exposure can be minimized by wearing personal protective equipment (PPE).

The handling and application of pesticides is prohibited for youth younger than age 16.

Chemical exposure can occur in four ways:

- Oral (mouth)
- Dermal (skin)
- Inhalation (lungs)
- Ocular (eye)

Let us examine these more closely.

Oral Ingestion (by the mouth)

Pesticides can contaminate the hands through the handling of the container. Small amounts of the chemical may end up on cigarettes, chewing tobacco, food, or drinks touched by contaminated hands. Ingestion of pesticides through food is a common means of ingestion. Hands could also be an oral source of exposure.

Dermal (Skin) Exposure

Pesticides may be taken in through the skin. Even the act of urinating with pesticide-covered hands causes pesticide exposure. Some persons mistakenly think that tough, calloused hands reduce the entry of the pesticides through the skin.

Even by wiping the sweaty forehead or the back of the neck, dermal exposure occurs to those more sensitive tissues.

Touching treated surfaces or handling empty containers may cause dermal exposure. Walking through a recently treated field can

lead to dermal exposure to pesticides.

Inhalation (Breathing) Exposure

Breathing pesticide or agricultural chemical mists, vapors, or dusts exposes the lungs to the product. Exposure can occur while mixing granular and powder forms of pesticides and during the burning of empty containers. Inhalation exposure provides the fastest route of exposure into the bloodstream.

Ocular (Eye) Exposure

Splashing of liquid chemicals and dust from granular pesticides during handling, mixing or rinsing of containers is a source of risk to the eyes.

Improper handling of agricultural pesticides can result in the production of toxic fumes and vapors.

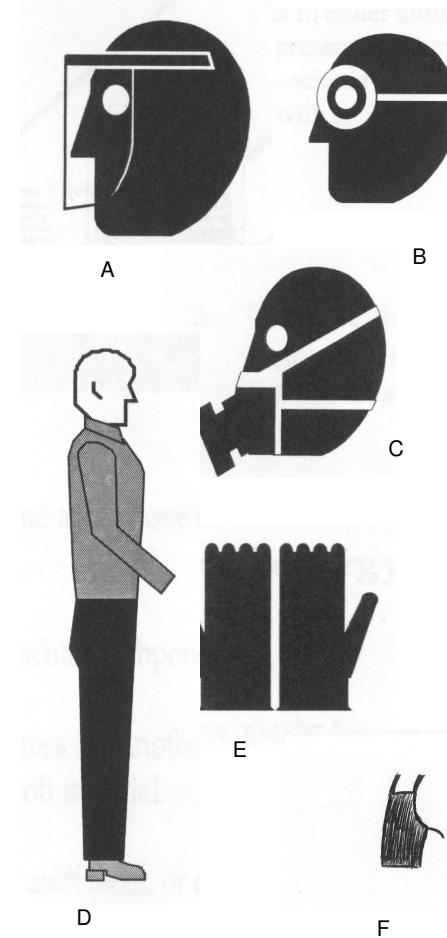
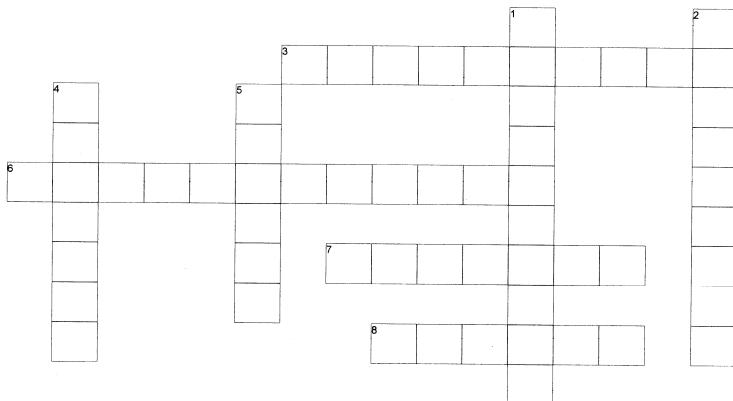


Figure 3.5.c. Face shields (A) and/or goggles (B), respirators (C), long sleeves and pants (D), chemical-resistant gloves (E) and aprons (F), should be used when handling pesticides, strong detergents, sanitizing chemicals, degreasers, and battery acid. Read the chemical label for the personal protective equipment (PPE) to use.

Safety Activities

1. Make an agricultural chemical inspection of a farm with the owner's permission. Make a list of all the chemicals that you find and the signal words that are included on the label. DO NOT HANDLE CONTAINERS WITH MATERIALS SPILLED OVER THE OUTSIDE OF THEM.
2. Solve this crossword puzzle.

Ag Chemicals



ACROSS	DOWN
3. Breathing exposure hazard	1. protects face and eyes from chemicals
6. protects the hands from chemicals	2. Oral intake of pesticides
7. a signal word	4. Signal word for moderate toxicity
8. exposure through the eyes	5. Pesticide exposure through skin

Use these words: Inhalation, face shield, ingestion, caution, warning, rubber gloves, dermal, ocular

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2. The Pennsylvania Pesticide Applicators Certification Core Manual, 2008 The College of Agricultural Sciences, Penn State University, University Park, PA.

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ELECTRICAL HAZARDS

HOSTA Task Sheet 3.6

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

Agriculture uses electricity as a tool. Jobs that were once labor intensive are now done with the help of electrical devices. The dairy industry uses compressors, vacuum pumps, refrigeration units, motors, and controls for all kinds of tasks. Grain producers use crop driers with fans and augers. Swine and poultry producers rely heavily on controlled ventilation and automatic feeding systems. There are many other examples.

This task sheet discusses the hazards posed by electricity. Beginning level farm workers will use many of the systems mentioned. Each year 30 to 40 persons are electrocuted on farms. Being safe with electricity is a work skill that must be mastered.

Electrical Hazards

Using electrical current and electrical equipment can lead to several hazards including electric shock, heat, and fire.

Electric Shock Hazard

When a person becomes part of an electric circuit, they are a conductor of the electrical current. Since electricity cannot be seen, the hazard is often overlooked until too late. Bodily injury and death can occur.

Current flowing through the body will affect the body in some manner. A slight tingling sensation may be felt. A shock may be felt which can result in muscular contractions that can "knock" the victim away from the circuit. Electric shock may "lock" the muscles to where release from the circuit is impossible. In severe cases, heart muscle rhythms are disrupted and death results.

Electrical current also produces heat which can burn body tissues both externally and internally.

Heat and Fire

Electricity can be the source of heat to ignite flammable materials. Current flow in a conductor produces heat because of the conductor's resistance to the flow of electricity. Increased heat in electrical conductors can be expected when:

- The wire size is too small to carry the current (trying to run an electric motor on a lamp cord)
- The electrical load is too great (operating a hair dryer, curling iron, and toaster on the same circuit)
- The electrical load is too far away from the electrical source (a 1/2 electric drill motor operated at the end of a 100- foot extension cord)
- The electrical connections are loose, and increased resistance develops



Figure 3.6.a. Contact with an electrical current can kill a person. The heart muscles will lock up if the electrical current passes through the heart when all the heart valves are closed (rest phase).

**Electricity
can kill. Be
careful!**

Learning Goals

- To understand electrical hazards
- To safely work with electrical equipment used in agriculture

Related Task Sheets:

Housekeeping

2.6

Fire Hazards

3.6.2

**Ground Fault
Circuit
Interrupters
(GFCIs) are the
best source of
worker
protection in
damp areas.**

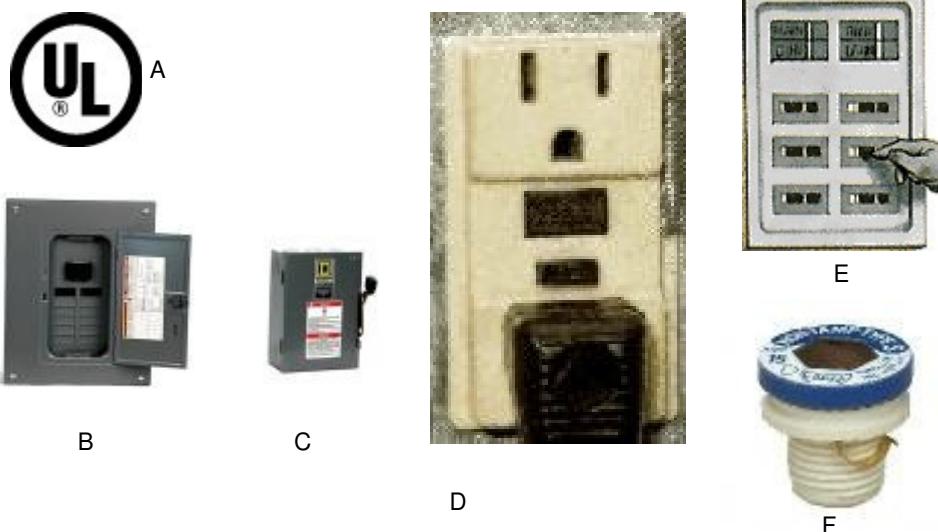


Figure 3.6.b. Electrical components are built to strict safety standards and tested for reliability by the Underwriters Laboratories. Look for the UL label (A) above. You may have to operate circuit breaker boxes (B,C) as switches for electrical tools. If the appliance suddenly stops working, then circuit breakers (E), fuses (F), or GFCIs, (D) may have broken the circuit to protect you and the wiring.

Electrical Devices You May Use

Work assignments on the farm may require use of electrical appliances and tools. The following describes the electrical equipment you may be called upon to use. *Note: A qualified electrician will be necessary to work with the electrical system beyond what is described here.*

Distribution Panel— The circuit breaker or fuse box contains many circuits. This is the location of circuit breaker devices to stop current flow to an electrical circuit. You may be assigned to go to the distribution panel (sometimes called circuit breaker panel or fuse box) to turn a circuit on or off.

Circuit Breakers and Fuses— These devices found in the distribution panel protect the wires of the circuit from overheating. Overloads cause fuses to “blow” and circuit breakers to “trip” to electrical flow. Three common

protective devices are:

- Fuses
- Circuit breakers
- Ground fault circuit interrupters (GFCIs)

Fuses are either a screw-in or cartridge type. A metal strip melts when the circuit is overloaded and interrupts the circuit. The fuse must be replaced. Shut off the “main” power switch before changing fuses. See page 3 for more details.

Circuit breakers look like switches. When a bi-metal strip (two different metals) is heated from electrical overload, the metal becomes distorted in shape and causes the circuit breaker to cut out. The overload problem must be corrected and the switch returned to the on position. See page 3 for more details.

Ground Fault Circuit Interrupters can look like an electrical outlet or a circuit breaker. These GFCI devices break the circuit in microseconds when a difference in current is sensed. These devices

are used where moisture is found. Milking parlors and milk rooms, swimming pools, kitchens, laundries, and outdoor receptacles should have GFCI protection. A red reset button and test light area make GFCI devices different than a regular outlet.

If fuses, circuit breakers, and GFCI devices are constantly “blowing,” ask your employer to check the situation before you continue.

Switches and Receptacles— Switches energize circuits. Receptacles connect the appliance to the circuit. Careless use can damage the receptacle and appliance. If you are assigned to a job where the electrical switch and/or receptacle is damaged, ask the employer to make the repairs.

Underwriters Laboratories

Electrical components must meet the Underwriters Laboratories (UL) standards. Look for the UL symbol to be sure that the device has approved safety construction. See Figure 3.6.b. above.

Overhead Power Lines

Many overhead power lines do not have insulating covers. They normally carry high or higher current than building circuits. The person, or machine the person is moving or operating, becomes part of the electrical distribution grid. Contact with these wires can lead to a fatality.

Many deaths on farms are due to contact with overhead wires. Elevators, augers, metal ladders, and irrigation pipes must be moved. These objects are good conductors of electricity, and the operator is usually in direct contact with them through the tractor and implement. See Figure 3.6.c.

To prevent this hazard situation:

- Lower augers and elevators for transport.
- Take notice of low-hanging wires.
- Use a “spotter” while moving equipment under utility wires.

Recognizing Electrical Hazards

You do not have to be an electrician to be safe around electrical circuits. Use these ideas to be a valuable and safe employee.

Circuit Breakers and Fuses— If circuits are constantly breaking (shutting off), the circuit is overloaded. Tell your employer. Do not put foil or a copper penny in the fuse socket to eliminate the fuse. Even larger capacity fuses add to the dangers. A jumper wire to bypass the circuit breaker is not a good idea.

Grounding— Three-prong appliance plugs assure that the circuit is grounded. *Do not cut off the third prong (round prong) to make the plug fit.* A two-prong adapter with ground strap should be used.

Lock-outs— Distribution panels or fuse boxes, (Figure 3.6.b) can be fitted with a lock. Lock these boxes to prevent children and visitors from contacting the wiring inside of them. When working with an electrical circuit that is out of sight of the fuse box, lock the fuse box or controller so that another person does not accidentally energize the circuit while you are working.

Hostile Farm Conditions—Dust, moisture, corrosive materials, gases (manure), and physical damage is hard on electrical equipment. Report broken or damaged electrical equipment to your employer (Figure 3.6.d.).

Extension Cords— Many times extension cords are used to operate equipment. Use heavy-duty cords when using heavy-duty tools.

Extension cords should not be used as permanent wiring. Do not jerk the extension cord from the wall receptacle by pulling on the cord. Be careful not to cut through the extension cord insulation. Report damaged extension cords immediately.

Underground Utilities— Phone, electrical, gas, satellite TV, and dog training wires may be buried. For public utility locations, call before digging. Check with www.digsafe.com, a national directory for the phone number in your state. The service is free.



Figure 3.6.c. Lower the hay elevator or grain auger to avoid contact with overhead power lines. *Farm and Ranch Safety Management*, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.

**Machinery
contact with
overhead wires
causes many
farm fatalities
due to
electrocution.**



Figure 3.6.d. Improper electrical wiring methods and materials placed into a hostile farm environment can lead to fires and electrocution of people and livestock.

Safety Activities

- With the permission of the farmer/owner, conduct a electrical safety survey of a farm in your area. Use this chart to complete the survey.

<u>Area to Inspect</u>	<u>How Many Found</u>	<u>Where Found</u>
A. Lock-out devices with locks attached	_____	_____
B. Electric boxes or controls damaged by hostile farm conditions	_____	_____
C. Low-Hanging Power Lines	_____	_____

- Research the topic “stray voltage” to learn how a dairy cow can experience being electrically shocked in a barn setting.
- Find out why a toaster wire heats up to toast our bread and an electric iron heats up to iron the wrinkles from our clothes. For help, access the website www.howstuffworks.com.
- Research the topic “Ground Fault Circuit Interrupters” (GFCIs). How does this device work and where should the device be used?

References

- Farm and Ranch Safety Management, John Deere Publishing, 2009. Illustrations reproduced by permission. All rights reserved.
-
- OSHA Publication 3075, Controlling Electrical Hazards, 2002. (Available free via Internet order through OSHA.gov)

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FIRE SAFETY

HOSTA Task Sheet 3.7

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Fires are common in the home, in the shop, barn, or silo, and around farm machinery and automotive vehicles. Grease can catch fire in the kitchen or shop. Flammable materials can be ignited when welding or metal cutting is done nearby. Dust and crop debris can be ignited in or on machinery. Spontaneous combustion can occur in stored damp hay, with improperly stored silage, or in piles of oily rags. Electric circuits can overheat and cause fires.

Many people panic when a fire occurs. Panic is not necessary if you understand what causes fires, fire prevention, and fire extinguishing methods.

This task sheet provides information on fires in agricultural buildings and structures. Task Sheet 3.7.1 will discuss fire prevention and control.

Definitions

Auto-ignition: The situation where flammable materials stored near an open flame or where heat can build up results in a fire risk.

Combustible: The capacity to be burned makes a material combustible.

Flammable/Nonflammable: These terms are used interchangeably with the term “combustible.”

Flash Point: A point at room temperature where a solvent will produce vapors in enough concentration to ignite when brought near a source of heat.

Kindling Point/Ignition Point: The lowest temperature at which a solid material will ignite and begin to burn when brought near a source of heat.

Spontaneous Combustion: The phenomenon in which a material unexpectedly bursts into flames without apparent cause. See Task Sheet 3.7.2.

Vapors: Vapors are the gas form of substances that are normally in the solid or liquid form.

Volatility: The tendency of a liquid to vaporize or evaporate into the air. Gasoline is volatile.

The Fire Triangle

The Fire Triangle: Three things are necessary for a fire to start and to continue to burn. They are: fuel, heat, and air. Fuels can be a variety of materials. See pages 2-4. Heat sources can be electrical, open flame, sparks, and chemical reactions. Oxygen is part of the chemistry that supports a fire. Without any one of these factors, a fire cannot exist.

Fires are classified according to the fuel that burns. A letter designation system is used. Categories of fire common to agriculture and rural residences are Class A, B, and C. See pages 2-4.

Fire Triangle

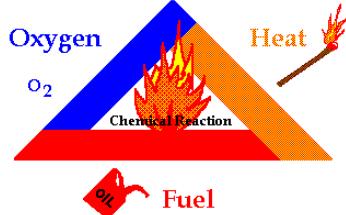


Figure 3.7.a To support a fire, three items must come together with a chemical reaction. Heat, fuel, and oxygen (air) must be available to support a fire.

**Three things are needed for a fire to exist:
fuel, heat, and air.**

Learning Goals

- To understand the three factors which support a fire
- To understand the three classes of fire

Related Task Sheets:

Housekeeping	2.6
Agricultural Pesticides	3.5
Electrical Hazards	3.6
Fire Prevention and Control	3.7.1
Hay Storage Fires	3.7.2

**Fires are
classified by
letters
representing
the fuel
involved.**



Class A

Class B

Class C

Figure 3.7.b. Fires are classified by letters representing the fuels which support them.
Class A fires involve wood, paper, rubbish, and plastic.
Class B fires involve burnable liquids like grease, oil, and fuels.
Class C fires involve electrical sources such as motors, wiring, switches, and connections.

Class A Fires

Class A fires involve wood, paper, rubbish, plastic, and crop materials. These fuels have a “kindling point” or “ignition point.” Kindling point is the lowest temperature at which the substance will ignite and begin to burn. Small pieces of wood burn more quickly than a large fire log for example. A fireplace in a home must have a fire started with small pieces of kindling wood.

The kindling point of Class A materials varies with the material, its thickness, and moisture content. You cannot start a campfire with the largest fire log because it has a high kindling point and would need much more heat than a match could provide.

Dust from Class A materials can also burn quickly and violently. Dust has a low kindling point. At

high levels of concentration, dust can even explode. Sparks from electric motors can cause the fire.

Dust explosion provides proof that smaller particles burn more quickly than larger particles. *Do you think that very fine, metal filings can burn also? How could you prove whether or not this is true?*



Figure 3.7.c. Dusty, dirty conditions in agriculture contribute to increased fire hazards. What materials in this picture are considered Class A fuel sources?

Class B Fires

Class B fires involve liquid materials which have the ability to produce vapors. These vapors can burn. When liquids give off enough vapors to burn, the fuel has a "flash point."

Three fuels can serve as examples of vapor-producing liquids. Gasoline is the most volatile liquid fuel and produces vapors which burn quickly and violently (low flash point). Diesel fuel and paint thinners produce less vapors (high flash point). Diesel fuel and paint thinners burn slowly when an open flame is placed directly near the fuel surface. Acetylene gas for welding and cutting is the product of a chemical reaction involving liquid elements producing gas. These vapors burn explosively.

Heavier Than Air or Lighter Than Air?

Some fuel vapors are heavier than air and settle to the lowest point nearby. Gasoline, propane, and diesel fuel serve as examples. Gasoline (the most volatile fuel) vapors are heavier than air and settle to a low point in a shop or enclosed space. Propane vapors are lighter than air and rise into the atmosphere. Diesel fuel is less volatile with the vapors being held near the surface of the fuel itself.

Precaution: When working on a vehicle inside of a shop or garage, do not permit gasoline to be spilled. Vapors may travel across the floor and be ignited by hot water tank pilot lights, welding sparks, and the sparks from a dropped, broken portable shop

light.

Heavier Than Water or Lighter Than Water?

Class B liquid material fuels have weight or density. Some fuels may float on water, while others may sink beneath the surface. Gasoline and diesel fuel float on the surface of water, while grease sinks beneath the water. Fuel spilled on a body of water could be ignited and burned on top of the water.

Precaution: A major fuel spill on a farm pond or slow-moving stream should be reported to local fire officials immediately.

Vapors Concentrated in the Air:

As vapors of gaseous products gather in an enclosed space, they may be ignited by simply turning on a light switch. There is a momentary arcing of electrical current behind the light switch unless the switch is a snap action device. Acetylene gas leaking from a cylinder into a closed storage room can explode when the light switch is turned on. Acetylene tanks should be drained properly. Ask your employer about this hazard.

Hint: Smell the air in the acetylene storage area before "flipping" the light switch to turn on the lights. If it is safe, you should not be able to smell acetylene vapors. You can prevent an explosion by smelling the air first!

Because of the volatility of Class B fuels, auto-ignition may occur near open flames or in storage areas where heat can build up.



Figure 3.7.d. Vapors are produced by cleaning solvents, gas, and paints. When these vapors pass off into the atmosphere, they are called volatile.

Vapors and dust can be explosive.

Class C Fires

Class C fires involve electricity. These fires have electricity as the source of both fuel and heat. Motors, wiring, switches, and controls can overheat. The overheating is usually caused by an electrical overload. Electrical parts can catch fire. Nearby flammable objects can be ignited.

Electricity generates heat. Increased heat in electrical wiring can be expected when:

- The wire size is too small

- (trying to run an electric motor on a lamp cord)
- The electrical load is too great (operating a hair dryer, curling iron, and toaster on the same circuit)
- The electrical load is too far away from the electrical source (a 1/2 horsepower electric drill motor operated at the end of a 100-foot extension cord)
- The electrical connections are loose
- The electrical equipment is malfunctioning

Electrical equipment also can create sparks during its operation. Class A and B fires can be ignited by electrical overloads and sparking.



Figure 3.7.e. Welding sparks from electric arc welders and oxyacetylene gas welding equipment can create the spark that ignites nearby flammable materials or vapors.

Safety Activities

1. Review the fire safety lessons you learned in elementary school. What does Stop, Drop, and Roll mean?
2. Learn about the correct method of using a fire blanket. If you had to help someone who had caught on fire, would you know what to do?
3. Conduct a survey of a local farm to locate the placement, condition, and number of fire extinguishers on the tractors and other machinery and in the buildings. Make a report of your findings by making a chart or map.
4. Join a Junior Volunteer Fire Department.
5. Use the Internet to learn more about fire hazards and fire safety on farms. Type the phrase “fire safety” into any search engine.
6. In a safe location, secure a lighted candle so that it does not fall over. Lightly sprinkle fine metal shavings over the flame. Do the metal filings burn? Hint: The metal filings can be secured from a science teacher or by sweeping the area around a shop grinder. Do not use oily filings.

References

1.
3. Farm and Ranch Safety Management, John Deere Publishing, 2009.

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FIRE PREVENTION AND CONTROL

HOSTA Task Sheet 3.7.1

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Understanding fires helps us to prevent and control them. Fires are often unexpected, but are usually predictable in their behavior. People, however, are unpredictable in their behavior with fire. People often panic when faced with a fire situation.

This task sheet discusses fire prevention and control as a means of helping the young agricultural worker deal calmly with unexpected fires. Task Sheet 3.7 describes the science of fire in detail.

Fire Prevention

A majority of fires can be prevented. Remember the science of the fire triangle? Fuel, air, and heat must react together for a fire to exist. Without any one of these factors, a fire is not possible. A fire prevention program can be built around knowledge of the fire triangle.

Several steps will lead to a sound fire prevention program. Work-site analysis, maintenance, housekeeping, and fire prevention and control training are proven methods of reducing the risk of fire. Each of these items is discussed.

Work-site Analysis: Fire hazards should be surveyed at each farm. Combustible materials should be identified and stored properly. Fire extinguishers must be easily located and readily available. Fire extinguishers should be professionally inspected and/or recharged on an annual basis.

Maintenance and Housekeeping:

Equipment and facilities must be maintained and in working order. Regular maintenance schedules should be followed. For example, worn bearings on a motor shaft can overheat and ignite nearby flammable materials. A regular lubrication schedule can reduce that cause of fire. Good housekeeping helps prevent fires. Clean up oil-soaked rags to reduce the risk of sparks igniting the cloths.

Fire Prevention and Control Training:

Everyone working on the farm must be a partner in the prevention and control of fires. All employees should have a job description which includes:

- Regular fire hazard inspection
- Training in fire extinguisher use
- Good housekeeping procedures

Each person is responsible to be knowledgeable in fire prevention and control procedures.



Figure 3.7.1.a. Sloppy housekeeping contributes to potential fire hazards in farm shops and other structures. What class of fire might exist in the area that this picture represents? Would it be Class A, B, or C? Review Task Sheet 3.7 for a clue.

People tend to panic in a fire. Such behavior causes further panic.

Learning Goals

- To be able to prevent fires
- To correctly select the proper fire extinguisher to use in a specific fire situation

Related Task Sheets:

Housekeeping	2.6
Ag Pesticides	3.5
Electrical Hazards	3.6
Fire Safety	3.7

**Fire
extinguishers
should be
regularly
inspected for
leakage!**

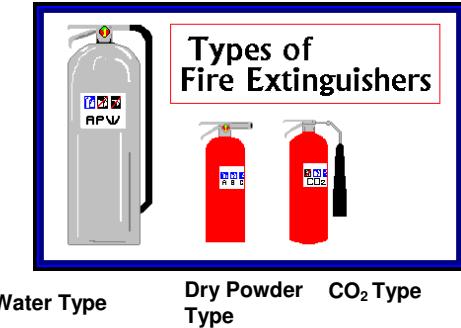


Figure 3.7.1.b. Fire extinguishers must be used for the class of fire for which they are rated.

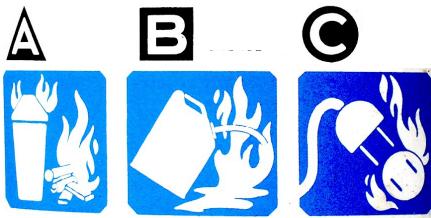


Figure 3.7.1.c. People do not have time to read directions in a fire emergency. Symbols attached to the fire extinguisher represent the type of fire. Can you identify the class of fire in each pictorial above? If you saw this pictorial on a fire extinguisher, what class or classes of fire would you be attempting to control?

Fire Extinguishers

Fire extinguishers are identified by a pictorial attached to the extinguisher body showing the type of fire for which they should be used. See Figure 3.7.1.c above. In an emergency, these standard graphics give us instant information about the extinguisher.

Water type extinguishers contain water under pressure. Use them for Class A fires only. Water spreads grease fires and conducts electricity. Water put on an electrical fire will conduct the electrical charge back to the user. Electrocution will result. The water cools the fire to extinguish it.

Water type extinguishers are made of stainless steel, have a pressure gauge, and long hose. See Figure 3.7.1.b above.

Chemical extinguishers contain a dry chemical powder. They can be used on class A, B, and C fires.

The dry chemical suffocates the fire by eliminating the air. A small amount of material can extinguish an equipment or motor fire quickly. The dry chemical does leave a residue to clean up. The 10-pound, dry chemical extinguisher is recommended for use. See Figure 3.7.1.b above.

The dry chemical powder extinguisher is identified by its short, thick, red-colored container with a bright metal nozzle next to the pressure gauge.

Another chemical extinguisher is the Halon extinguisher. These extinguishers contain a gas that interrupts the chemical reaction that takes place when fuels burn. These types of extinguishers are often used to protect valuable electrical equipment since they leave no residue to clean up.

Carbon dioxide extinguishers contain CO₂ (carbon dioxide) gas. This extinguisher can be used on

small class B and C fires. It leaves no residue. The pressurized CO₂ gas contacts the air and forms dry ice. The fire is cooled by the dry ice.

There are limits to the CO₂ extinguisher's use. Larger fires will require a greater capacity for control than what this extinguisher can provide. Also, the dry ice is so cold that it can burn the skin if a person touches the dry ice.

CO₂ extinguishers are identified by a red container with a larger black funnel-shaped nozzle which can pivot near the pressure gauge area. See Figure 3.7.1.b above.

DO NOT TREAT FIRE EXTINGUISHERS AS TOYS.

Squeezing the trigger to discharge the fire extinguisher just once will be enough to drain the pressure from the extinguisher. When it is actually needed, it will be worthless.

Using a Fire Extinguisher

To use a portable fire extinguisher, follow the steps called PASS. The steps include:

- Pull the pin
- Aim at the base of the fire
- S
- Sweep from side to side

Remember the acronym-PASS!

Important note: Always aim at the base of the fire. This is important for two reasons. First, a small fire extinguisher has limited material. It will be wasted aiming above the flame. Secondly, the fire extinguisher material will form a barrier above the fire. The flames can roll up under the barrier toward you.

See Figure 3.7.1.d for a graphic view of using a fire extinguisher.

phone lines are burned by fire.

- Written directions to the home or farm should be stored near each phone. In a panic, people commonly forget the simplest of directions or cannot state them clearly.
- Provide the local fire company with a detailed map of the farm including pesticide storage areas, fertilizer storage areas, manure pits and lagoons, and clean water pond sources. The fire company could have these on file, or they could be available in a weatherproof box at the farm lane.
- Install smoke alarms and carbon-monoxide detectors. Test the batteries regularly and replace them as needed.
- Schedule regular fire training and fire drills with the family and with the employees.
- Supply the correct fire extinguishers on all tractors.

Being prepared for a fire is good insurance that all persons involved will react in a focused and safe manner.

Fire Preparedness

Being prepared to control a fire is different than prevention of fire hazards. There are a number of steps to take to be prepared for a fire emergency. Consider starting these practices in your home or place of employment.

- All family members/employees should be trained in fire prevention and control measures.
- Local fire company phone numbers should be accessible to all persons involved with the farm. Cell phones may be the best form of communication if

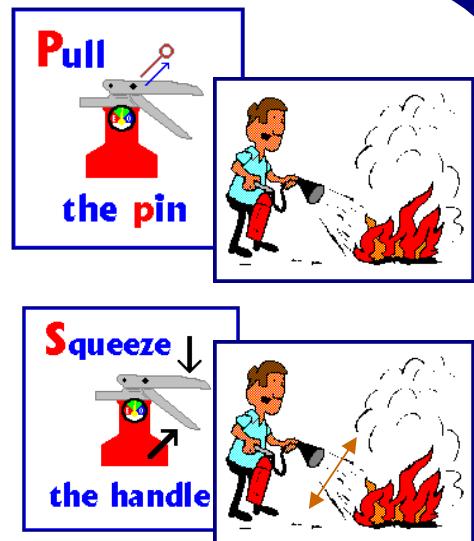


Figure 3.7.1.d. Review the PASS acronym as you look at these pictures. Can you repeat the steps to use a fire extinguisher?

**Are you and
your family
and your
employer fire
prepared?**



Figure 3.7.1.e. All tractors should have a dry, chemical-type fire extinguisher on board. Today's high-priced tractors and equipment should be fire control ready. What class(es) of fire will the dry chemical extinguisher control?

Safety Activities

1. What three factors make up the fire triangle?
2. Make a housekeeping inspection of the home shop, school shop, or a local farm shop to locate any hazards which could show a potential for fire. Make a list of those hazards. Ask for permission to eliminate the problem.
3. The kitchen stove catches fire while eggs are being fried. Should you throw water on the fire to control it? Why or why not?
4. How could you control a kitchen grease fire?
5. An electric motor is on fire. What fire extinguisher should you use and why?
6. Could a shovel full of soil be used to put out a small fire on the top of a farm machine? Explain your answer in terms of the fire triangle.
7. Does your computer room at school or at home have a Halon-type fire extinguisher available for use? Why is a Halon extinguisher a good idea in the computer area?
8. Recite the PASS process for using a fire extinguisher.
9. Conduct a survey of a local farm to determine how many fire extinguishers are found in the shop and on the tractors. Look for an inspection date. Are the extinguishers currently inspected?

References

1. Safety Management for Landscapers, Grounds-care Businesses and Golf Courses, John Deere Publishing, 2001.
2. Farm and Ranch Safety Management, John Deere Publishing, 2009.

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HAY STORAGE FIRES

HOSTA Task Sheet 3.7.2

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Barn fires destroy property, stored crops, livestock, as well as cause a loss of revenue. Thousands of dollars can be lost as a result of barn fires. Investigations pinpoint many causes of these fires. Barn fires are a result of “spontaneous combustion,” electrical malfunctions, poor housekeeping, and careless work habits.

Plant material (hay and straw) continues to respire (produce oxygen) for a short time after it is stored. Plant respiration and bacterial action creates heat as the plant oxygen is used up. Too much heat generated causes combustion.

This task sheet discusses recognizing hay fire risks and the proper handling of a hay crop as a means of preventing fires caused by spontaneous combustion.

The Chemistry of Hay Fires

Fresh cut forage crop cells continue to respire until the crop material dries or is cured. This chain of events occurring within the forage depends upon many factors. Moisture content is the most critical and is the only influence discussed from a fire safety standpoint.

Hay placed in storage should have a moisture content under 25%. Higher levels of moisture require

an oxygen limiting storage system. The heat generated by the crop plus the presence of oxygen increases the risk of a fire.

Drying or curing of the forage takes several weeks, but the risk of fire in stored hay usually occurs within two to six weeks of storage. Stored hay of normal moisture levels undergoes some heating, but the heat is normally less than 125 degrees F. See Table 3.7.2.a. on page 2 of this task sheet.

Some hay growers apply chemical or biological additives and preservatives to the hay at harvest time to increase the rate of field drying or to bale and store the hay at higher moisture levels. The hay may still heat in storage.

Note: Stored cured hay can become damp due to a leaky barn roof, from ground moisture, or from high humidity and can still burn due to spontaneous combustion.



Figure 3.7.2.a. Hay storage fires result in devastating damage. The building, crop, and livestock losses can be tremendous, as well as the loss of income-producing facilities.

**Store baled hay
when the hay has
less than 20%
moisture.**

Learning Goals

- To understand that improperly stored hay can ignite by spontaneous combustion
- To learn how to prevent hay storage fires
- To understand what to do if stored hay is getting too hot.

Related Task Sheets:

Fire Safety	3.7
Fire Prevention and Control	3.7.1

An experienced worker should monitor rising temperatures in hay storage, not a youth worker.

Table 3.7.2.a. Critical temperatures, conditions, and actions to take with hot hay according to the NRAES-18 publication. See the Reference Section of this task sheet.

Temperature	Condition and Action
125°F	No action needed.
150°F	Temperature will most likely continue to rise. Check temperature twice daily. Move hay to allow air circulation to cool the hay.
160°F	Check temperature every few hours. Move hay to allow air circulation to cool the hay.
175-190°F	Hot spots or fire pockets are likely. Alert fire service of a possible hay fire incident. Stop all air movement around the hay. Remove hot hay with assistance of fire service personnel.
200°F or above	Fire is present at or near the temperature probe. Inject water to cool hotspots before moving the hay. Fire service should be prepared for hay to burst into flame when contacting the air.

Hazards of Hay Fires

Three potential hazards exist from hay fires. They are:

- Sudden flareups of flame with exposure to fresh air
- Burned-out cavities in the hay that present a fall or entrapment hazard
- Toxic gases

Let us examine each of these in more detail.

Flareup of flame:

At temperatures between 150 and 170 degrees F the potential for spontaneous combustion of hay increases. Hay in this temperature range should be moved to allow for cooling. At the higher end of this temperature range, moving the hay exposes the heated material to oxygen and a sudden flareup can

occur. Fire service officials should be notified if possible. Always have a charged water hose available.

Burned-out cavities in the hay:

Deep within the stored hay mass, temperatures may have reached levels where the hay has already burned. This burning has been a smoldering fire. Hollow cavities may have formed. These cavities can entrap a person who collapses the top of the hay pile by walking over it.

To prevent entrapment in burned-out cavities, place a wooden plank over the hay before walking over the area. A rope harness tied to a secure location is also recommended. Falls into a burned-out cavity may lead to broken bones, burns, and lung damage. Since the hay may have been chemically treated, a trained fire

service person with a self-contained breathing apparatus (SCBA) should be called upon to provide the assistance needed in solving the potential fire problem.

Toxic gas exposure:

Smoldering and burning hay can be the source of toxic gases. Carbon monoxide can be concentrated within the smoldering fire and surrounding area. Chemically preserved hay crops may produce toxic gas vapors. Deadly gases add to the fire risk.

Crop preservative Material Safety Data Sheet (MSDS) information should be available to fire service personnel.

Note: The young farm worker should not be assigned to monitor temperatures of hay in storage. This poses an unnecessary risk to the inexperienced worker.

Monitoring Hot Hay

Smoldering hay gives off a strong, pungent odor. This odor indicates that a fire is occurring. At this point, stay off the hay, as a burned-out cavity may be found beneath where you would be walking.

The first reaction is to remove the heated hay. The temperature of the hay must be known before removal occurs. At lower temperatures, removing hay helps to move heat away from the hay by normal ventilation. When stored hay reaches 175 degrees F, any increased ventilation could result in rapid combustion.

Hay temperatures must be monitored. An experienced person should do this. Close coordination with a local fire service is of importance should the hay temperatures continue to rise.

Preventing Hay Fires

To prevent hay fires in storage areas, follow these approved practices to reduce the potential for forage crops to heat in storage.

Harvest Practices:

To reduce crop moisture levels rapidly, mow the forage early in the morning to allow one or more full days of drying time before baling. Storing dry hay reduces the risk of overheating.

Conditioning Practices:

Although it is difficult to achieve, the best weather conditions for hay curing is less than 50% relative humidity with some wind move-

ment. Monitor the weather conditions and predictions to help schedule haymaking operations.

Hay mower conditioners, or crimpers, crush the forage stem and speeds the drying time of the crop. Windrow inverters, tedders, and hay rakes also speed the drying process. Each haying operation can shatter leaves from the stem and reduce the quality of the hay.

Chemical drying agents and preservatives may help to condition the forage crop. These materials can be used to speed up field drying rates. Most additives and preservatives increase the moisture level at which the forage can be safely preserved. Inoculant and acid-based preservatives increase the safe hay baling moisture levels to 25-30%. Spontaneous combustion ignition temperatures may be avoided when using these materials, but internal heating of the forage may cause heat-damaged protein. Heat-damaged protein reduces the nutritional value of the feed.

Baling Practices:

Bale the hay at 18-20% moisture to reduce the risk of conditions that support spontaneous combustion.

Storage Practices:

Store hay under cover to prevent rain damage and potential for heating. Leaky roofs and plumbing leaks can increase moisture levels of the stored forage to a point of reheating, which may lead to spontaneous combustion.

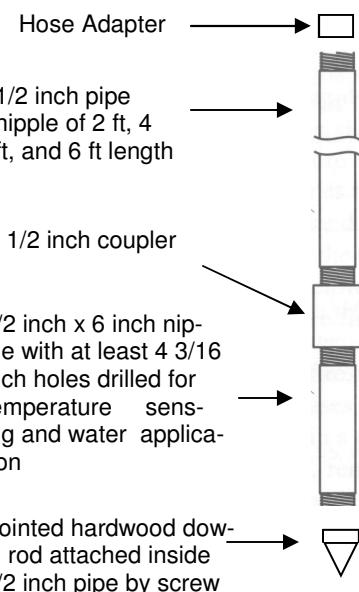


Figure 3.7.2.b. A homemade probe can be easily constructed.

**Prevention of
hay storage
fires begins in
the field with
sound crop
management.**

Hay Loft—Top View

X	X	X
X	X	X
X	X	X

Figure 3.7.2.c. Use an organized pattern to monitor and record hay temperatures if overheating is suspected.

Safety Activities

1. Use a crop production reference to locate information about optimum moisture levels to harvest and store the major crops in your area. Make a chart to show what the moisture level should be for storage of those crops.
2. Contact your local agricultural chemical dealer to request brochures or labels for crop additives and preservatives. Write a report on these materials showing what they do.
3. Contact your local fire service personnel to ask about barn fires in your area. What were the causes? Were there hazardous chemicals involved? What special training do the fire service persons receive?
4. Develop a hay temperature monitoring kit of a probe, a thermometer and cord, and record sheet for use by farmers in your community.
5. Write a news release for your community farmers telling them about hay storage fire hazards.
6. Study silo fires, and write a report comparing a hay storage fire with a silo fire.

References

1. Extinguishing Fires in Silos and Hay Mows, NRAES-18, 2000, Cooperative Extension NRAES, 152 Riley-Robb Hall, Ithaca, NY 14853.
2. Visit www.cdc.gov/nasd/ Click on locate by topic/ Type in hay fires.

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CONFINED SPACES

HOSTA Task Sheet 3.8

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

Do you know what a confined space work area is? Farmers may think about silos, manure pits, and grain bins as the only confined spaces on their farms. Trenches, grain dryers, milk tanks, liquid manure spreaders, petroleum tanks, well shafts, and agricultural chemical tanks are other examples of confined spaces.

The Hazardous Occupations Order in Agriculture prohibits youth workers younger than age 16 from working inside confined spaces. See page 4 of this task sheet.

This task sheet discusses the hazards of confined space work areas. Young workers should not be assigned to work in these confined space areas.

regulations, the farm worksite contains confined space hazards for which every person associated with the farm should receive training. Silo, grain bin, manure storage, and farmstead chemicals are discussed in other task sheets in Section 3.

Think about the definition of these work areas. Have you been assigned to work in an area that meets the definition of a confined space?

- Do you have to enter an area to work by crawling, stooping, crouching or climbing into?
- Does the work area have an exit besides where you entered?
- Is there adequate, natural ventilation in the work space?
- Does that work space produce dangerous air contaminants as you do your work?
- Are there breathing hazards to be found in the confined space?
- Is the space capable of normal body movements for long time periods?

Youthful workers should discuss this type of work assignment with an adult before beginning the job.

Confined Space Definition

A confined space is defined by OSHA as:

- a space large enough and so configured that a person can enter and perform assigned work
- a space limited in openings for entry and exit purposes
- a space not intended for continuous human occupancy

Although specific standards for agricultural confined space work areas are not part of the OSHA



Figure 3.8.a. A manure pit is a confined space work area. Many lives have been lost in manure pits due to toxic gases and lack of oxygen.

Youth younger than age 16 are prohibited from working in confined spaces.

Learning Goals

- To understand the hazards of confined space work areas

Related Task Sheets:

Hazardous Occupations Order in Agriculture	1.2.1
Occupational Safety and Health Act	1.2.2
Respiratory Hazards	3.3
Respiratory Protection	3.3.1

**If you have
to climb
into a space
to do work,
you are
confined.
Know the
risks.**

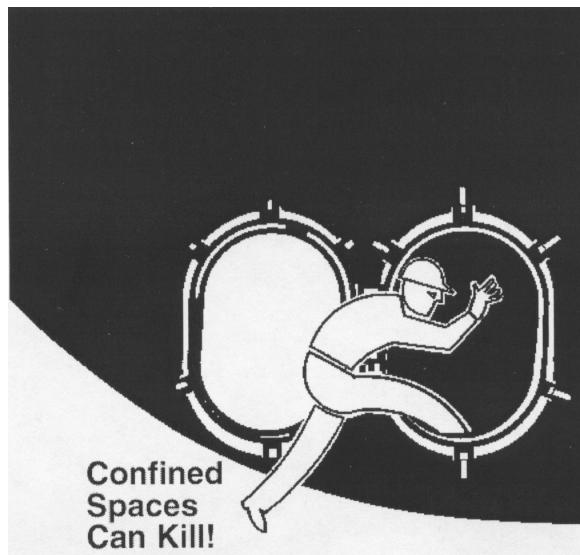


Figure 3.8.b. The OSHA Confined Space Entry Poster shows that confined space work areas pose a risk to the worker. You may not see this poster in farm confined space work areas, but remember the message shown.

Storage Tanks, Milk Tanks, and Oil Tanks

Some confined space work areas may appear to be safe for periodic inspection, cleanup, maintenance, or repair tasks. Storage tanks, milk tanks, and oil tanks may offer risk to health and safety. Consider these problems.

- an oxygen-deficient atmosphere
- a flammable atmosphere
- a toxic atmosphere

Oxygen-Deficient Atmosphere:

The air we breathe contains oxygen. At a minimum, the air should contain 19.5% oxygen. Oxygen levels may be normal when work begins inside a confined space, but the work being done can reduce the oxygen levels as the work proceeds.

Oxygen levels can be decreased by the presence of other gases and vapors. Welding inside a storage tank can deplete oxygen supplies. Cleaning rusty metal with a grinder will fill the atmosphere with particulates, which may reduce the available oxygen.

Toxic Atmosphere:

Depending upon the storage structure and its use, toxic material may be present when the worker enters the tank. The product stored in the tank may be toxic. Cleaning or scraping the tank can also release toxic chemicals.

The work being performed may cause chemical reactions. Cleaning a milk tank with degreasers and sanitizers must be done according to product directions. Some cleansing materials can harm the eyes and lungs if not handled properly. See Task Sheet 3.13.

Flammable Atmosphere:

Flammable materials can be gas, vapor, or dust in the proper mixture with oxygen. A source of ignition from welding or an electrical tool can ignite. An explosion inside the confined space can result.

Petroleum product storage tanks that must have repairs may contain highly flammable materials. These tanks may appear to be empty, but the residual vapors can be ignited. Vapors trapped in sludge-like material that must be scraped from tank walls are released and increase the risk of ignition.

It is recommended that welding on any storage tank should not begin until it is known what is inside the tank.

Working in Trenches

Trenches may be storage pits for silage or composting. The trench could be a ditch that is being dug for installation of electric utility or water lines. You may have been assigned to work in that trench. Is it a safe place to work?

Trench sidewalls can cave in and trap workers. Death by suffocation is possible. Trench cave-ins have trapped countless workers. Follow these safety plans for working in a trench.

- Do not enter a deep ditch that has sidewalls higher than your head unless it has steel retainer walls (trench box) to stabilize the trench.
- The trench should be cut so that “steps” or a sloping ramp are cut into the excavation to allow workers to exit easily.
- Use a hardhat and lifeline harness to protect yourself.
- While working in a trench, be within eyesight of another person who is not in the trench.



Figure 3.8.c. Trenches and pits in agriculture pose risk of sidewall cave-in and entrapment of the worker. Death by crushing can result. Suffocation can also occur.

Ventilation:

Ventilate confined space work areas before entering the area.

Isolate the confined space from entry:

Post signs at the confined space work area to warn of the hazard. Lockout/Tag out electric circuits to prevent start-up problems.

Test the Atmosphere:

If possible, monitor the atmosphere for oxygen deficiency. Most farms will not own this equipment, but fire service companies may have the equipment.

Self-Contained Breathing Apparatus:

Toxic atmosphere confined spaces should not be entered unless the worker is equipped with SCBA and has been trained in its use.

Safety Equipment:

Safety equipment needs are greater for confined space work.

Respirators for a specific purpose are recommended. Hard hats and steel-toed shoes may be required. Communication equipment will be needed if direct contact with a helper cannot be made. Spark-proof tools will prevent ignition of flammable gases and dust. In addition, a safety harness and safety lines are advised.

Standby/Rescue:

Confined space work dictates that a helper or helpers must be available. Ladders, ropes, and lifts make immediate rescue possible. Do not work alone in confined spaces.

Confined space work requires training and body harness equipment to be available.



Figure 3.8.d. Confined space entry into oxygen-deficient areas requires SCBA. Training is necessary to use this equipment. Do not work alone in a confined space.

Reducing Confined Space Risks

Confined space work is usually done on a periodic basis rather than on a regular schedule. Safe work practices may not be remembered and repeated from one work period to another. To reduce the risks associated with working in a confined space, follow these approved practices.

Hazardous Occupations Order in Agriculture Prohibitions

Some occupations in agriculture are considered to be particularly hazardous for the employment of youth younger than age 16. The Hazardous Occupations Order in Agriculture prohibits youth younger than age 16 from working inside the following areas. They include:

- fruit or grain storage designed to be oxygen-deficient or of a toxic atmosphere
- an upright silo within two weeks after silage has been added or when the unloading device is in operating position
- a manure pit
- a horizontal silo while operating a tractor for packing purposes

Other confined space work areas may be less well-defined. Many times a confined space work area does not appear to be hazardous until an injury or fatality reminds us of the risks. Reread the section on page 3 of this task sheet about reducing confined space work risks.

Safety Activities

1. Interview a local fire service member to learn more about SCBA and its use.
2. Review the occupations that are considered hazardous for youth younger than age 16.
3. Visit OSHA's website (www.osha.gov), and search for the regulations regarding confined space work areas. Are there any points that farmers should consider for educating their employees and families? What are they?

References

1. www.cdc.gov/niosh/ Search for "A Guide to Safety in Confined Spaces," NIOSH Publication No 87-113, July 1987.
2. www.osha.gov/ Type confined space in search box.

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SILOS

HOSTA Task Sheet 3.9

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

The farm silo serves the purpose of providing a storage space for finely chopped forages. These feeds ferment and become acidic. The low pH prevents bacteria from spoiling the silage.

Silos can be an upright tower or a trench, bunker, or stack or bag on the ground. Each has its own set of safety hazards. This task sheet discusses the safety considerations that a worker must understand when working with silos and ensiling of crops.

Silage Chemistry

Silage fermentation is the process of controlling bacterial actions that naturally break down the plant fibers of corn, hay, and other crops. Ideal silage is produced when silo oxygen is used up. Plant and bacterial respiration action will cause silage temperature to increase to 80-90 degrees F. During this stage, silage gas (see below) is produced. The silage becomes more acidic. This acid condition prevents further spoilage until oxygen enters the silo as the silage is fed.

Silo Gas

Silo gas is formed as the stored crop begins to ferment. Nitrogen dioxide and carbon dioxide are produced as the oxygen in the crop is depleted. During the first few days after filling the silo, the

increase in these gases occurs.

The type of silo used determines which silo gas will predominate. In a sealed silo, carbon dioxide, an odorless, colorless, heavier-than-air gas is produced in large quantities. The carbon dioxide replaces the oxygen in the silo thus preventing the silage from spoiling. In a conventional silo nitrogen dioxide, a heavy, yellowish brown colored gas with a bleach-like odor is abundantly released. This heavier than air gas settles to low spots including feed rooms. Both of these gases cause death through asphyxiation (lack of oxygen).

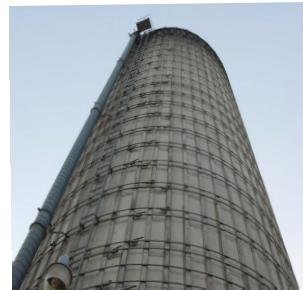


Figure 3.9.a. Silos may be 80-100 feet in height. A person overcome by silo gas will present a very difficult rescue problem.

**Silage gas
can kill!**

Working Safely With the Chemistry of Silage

Understanding how silage is produced helps to prevent exposure to deadly silo gases. To prevent silage gas health problems, observe these precautions.

- Stay out of newly filled silos for at least two weeks. Use self contained breathing apparatus if the silo must be entered.
- Close the feed room door to the barn.
- If the silo must be entered, then:
 - Run the ventilation fan.
 - Get the help of an adult.
 - Wear a dust mask.

Learning Goals

- To understand how silo storage structures and equipment present hazards
- To develop safe work skills to use while working around silos

Related Task Sheets:

Hazardous Occupations Order in Agriculture	1.2.1
Injuries Involving Youth	2.1
Mechanical Hazards	3.1
Common Respiratory Hazards	3.3
Respiratory Protection	3.3.1
Grain Bins	3.10
Manure Storage	3.11
Using Power Take-Off Implements	5.4.1

**Shut down
the tractor
before
attempting
to unplug a
silage
blower or
wagon.**



Figure 3.9.b. While filling the silo, the work is done in close quarters. Two tractors are often involved with the PTO shafts operating the self-unloading wagon and the silage blower. Extreme caution is needed to do this work safely.

Working Safely with Silo Filling Equipment

Keep children away from silo filling operations.

Filling silo involves many tractors and many implements working together. Forage harvesters, self-unloading wagons, forage blowers, unloading platforms, bagging units, and silo distributors and augers are in constant use. The work area is crowded also. These machines are powered by PTOs or other moving shafts. An increased exposure to machine hazards occurs at silo filling time.

Silos produce the best silage when filled quickly and packed tightly. Much work occurs in a short time period. Corn silage harvest time can coincide with early fall and rainy weather. An increased need for safe work habits exists in changing work conditions. Let's

examine each area that can pose a problem.

The Unloader

Before filling the conventional silo, the unloader must be raised by cable and pulleys to the top of the silo. One person at ground level can operate the electric control to do this job, but a second person observing the procedure from the blower pipe platform can signal if the cables become tangled. No one should be in the silo under the unloader as it is raised. Do not ride the unloader to the top of the silo in case the cables break.

Self-Unloading Wagons and Blowers

Self-unloading wagons contain moving aprons, beaters, conveyors or augers, and an assortment of chains and sprockets. PTO shafts are involved. The silage is moved by conveyor or auger to the PTO

powered blower fan blades. These blades turn at high speeds to "blow" the silage to the top of the silo or further back into the trench. Silage bagging equipment also has numerous moving parts that pose risk.

Moving the moist, fine chopped crop can result in the equipment becoming plugged. Before attempting to unplug a clogged machine, follow these safety procedures.

- Disengage the power to the machine.
- Turn off the tractor engine.
- Wait for free-wheeling blower fan blades to come to a complete stop.
- Do not attempt to use your hands or feet to unplug a machine.

Falls

Falls account for a major source of injury to young agricultural workers.

Note: The Department of Labor Hazardous Occupations Order in Agriculture prohibits youth ages 14 and 15 from using a ladder higher than 20 feet from the ground.

Upright silos can be 80 to 100 foot tall. The silo's attached ladder may have a protective cage surrounding it. This cage offers some fall protection to the climber.

Trench or bunker silos often exceed 20 feet in height as well. Ladders may be placed against the silo walls for use when a plastic covering is installed.

Remember: Use three-point contact on the silo's ladder when climbing (two feet, one hand or two hands and one foot). Face the ladder while climbing. Stay inside the protective cage surrounding the silo's ladder.

is a safety hazard as the silage pile is "packed." To avoid serious injury or death to the operator and to prevent costly equipment damage, use these practices.

- Use only tractors equipped with ROPS and seat belts.
- Use the seat belt when packing silage.
- Use low-clearance, wide front end tractors.
- Add weights to the front and back of the tractor to improve stability.
- Do not use wheel-type tractors on silage surfaces with slopes greater than 1 to 3 (1 foot of rise in 3 foot of run).
- Back up sloped silage surfaces, and drive down those areas.
- Distribute silage evenly in 6-inch layers for uniform packing.
- Front-wheel and assist-drive tractors provide extra traction and stability for packing and towing on silage.
- Mature, experienced operators should only be permitted to operate the packing tractor, unloading tractor, or forage wagon on the silage surface.

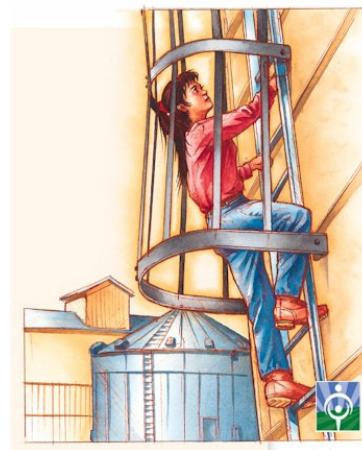


Figure 3.9.c. When climbing silos, use the ladder, stay inside the enclosed protective cage, and maintain a three-point contact with the ladder.

**Only mature,
experienced
operators
should be
assigned to
pack silage in
a horizontal
silo.**

Trenches, Bunkers, Stacks

Silos take many forms. Upright silos require expensive maintenance. Horizontal silos have capacity limited only by the location of the trench, bunker, or silage bag. Silage can even be stacked on a firm base. Each silo type has its own set of operation rules.

Horizontal silos like trenches, bunkers, and stacks must be packed tightly to exclude oxygen from the crop. Equipment rollover

Trenches, bunkers, and stacks of silage are danger zones in crop harvest. Extra caution is needed to do this job safely and successfully.



Figure 3.9.d. Bunker silos must be packed tightly to limit the amount of oxygen available to bacterial and plant fermentation. Back and forth driving of a packing tractor can lead to tractor rollovers. Read the text on this page for safety pointers.

Safety Activities

1. Visit a local farm with upright silos to learn more about how the silo is loaded, unloaded, ventilated, and kept safe from youngsters or visitors. Develop warning signs that could advise operators or visitors about the dangers of the upright silo.

2. Visit a farm with horizontal silos to learn how they are filled, packed, and unloaded. Develop warning signs that could advise operators or visitors about the dangers of the horizontal storage areas.

3. Match the silo type with its description and related hazard.

<input type="checkbox"/> A. Trench Silo	1. An upright silo with a roof and is accessible to workers. Presents silo gas hazard.
<input type="checkbox"/> B. Bunker Silo	2. Can be a pit dug into the ground, which means an embankment collapse hazard is possible.
<input type="checkbox"/> C. Stack Silo	3. Plastic wrapped silage where machinery operation by PTO is a safety risk.
<input type="checkbox"/> D. Silo Bag	4. A horizontal silo with wooden timber or concrete sides. Packing this silo creates an increased risk of tractor rollover.
<input type="checkbox"/> E. Oxygen-limiting silo	5. Tightly packed silage piled on the ground where the risk of tractor rollover is increased.
<input type="checkbox"/> F. Tower silo	6. A lined, sealed steel or concrete silo with limited entry. Suffocation is likely if entered.

References

1. Farm and Ranch Safety Management, John Deere Publishing, 2009.
2. www.cdc.gov/nasd/ Type the keyword silo into the search box.

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HORIZONTAL SILO SAFETY

HOSTA Task Sheet 3.9.1

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Silage harvest time often becomes a hurry up time. Research shows filling the silo quickly and packing the forage tightly yields a higher quality silage. Increased opportunity for injury or fatality follows this haste. PTO and machinery entanglements, highway mishaps, dump truck incidents, silage baggers and horizontal silos have all played a role in injury and fatality during the busy silage harvest season. While corn is the most often harvested crop for silage, hay crops can also be placed into horizontal silos.

This task sheet discusses horizontal silo safety for those who may be required to work as part of a team during silo filling and feed-out.

Horizontal silos

Horizontal silos vary in form. Whether it is a trench cut into the ground, forage piled on top of the soil, or a bunker-type silo with concrete or wooden sides, the process of filling and feeding from a horizontal silo is similar. Sizes of these trenches, bunks, and drive-over piles can vary according to the size of the livestock operation. Flexibility in expanding the storage area often makes the horizontal type storage more desirable compared to upright silos, but there are hazards



Figure 3.9.1.a. Three forms of horizontal silo are shown: a trench silo (A), a drive-over silage pile (B), and a concrete bunker silo (C). Horizontal silos can vary in height from only 4-5 feet high to over 40 feet.

Photo B, Courtesy of KJ Bolen

Silo filling must be done rapidly; safe practices are necessary.

involved in filling and feeding silage from horizontal silos.

Although wagons are often used to haul and dump forage, larger farms are increasingly using dump trucks for transport. As the forage depth and the side slope grows, the risk of tractor or dump truck overturn increases. As the forage depth becomes even greater, bunker sidewall capacity can be exceeded adding to the hazard potential. Dumping and packing equipment must operate away from these sidewalls to reduce stress on the structure, and to avoid overturning off the sidewall.

Learning Goals

- To understand the hazards involved with horizontal silos
- To safely fill horizontal silos
- To practice safe silage removal procedures

Related Task Sheets:

Silos	3.9
Packing Forage in a Horizontal Silo	3.9.2
Tractor Stability	4.12
Using the Tractor Safely	4.13
PTO	5.4
Dump Truck and Trailers	6.5
Silage Defacers	6.9

Harvest Pre-Inspection

Regardless of the style of horizontal silo, wear and tear occurs over time. Earthen trench sides can slip, earthen trench and drive-over pile site approaches can become muddy and rutted, and concrete or wooden-sided bunkers can become cracked over time. These should be repaired before use to maintain traction and stability for trucks and tractors.

Bunker silos should be equipped with iron pipe or steel sight rails. These sight rails give the operator a visual clue to the edge of the bunker while backing, unloading, and packing forage into the bunker. These rails are not intended to stop an overturning tractor or dump truck from toppling over the side of the bunker. They can also serve as fall protection for workers as they move around the sidewalls while working with plastic covering and weights used to seal the surface.



Figure 3.9.1.b. Bunker silo sidewalls are under great stress from silage weight and packing. A sidewall collapse could send a truck or tractor into an overturn. This situation must be repaired before harvest begins.



Figure 3.9.1.c. Sight rails offer a visual clue as to how close to the edge of the bunker you are operating the dump truck or packing tractor. These should be kept in good repair.



Figure 3.9.1.d. Dump trucks are commonly used to fill horizontal silos. A truck equipped with an unloading, webbed-floor is more stable than a raised-bed truck. Operate the truck up and over the drive-over pile, not across the slope; and up then down on a trench fill silo.

Fill and Pack Techniques

To help achieve the required amount of crop compaction a “progressive wedge” of forage is formed during the filling of the silo. The wedge provides a safe slope for the unloading and packing operations. A progressive wedge with a maximum slope of 1 to 3 minimizes the risk of roll-over. The resulting slope has a rise of 1 foot in every 3 feet of horizontal run. The operator must remember that while the surface is being packed it still can have ruts and soft areas that can lead to equipment

roll-over. A rut or soft spot on the lower side of the truck or tractor can cause a sudden, unexpected shift of the vehicle to the side. There is seldom enough time to react to avoid this occurrence. Forage should be leveled before the next load is dumped and compacted.

Ideally, do not fill the trench or bunker higher than the sides of the retaining wall.



Figure 3.9.1.e. Use a ROPS equipped tractor fitted with dual wheels, extra weights, and a leveling blade to spread forages for packing. Be sure the seat belt is fastened when operating in a ROPS cab. Keep the pile level and rut-free before the next load arrives to be dumped and compacted.

Feeding silage safely

Work safely through the feed out process. Silage feed-out injury may occur from silage face collapsing due to undercutting, equipment roll-over, and entanglement. Observe where other workers and obstructions are located before beginning to work.

Silage face collapse may occur when equipment cannot reach the top of the feed-out face to remove an even amount of the feed. The silage that is removed from the bottom of the feed-out face allows heavy, unsecured silage from the top to break free. Workers, by-standers and even equipment operators can be buried beneath tons of silage. Numerous deaths have occurred with an avalanche of silage trapping persons and equipment. Using a silage defacer or equivalent accessory mounted on a material handler's boom to reach to the top of the silage face is a safe practice.

Equipment should not be operated from atop the silage. Edges of the feed face can be loosened allowing the silage face to collapse due to weight of equipment.

Using silage feeding equipment

Feed equipment to blend silage with other feedstuffs may be powered by a PTO shaft. The risk of entanglement in the turning shaft increases with use. PTO guards must be in place. Disengage the PTO and stop the tractor engine if adjustments or repairs must be made to feeding equipment. Never step across a turning PTO shaft for any reason.



Figure 3.9.1.f. Equipment that cannot reach to the top of the silage face will undercut the feed-out face at the bottom. A collapse of the silage can result. Photo courtesy of KJ Bolen



Figure 3.9.1.g. A silage defacer mounted on a skid steer can reach the top of the silage face, but a material handler with boom may be needed to remove silage from higher reaches.

Other considerations

Silage can collapse. Fatalities have occurred while taking samples for nutritional analysis. Nutritionists, herds-persons, and students who must gather silage for forage quality evaluation should have an equipment operator scoop out and bring the silage sample to them. Avoid the feed-out face of the silage if it exceeds your own height.

Working near the top edge in a trench, bunker, or pile while removing the plastic cover or weights can cause the silage to collapse if it is weakened from undercutting. Freezing and thawing can weaken the face of the silage also. Do this job only if you can stay back away from

Remind children and by-standers of the dangers of machinery and silage face collapse.



Figure 3.9.1.h. This is not a safe place to be. What seems to be an activity in studying quality silage production or gathering feed samples could quickly become the scene of a tragedy should the silage feed-out face collapse.

the edge a safe distance.

When working around the silage face, use a fellow worker to assist should a collapse occur.

Safety Activities

1. Conduct an Internet image search for horizontal silo topics. Without violating copyright laws use the pictures to make a scrapbook or poster display of the size and scope of corn or hay silage storage facilities. Label the pictures with important information found in this task sheet. For example: label the parts of the bunker silo, calculate and label the slope, or identify hazards.
2. Draw a map of your community and identify, with the help of your classmates or club members, where the silage trenches, bunkers, and drive-over piles are located. Estimate the total tonnage of silage that the largest bunker contains. Corn silage often weighs between 14 and 18 lbs/cubic foot as an average density.
3. Locate on the map from activity 2 where the local fire and rescue companies are to be found. How far from the furthest farm that has a horizontal silo are they?
4. With your class develop a 10-minute presentation about horizontal silo safety and the potential for silage face collapse and present the program to a local emergency rescue group or community farm or ranch group.

References

1. Horizontal Silo Safety, Fact Sheet E49, College of Agricultural Sciences, Department of Agricultural and Biological Engineering, Dennis J. Murphy and William C. Harshman
2. Farm Dump Truck and Trailer Safety, Fact Sheet E-44, College of Agricultural Sciences, Department of Agricultural and Biological Engineering, Dennis J. Murphy and William C. Harshman

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PACKING FORAGE IN A HORIZONTAL SILO

Hosta Task Sheet 3.9.2

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

One task assigned to new employees may be packing freshly cut forage in a trench, bunker, or drive-over pile. The packing tractor is operated back and forth over the forage surface as the crop is harvested and dumped on a progressively, deeper wedge-shaped surface. As the forage depth grows and the sides become steeper, risks increase for a tractor roll-over.

This task sheet discusses forage packing safety.

The basics of top quality silage

Chopped forage must be packed tightly in trenches, bunkers, or drive-over piles. Rapid filling and packing limits air (oxygen) from the forage mass. Excessive air leads to a loss of plant sugars and undesirable fermentation by-products and potential for spoilage which limits the animal's consumption and utilization of the silage.

The packing equipment must be heavy enough (Figure 3.9.2.a) to achieve a dense pack. Heavier tractors equipped with dual wheels and a leveling blade attachment offer greater stability on the forage surface than smaller equipment. The ROPS enclosed cab and use of the seat belt offers a "zone of protection" to the operator. Smaller, older model tractors with



Figure 3.9.2.a. Rapid and thorough packing of forage results in a high quality ensiled crop which when fed to livestock produces top yields of milk or meat. The packing tractor must be stable enough to operate on the forage surface.



Figure 3.9.2.b. Steep sides should never be allowed to develop as the forage surface increases in depth. Steep slopes contribute to tractor rollover potential.

Tractor stability while packing forage may be a matter of life and death.

single rear tires do not pack the chopped forage as densely and may cause ruts in the forage surface. The ruts in the surface coupled with the ever increasing side slope, (Figure 3.9.2.a and 3.9.2.b) increases the risk of rollover. Older tractors may not be fitted with a ROPS cab which further places the operator in danger.

Learning Goals

- To develop safe operating skills when packing forage in a horizontal silo.

Related Task Sheets:

Silos	3.9
Tractor Hazards	4.2
Tractor Stability	4.12

Safely packing forage in a horizontal silo

Since harvesting forage and filling silos must be done quickly it is important to do the job safely.

- Use a ROPS equipped tractor and fasten the seat belt.
- Recognize traffic flow of all vehicles involved in the operation.(Figure 3.9.2.c)
- No person on foot should be on the packing surface while equipment is operating.
- Develop a forage surface with side slopes not to exceed a 1 to 3 (1:3) slope. This means no more than a 1 foot rise in 3 feet of run.
- Do not exceed the side wall height of the bunker.



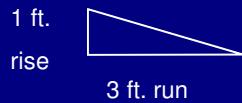
Figure 3.9.2.c. Coordination of dumping of forage with the packing operation is necessary. Movement of several trucks and more than one packing tractor means attention to their location is necessary.
Photo courtesy of KJ Bolen



Figure 3.9.12.d. Forage piles should not exceed the side wall height of the bunker. Sighting rails provide a guide to the operator. Do not operate the packing tractor close to the steep sides.

- Sighting rails at the top of the bunker (Figure 3.9.2.d) provide a guide to help the operator stay back from the side.
- Do not let ruts develop. Ruts may throw the tractor to the side and cause an overturn.
- Dump wagons and dump trucks must be kept as level as possible when unloading chopped forage.

A 1:3 slope



Safety Activities

1. Ask your instructor or club leader to schedule a field trip to observe the filling and packing of forage in a horizontal silo. If the field trip is not possible search the Internet using YouTube or a similar source to see if you can see a horizontal silo being filled.
2. Solve this problem. A corn grower has 1600 acres of corn silage to harvest. Yield is 24 tons per acre. The average forage wagon hauls 7 tons and the average dump-equipped truck can haul 12 tons. How many loads must be hauled if only using the forage wagon? If only using the dump-equipped truck?
3. If a silage depth is 40 feet to the top-center, and a safe side slope of 1:3 ratio is recommended, how far out from the center does the silage extend? This is the distance for one side only so double the results to get the overall width of the storage area.

References

1. Horizontal Silo Safety, Fact Sheet E49, College of Agricultural Sciences, Department of Agricultural and Biological Engineering, Dennis J. Murphy and William C. Harshman
2. Internet search. Using any search engine, type in horizontal silage safety.

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GRAIN BINS

HOSTA Task Sheet 3.10

Core

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Unloading grain from storage bins and wagons exposes workers to the risk of being pulled into the flow of the grain and becoming entrapped. Moldy, damp grain creates a flow problem, often leading workers toward unseen hazards. Children playing in and around grain storage areas are often victims. Flowing grain entrapments cause an average of 12 deaths each year.

This task sheet discusses the hazards of flowing grain in storage bins, wagons, and trucks.

Flowing Grain

Grain harvest produces huge amounts of material to transport and store. Fortunately many labor-saving devices have been developed to make grain handling fast and efficient. Augers move grain rapidly. Gravity flow wagons and trucks make grain movement efficient. Flowing grain has many hazards that may go unnoticed.

Augers move grain from the bottom center of storage bins to the outer edge of the bin and into grain hauling vehicles or other storage bins. When the auger is running, grain flows out of the bin from directly above the outlet of the unloading auger in the center of the bin floor. A funnel-shaped flow on the top of the grain occurs with the

grain flowing in a column below the surface toward the outlet (Figure 3.10.a.). This flow is like a moving conveyor belt or escalator.

With a large auger, a worker inside the bin can be pulled knee deep into the column of grain within a few seconds. Once your knees are covered by grain, it is almost impossible to free yourself without the assistance of others. If the knees are covered and the grain is still flowing, the flowing grain is similar to quicksand and can completely engulf a person very quickly. Figure 3.10.b and c. illustrate just how quickly a person will sink into flowing grain.

Note: Gravity unloading wagons have similar grain-flow patterns as grain bins. The grain flows in funnel-shaped form with a column of grain moving toward the unloading door of the wagon or truck.



Figure 3.10.a. The normal flow of grain from a bin is off the top and down a center column of grain flowing toward the unloading auger. The unloading auger is found at the bottom center of the grain bin.

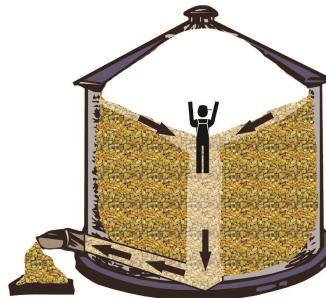


Figure 3.10.b. Grain flowing out of storage causes a downward moving floor to move away from your feet. The victim is pulled waist deep in about 10 seconds. See Figure 3.10.c.

**A 10-inch auger
can move 85
cubic feet or 65
bushels of grain
per minute.**

Learning Goals

- To understand that flowing grain can be a deadly hazard
- To understand how to prevent flowing grain hazards while working with bins, wagons, and trucks

Related Task Sheets:

Common Respiratory Hazards	3.3
Respiratory Protection	3.3.1
Confined Spaces	3.8

Within seconds, a person can be helplessly trapped in flowing grain.

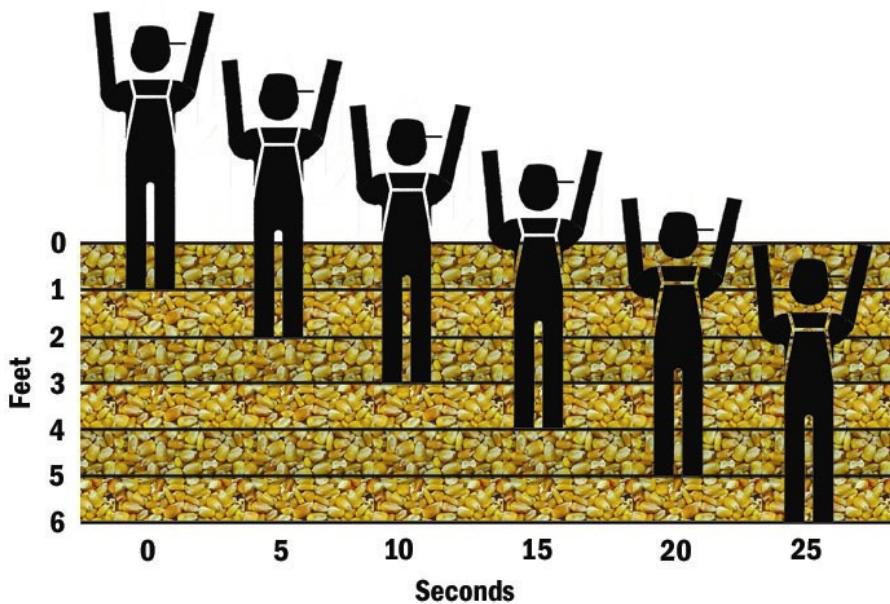


Figure 3.10.c. In a matter of a few seconds, a person standing in the grain bin can be helplessly trapped as the grain begins to flow. A person can be completely engulfed in the grain in about 25 seconds. Death from suffocation most often results.

Grain Bridging

Grain that is harvested before it has dried down adequately is damp and can mold quickly. This damp, moldy grain clumps together and hardens into a crusty mass. It gives the appearance of being a solid walking surface. This situation is often not recognized as a potential hazard.

As poorly conditioned grain is unloaded from the bin, a cavity may develop. See Figure 3.10.d. Often the worker recognizes that the grain has stopped flowing but the bin appears full. The temptation is to enter the bin to break up the grain bridge. The “grain bridge” gives way as the worker walks over it (Figure 3.10.e), and the person is pulled into the flowing grain. Figure 3.10.c and d show the hazards of walking over the grain bridge.



Figure 3.10.d. A “grain bridge” cannot support the weight of the worker.



Figure 3.10.e. As the grain bridge gives way, the worker is pulled into the pocket and is engulfed. The grain auger may have been left running and the flowing grain pulls the victim under the grain.

Wall of Grain Avalanches

In some cases, moldy grain will be found sticking to the walls of the bin. After removing the loose grain, the worker may be faced with a wall of crusted grain that must be broken free before it can be unloaded. If the wall of grain is higher than the height of the worker when the worker stands on the grain bin floor, an avalanche may occur as the worker tries to break up the crusted wall of grain. This avalanche could completely engulf the worker leading to injury and possible death (Figure 3.10.f). One foot of grain covering the engulfed worker would weigh approximately 300 pounds. This is normally too much weight for individuals to move to free themselves.

Preventing Flowing Grain Entrapment

The following steps can reduce the risk of flowing grain entrapment in storage bins, wagons, and trucks. These practices can save your life.

- Place entrapment warning decals on grain bins and grain transport vehicles.
- Prevent unauthorized entry to grain bins and grain transport vehicles, especially by children.
- Make sure all workers and children are aware of entrapment hazards.
- Keep grain in proper condition. This may include the use of

mechanical stirrers to prevent the grain from molding. Out-of-condition grain is considered the leading cause of adult entrapments.

- Use inspection holes or grain bin level markers instead of entering a grain bin.
- Enter a grain bin or grain transport vehicle only if it is absolutely necessary. Use a body harness secured to the outside of the bin or vehicle.
- Use a pole to break up possible grain bridges from outside the bin.
- Lockout/tagout all power controls before entering a bin.
- Have at least two observers present during grain bin entry.
- Establish a form of nonverbal communication with observers (hand signals).
- Work from top to bottom when cleaning grain bin walls.

Special Notes:

Small children do not understand the hazards of agricultural work. Grain brought from the field to the farmstead has play appeal. Machinery that is moving grain draws their attention. The chances of a child being entrapped in flowing grain are very high. Most children do not survive grain storage entrapments.

Rescuing victims of grain bin entrapments calls for special tools and expertise from your local EMS groups (Figure 3.10.g.).



Figure 3.10.f. Damp, moldy grain can stick to the side of the grain bin. It can collapse on the worker who tries to dislodge it.

**A 12-inch layer
of corn
covering a
victim can
weigh as much
as 300 pounds.**



Figure 3.10.g. It takes much force to remove a grain bin entrapment victim. Rather than removing the victim, it is easier to remove the grain. Special tools and skills are needed to cut through grain bins and remove the

Special Note:

Grain vacuum equipment is becoming popular. The vacuum can quickly move grain from trucks to bins or can be used in more remote locations to empty wagons onto trucks. These vacuums can be moved over top of the grain in a side-to-side sweeping motion, and can remove thousands of bushels per hour. Hold the vacuum at an angle away from your body. If held close to the body, grain can rapidly be removed from under the operator's feet quickly pulling the operator down into the grain, possibly entrapping the person in the grain.



Fig.3.10.h The grain vacuum moves large quantities of grain from storage to truck, or from truck to grain bin.

Safety Activities

1. Arrange to visit a farm to observe grain being unloaded. Make a list of the hazards that can be found in this farm job.
2. Place a small doll in a grain-filled gravity unload wagon (above the grain unload door and on top of the grain). Open the unload door and describe what happens.
3. Use the Internet to search the Land Grant University College of Agriculture in your state to find information about grain moisture levels considered safe for preventing moldy grain. Fill in the blanks in the following chart.

<u>Grain</u>	<u>Moisture Level Recommended for Safe Storage</u>
Ear Corn	_____ % Moisture
Shelled Corn	_____ % Moisture
Wheat	_____ % Moisture
Barley	_____ % Moisture
Oats	_____ % Moisture

References

1. Farm and Ranch Safety Management, John Deere Publishing, 2009.
2. Hazards of Flowing Grain, Task Sheet E43, Aaron M. Yoder, Dennis J. Murphy, and James W. Hilton, 2003, Agriculture and Biological Engineering, Penn State University, University Park, PA.

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MANURE STORAGE

HOSTA Task Sheet 3.11

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

The manure pit is full. It must be agitated and spread on the field. It is a routine in animal agriculture which must be done over and over again. The daily caution with machine hazards is coupled with exposure to manure gases.

Farm work exposes the worker to a variety of sights, sounds, and odors. Some of the odors, such as manure, are more than the strong smell. Some odors come from hazardous gases, which can also be harmful to us.

This task sheet discusses manure storage and the hazardous gases stored manure produces.

Knowledge of manure gases is an important subject for those persons working in animal agriculture.

Manure Storage

Manure storage structures vary in size and type. The farm's animal numbers, the length of storage time needed, and the soil structure where the storage is built will influence what type of manure storage is used. Modern animal agricultural practices and environmental laws also make storage and management of manure a normal farming routine.

Manure storage is considered a confined space work area (Task Sheet 3.8).

Aboveground Storage

Manure sheds and aboveground storage tanks are used to store manure in many areas. The shed may have a roof covering and have open sides. Manure tanks are often open-top, silo-type structures. Semi-solid manure may be removed from sheds by tractor high-lifts. Liquid manure in tanks must be agitated and pumped to manure spreaders. In some cases, liquid manure is removed from storage by way of irrigation systems.

Belowground Storage

Manure storage pits may be separate structures from the barn or below the barn itself. Some manure pits are open. Manure is scraped into the pit. Other manure pits have slotted floors and storage lids or caps for covers. Animal foot traffic and gravity fill the pit. Pump-out pits are usually of smaller capacity, serve as temporary storage structures, and are pumped to larger storage structures.

Manure storage pits directly beneath animals, pits under the farm building, and closed or covered pump-out pits pose the most risk of manure storage gas hazards. Fatalities to humans and to livestock have been documented.

While odor may be a tell-tale sign indicating the presence of manure gas, several toxic gases are odorless and colorless when present.



Figure 3.11.a. Manure storage pits are often found below ground level. They are covered until time to pump them out. The agitation and pumping releases toxic gases.

**A manure pit
lacks the
oxygen needed
to keep you
alive.**

Learning Goals

- To understand the hazards of liquid and semi-solid manure storage

Related Task Sheets:

First Aid and Rescue	2.11
Respiratory Hazards	3.3
Respiratory Protection	3.3.1
Confined Spaces	3.8

**Manure
gases can be
so
concentrated
that they can
suffocate
you
instantly!**

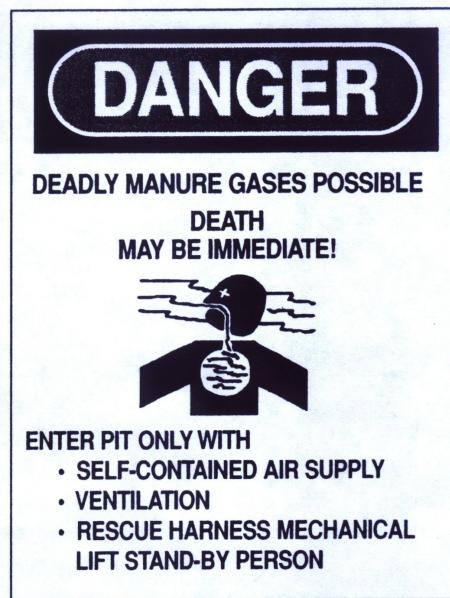


Figure 3.11.b. A danger sign posted near a manure storage structure provides a clear warning that immediate death is possible from manure gases.

Manure Gases

Manure is the product of digestion. Undigested feed materials, body cells and tissues, and minerals pass through the animal and are excreted. This material is in the beginning stages of decomposition, rot or fermentation. Fermentation or the rotting process produces manure gases.

Manure gases are poisonous. Low-level exposure produces lung and eye irritations, dizziness, drowsiness, and headaches. Additionally, some manure gases are heavier than air and deplete or displace the oxygen in the storage area. High levels of manure gases can quickly render a person unconscious. Death from suffocation can occur.

Four hazardous gases can be found in stored manure. They are:

- Hydrogen sulfide

- Ammonia
- Carbon dioxide
- Methane

Each of these gases is discussed further.

Hydrogen Sulfide - Hydrogen sulfide has a foul odor similar to rotten eggs. It is rapidly released from agitated manure. It can cause headache, dizziness, and nausea in as low a concentration as 0.5%. At a concentration of 1% in the atmosphere, hydrogen sulfide can cause death. It is heavier than air and settles to the lower level of the manure storage or on top of the manure level.

Ammonia - Ammonia is a colorless, pungent gas with a bleach-like odor. It is soluble in water and irritates the eyes, nostrils, lungs, and throat. The burning effect on the eyes and nose is reduced with breathing fresh air. It is lighter than air and rises out of

the storage area rapidly.

Carbon Dioxide - Carbon dioxide is an odorless and colorless gas. It exists in low levels in the air we breathe, but in high concentration causes difficult breathing, headaches, and even death. It is heavier than air and concentrates in low areas of the storage.

Methane - Methane is a nontoxic, colorless, odorless gas. This gas is lighter than air and rises from storage areas. Headaches may be experienced in methane concentrations of 50% of the atmosphere. Methane in manure gas is just as explosive as the methane gas found in a coal mine.

All of these gases are released into the atmosphere when the manure is agitated and pumped prior to spreading. The gases can also remain in the manure pit or tank even after the manure is removed.

Manure Gases Can Kill

A 31-year-old male dairy farmer and his 33-year-old brother died after entering a 25 square foot, 4 1/2 feet deep manure pit inside a building on their farm. A pump intake pipe in the pit had clogged, and the farmer descended into the pit to clear the obstruction. While in the pit, he was overcome and collapsed. The victim's brother was standing at the entrance of the pit and apparently saw the victim collapse. He entered the pit in an attempt to rescue him. The brother was overcome and collapsed inside the pit. Four hours later, another family member discovered the two victims inside the pit and called the local fire department to rescue them. The victims were pronounced dead at the scene by the coroner. The coroner's report attributed the cause of death in both cases to methane asphyxiation.

See the NIOSH reference for other case examples.

Manure Storage Precautions

Safe work practices can be applied to manure storage areas. The following approved practices will reduce the risk of exposure to deadly manure gases and drowning hazards. They include:

- Keep people and animals out of confinement buildings during manure storage agitation and pumping.
- Ventilate the area for several hours following pumping

activities. A back-up ventilation system and emergency power source should be considered in the event that the power should fail.

- Allow one to two feet of air space above the manure surface for gases.
- Eliminate or prohibit smoking or any source of ignition near manure storage facilities.
- Keep manure agitators below the liquid manure's surface to reduce the volume of gas released.
- Remove temporary access ladders leaning against aboveground manure tanks.
- Lock access to permanent ladders on the aboveground manure tanks.
- Do not drive on crusted manure surfaces of aboveground, open-air manure storage tanks, as the crust is not uniformly solid and can break.
- Warn visitors and guests of the hazards of manure storages.
- Provide signs at the manure storage area, and give verbal instruction to all visitors and guests.



Figure 3.11.c. Open manure storage areas pose a less deadly gas hazard than belowground pits. The major hazard of the open manure storage becomes drowning. Fencing and warning signs alert people of the liquid manure hazard.

**Do not enter
a manure pit
for any
reason.**



Figure 3.11.d. The only safe way to enter a manure pit is by using a self-contained breathing apparatus (SCBA). Only trained persons should use the SCBA. A lifeline is also a part of safe entry. Do not work alone.

Safety Activities

1. Conduct a survey of the farms in your area. Make a chart comparing how many aboveground manure storage facilities exist compared with the number of belowground manure storage structures.
2. One mature cow produces approximately 1 cubic foot of waste per day. For a herd of 500 cows, how many cubic feet of storage space would be necessary to store the waste for 180 days?
3. Using farm magazines, newspapers, the Internet, or any other source, make a collection of news articles which tell about manure storage injuries or fatalities.
4. Contact your local fire and emergency response company to learn more about self-contained breathing apparatus. Write a report for your group or employer.
5. Invite local firefighters to visit a farm to learn more about the hazards associated with manure storage.
6. Research the topic, “positive ventilation systems”. Determine which is better at ventilating a manure pit, a positive ventilation system or a negative ventilation system. Write 2-3 paragraphs with your answer or explain your answer to your instructor or leader.

References

1. www.cdc.gov/NIOSH/Topics/Agriculture>Type manure storage in search request.
2. Farm and Ranch Safety Management, John Deere Publishing, 2009.
3. American Society of Agricultural and Biological Engineers (ASABE), ANSI/ASABE S607, Ventilating Manure Storage to Reduce Entry Risk.

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ANHYDROUS AMMONIA

HOSTA Task Sheet 3.12

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

Plant growth is improved with fertilizer application. Nitrogen is one plant food element. Nitrogen is responsible for green, healthy, productive leaves. Soils usually lack nitrogen so this element must be added to the soil.

Anhydrous ammonia is a powerful source of nitrogen containing 82% nitrogen. Nitrogen solutions are caustic. Caustic chemicals can burn plant and human tissues.

This task sheet discusses the hazards of anhydrous ammonia.

Youth younger than age 16 are forbidden by the Hazardous Occupations Order in Agriculture regulations from handling or using anhydrous ammonia. There are no exceptions to these regulations based upon a supplemental training program. If assigned to the task of working with anhydrous ammonia, tell your employer that you are not permitted to do so.

Even so, youth may be working around anhydrous ammonia and should understand its hazards.

Use of Anhydrous Ammonia

Anhydrous ammonia (NH_3) is a powerful ammonia nitrogen fertilizer. Stored under pressure, anhydrous ammonia exists in liquid form. In the air, anhydrous ammonia becomes a gas.

Pressurized tanks (nurse tanks) are used to store and deliver this form of fertilizer to application tanks used on the farm. Field application tanks apply the anhydrous ammonia by injection into the soil. Soil moisture then attracts and holds the nitrogen.

Anhydrous means “without water.” Anhydrous ammonia is quickly attracted to any form of moisture. Soil moisture absorbs the fertilizer rapidly.

Just as soil moisture reacts quickly with anhydrous ammonia, so does the human body. Moist skin, eye, and lung tissues react with NH_3 by severe burning of those body areas. Severe health problems will result by improper handling and application of anhydrous ammonia. **Anhydrous ammonia can result in permanent damage to your lungs.**

Using anhydrous ammonia is more complex than applying dry, granular fertilizer. Pressurized tanks, control valves, and pressure hoses must be in working order and used properly. The operator must follow several specific procedures exactly. Safety equipment must be nearby and not stored away from the job site.

Important: The danger of using anhydrous ammonia comes through the risks of handling the material. Youth workers younger than age 16 are not permitted to handle anhydrous ammonia.

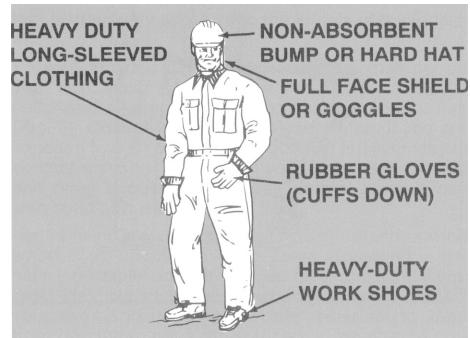


Figure 3.12.a. Personal protective equipment for working with anhydrous ammonia lowers the risk of being exposed to the burning effects of the NH_3 on the skin, the eyes, and the lungs. *Farm and Ranch Safety Management*, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.

**NH_3 is also
added to corn
silage at the
silo to increase
protein levels**

Learning Goals

- To understand anhydrous ammonia uses and the risks that this material can pose

Related Task Sheets:

Hazardous Occupations Order I in Agriculture	1.2.1
Occupational Safety and Health Act	1.2.2
Personal Protective Equipment	2.10
First Aid and Rescue	2.11
Respiratory Hazards	3.3
Respiratory Protection	3.3.1
Silos	3.9

**An estimated
80% of NH₃
injuries and
fatalities are
the result of
a lack of
knowledge or
training.**

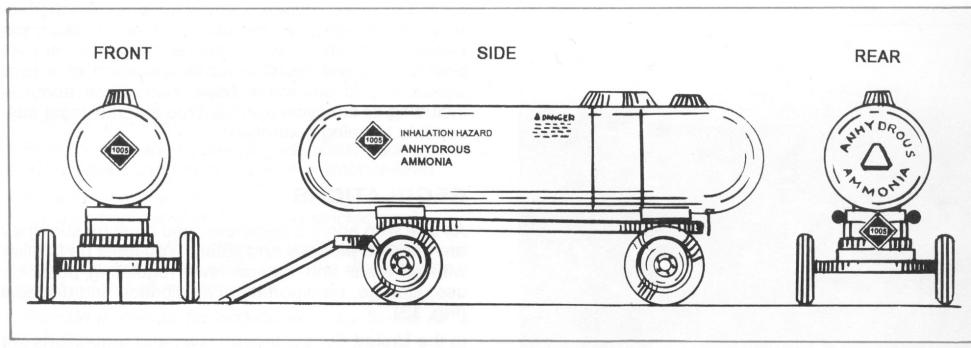


Figure 3.12.b. Anhydrous ammonia tanks must be plainly marked on all surfaces as containing an inhalation hazard. Such markings provide the message that this material is deadly. *Farm and Ranch Safety Management*, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.

Anhydrous Ammonia Systems and Safety

The anhydrous ammonia system is made of several components. Each component operates under a pressurized condition. System components include:

- the nurse tank (the delivery tank)
- control valves for withdrawal, fill, pressure relief, and return lines
- pressure gauges
- transfer hoses
- the applicator tank (for field application)

Anhydrous ammonia system components must meet rigorous safety standards. Anhydrous ammonia is corrosive, therefore system parts must be of high strength steel or other suitable

materials. Fittings should be made of black iron. All parts and surfaces must withstand a minimum of 250 pounds per square inch of pressure (psi). Containers used to store anhydrous ammonia must be painted white or silver to reflect away the heat of the sun to control tank temperatures and pressure.

Daily system checks and routine maintenance are a must. A regular, scheduled replacement program of valves and hoses is recommended. Leaks in the system must receive immediate attention. Dents, gouges and cracks must be repaired by qualified service representatives. Certified welders must be utilized for repairs requiring welding.

Equipment markings must warn users and bystanders of the hazards of anhydrous ammonia. The labels, markings, and safety signs include:

- anhydrous ammonia labeling in 4-inch letters on the side and

rear of the tank

- inhalation hazard labeling required by the federal Department of Labor must appear as 3-inch high lettering on both sides of the tank
- nonflammable gas placard with the numbers 1005 (identification number for anhydrous ammonia) must appear on both sides and both ends of the tank
- SMV emblem must be displayed on the rear of the tank
- valves must be labeled by color or legend as vapor valves (Safety Yellow color) or liquid valve (Omaha Orange color). Lettering must be at least 2 inches in height and within 12 inches of the valves.

Anhydrous Ammonia Safety Precautions

Anhydrous ammonia is a deadly material. It can kill or cripple a person quickly. Constant attention to safety must be part of working with this material. Follow these safe practices.

- Use the correct personal protective equipment (a face shield or splash-proof goggles, rubber gloves and heavy-duty, long-sleeved shirts and pants are recommended).
- At least 5 gallons of clean, fresh water is required to be carried with each vehicle transporting anhydrous ammonia (exposure from spills or splashes will require at least a 15-minute flushing with water to dilute the anhydrous ammonia).
- Operators who are working directly with the NH₃ should carry a squeeze bottle of water in their immediate possession to treat exposure.
- Remove contaminated clothing which can become frozen to the skin (NH₃ works as a cooling gas in the air).
- The operator should be trained in system components and how they operate.
- Daily safety inspections are necessary.

- All labels, markings, and safety signs must be in place and clear for visibility.
- Highway towing speeds should be reduced to less than 25 mph to decrease the risk of upsets or damage.
- Safety chains must be used for highway transport.
- Use a qualified service person to repair the tank, valves, fittings, and hoses.
- Keep untrained persons away from the anhydrous ammonia tanks and equipment.

The same safe practices are to be followed if anhydrous ammonia is to be injected into corn silage as it is blown into the silo. Anhydrous ammonia is a valuable crop nutrient and feed additive if handled safely.

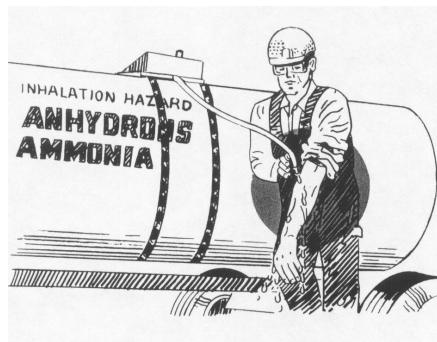


Figure 3.12.c. Transfer of anhydrous ammonia from nurse tanks to field application tanks is a critical time period for using personal protective equipment. Standard operating procedures like having a source of water nearby to flush away spills is important. *Farm and Ranch Safety Management*, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.

**A small squirt
bottle of water
should be
carried with
the worker as
they work with
anhydrous
ammonia.**



Figure 3.12.d. A small amount of water carried on the person working with anhydrous ammonia may be the needed protection to flush the eyes should a spill or splash occur. This small amount of water will help until the victim can get to a larger supply of water. *Farm and Ranch Safety Management*, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.

Safety Activities

1. Draw a sketch of the parts of an anhydrous ammonia fertilizer system. Label the parts by name and function. The information can be found by using the website www.cdc.gov/nasd.
2. Use the website of the Department of Labor (www.dol.gov) or your own state's Department of Transportation website to locate information on hazardous materials placards. Print a copy of the various placards that are found on trucks hauling materials through your community.
3. Practice flushing the eyes with water for 15 minutes to prepare yourself for spills or splashes of any chemicals which could contact your eyes. Is there a water temperature that is best recommended? What source of water is best recommended?
4. Conduct a survey of local farmers to determine how many use anhydrous ammonia. Present the results at your 4-H club, FFA meeting, or to your mentor.
5. Research the possibility of purchasing small squeeze water bottles to use for eye flushing. Make these bottles available to local farmers along with a brochure on anhydrous ammonia safety.
6. Write a letter to local fire service groups informing them of the dangers of anhydrous ammonia. Ask them if they have the necessary equipment to work with local farmers who may need their emergency services.

References

1. Visit www.cdc.gov/nasd/ Click on search by topic/
Type anhydrous ammonia in search box.
2. Farm and Ranch Safety Management, John
Deere Publishing, 2009. Illustrations reproduced
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FARMSTEAD CHEMICALS

HOSTA Task Sheet 3.13

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

Not all chemicals used on a farm are toxic pesticides. Pesticides are those chemicals which kill pests. Workers younger than age 16 are not permitted to work with restricted use pesticides in any manner.

There are many other chemicals used on the farm which are not pesticides. Chances are high that you will be exposed to some chemicals which are not regulated under pesticide laws.

This task sheet discusses farmstead chemicals and working with these chemicals safely.

Farmstead Chemicals

The beginning farm worker may be assigned to the milking parlor of a dairy farm, the animal treatment area, a livestock center, the field crop area, or to the farm shop. The milking process involves working with cattle, cleaning facilities, and equipment including milk pipelines. The animal treatment area may expose the worker to disinfectants and medicinals.

Livestock center chores may range from baby pig care to feeding and care of beef steers. Field crop work involves handling fertilizer and lime. Farm shop work finds a young worker cleaning parts and servicing equipment.

Dairy farm work involves using cleaners and sanitizers. Acid rinses, alkaline compounds,

chlorine, and iodine materials are commonly found on farms. These can damage skin and produce toxic fumes.

The animal treatment area of a dairy farm has potentially hazardous materials. Animal medications may be applied externally or by injection. Young persons are often trained to administer vaccinations. The needles can expose workers to vaccines or puncture wounds.

Livestock center work parallels the work of the dairy industry. Animal medications mixed into the animals drinking water are used. Foot bath chemicals are mixed to treat foot health problems.

Field crop work with the exception of pesticide application will be assigned to most young workers. Hauling fertilizer and lime is a dusty chore. Those particulates can create respiratory health risks and skin irritation.

Farm equipment becomes greasy and dirt-covered. Degreasers and solvents may be needed to clean the parts. Hydrosulfuric acid will be encountered while servicing a battery (Task Sheet 4.6.2). These materials are also hazardous.

There are many types of chemical materials used on the farm. They are so numerous that the list would be endless. Every year new products are added to the list. It is impossible to discuss all farmstead chemicals in this task sheet.

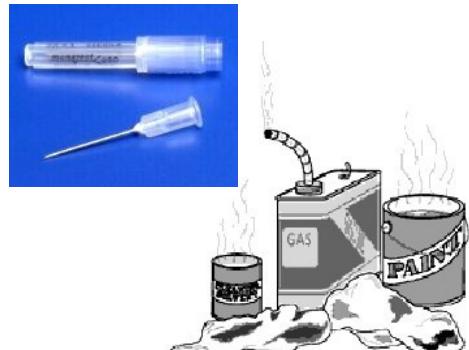


Figure 3.13.a. All farmstead chemicals are not pesticides. Animal medicines, fuels, paints, and solvents are also chemicals. The young farm worker may be exposed to many such products.

**Do you know what
the chemicals you
are handling can
do to your body?**

Learning Goals

- To understand that farmstead chemicals are used in agriculture and that each one of these must be handled in a safe manner

Related Task Sheets:

Hazardous Occupations Order in Agriculture	1.2.1
Worker Protection Standards	1.2.4
Injuries Involving Youth	2.1
Age-Appropriate Tasks	2.4
Respiratory Hazards	3.3
Respiratory Protection	3.3.1
Working with Livestock	3.4
Agricultural Pesticides	3.5
Fire Safety	3.7
Fire Prevention and Control	3.7.1

Young farm workers are often assigned to work with animal cleaning and sanitation products.



Figure 3.13.b. A young farm worker should not be surprised that beginning level jobs will involve cleaning equipment. Dairy facilities, for example, require use of a variety of cleaners, degreasers, and sanitizers to meet milk inspection standards.

Animals and Chemicals

Working with dairy, livestock, and small animals often requires the use of a variety of chemical products. Animals must be kept clean and healthy. Equipment used with animals must be disinfected. Unhealthy animals must be treated.

A variety of chemical products may be handled by young farm workers. Disinfectants are used with livestock to reduce infectious organisms. These products may be applied to the animal directly by the worker. The material may be diluted with water and applied by way of foot baths.

Direct application of chemical formulations to the animal can be done by sanitary wipes or dust application. Udders and teats of the dairy cow are disinfected with individual sanitary wipes. Teat dips are used before and after milking to reduce bacterial infection. Foot

baths contain copper sulfate solutions to control and prevent foot rot organisms from destroying hoof tissues of cattle, horses, and sheep.

Milking equipment, milk pipelines, and bulk tanks must be cleaned and sanitized. Butterfat and protein particles must be removed by degreasing chemicals. The milking equipment components must also be sanitized to prevent growth of harmful microorganisms.

Livestock equipment must be disinfected to prevent spread of disease from one group of animals or from one farm to another.

Weigh scales and head locks are treated with disinfectants and may be applied by pressure-washing equipment. Livestock tools, such as dehorning and castration equipment, must be sterilized after each use.

Many animal medicinals or pharmaceuticals are also

agricultural chemicals.

Dairy and livestock must be treated for disease or vaccinated to prevent disease. Injections supplement nutritional needs of the animal as well. The young farm worker will often be trained to assist with these injections.

Safe work habits will prevent you from unnecessary exposure to the active ingredients in these products. Follow these safety points:

- Read product labels to understand the safety requirements of the product.
- Do not mix chemical solutions without adult supervision.
- Use proper personal protective equipment to protect eyes, skin, and lungs.

Note: The maturity and strength of a young worker must be considered when accepting animal care tasks.

Lime and Fertilizer

Fertilizer and lime are necessary for plant growth. Fertilizer provides the plant food elements like nitrogen, phosphorous, and potash. Lime neutralizes soil acidity to make fertilizer elements more available to the plant. Fertilizer materials are applied in dry, gas, or liquid form. Lime is applied in a dry powder or liquid form.

Fertilizer is a hygroscopic material. This means that it attracts moisture. As it pulls moisture from the skin, eyes, nose, or mouth, tissues can blister and burn. Exposure occurs when fertilizer is being handled. Operator exposure is increased when you are unprotected.

Lime in the hydrated form is also a hygroscopic material. Hydrated lime is often used to treat barn alleyways as a disinfectant and as a fast-acting soil amendment.

Wear long-sleeved shirts, long pants, and eye protection while handling and applying these materials. A toxic particle dust mask is also recommended.

- antifreeze
- battery acid
- solvents

Each of these materials can be toxic, caustic, or flammable.

Toxic materials poison a person if they are ingested, spilled on the skin or in the eyes, or inhaled. Petroleum products can be fatal if swallowed. Antifreeze poisons a person who has swallowed it.

Caustic materials burn skin tissues quickly. Battery acid burns skins and clothes. Solvents can dry the skin and cause irritation.

Flammable materials can explode or ignite and burn violently.

Petroleum products and cleaning solvents are class B fuels for fire sources (See Task Sheets 3.7 and 3.7.1).

Safe work habits should be practiced in all areas of the farm. Shop safety with chemicals should include:

- Use of personal protective equipment, such as goggles, chemical gloves, and aprons
- Understanding label directions for the material's use in mixing and application
- Adult guidance for those areas of confusion

Special note: Shop rags pose a hazard as well. The rags may be soaked in toxic material from wiping up an area. The rags can be soaked in caustic material, such as battery acid, or the rags could contain flammable materials. Rags can expose the worker to hazardous materials and should be disposed of after use to prevent fires.



Figure 3.13.c. . Exercise care when using all farmstead chemicals. Spills can pose hazards such as slips and falls. Follow cleanup and proper disposal procedures on the product's label.

Young farm workers are often assigned to clean equipment and to move crop supplies.



Figure 3.13.d. Machinery cleanup may require a solvent. What would you use to clean the grease away from the hydraulic fittings?

Safety Activities

1. Visit a dairy farm, a horse farm, a beef farm, or a swine facility. With the owner's permission, make a list of all the farmstead chemicals that you can find. Do not include pesticides.
2. If you are studying this material in a group, have the group make a list of farmstead chemicals that they have used on their farm or a farm where they are working.
3. Are dairy cleansers, sanitizers, and medicines covered by the Worker Protection Standards Act? You will have to refer to Task Sheet 1.2.4, or use the Internet to search for the subject of Worker Protection Standards.
4. Research foot rot in livestock and how it's controlled.
5. Find out what procedures a local farmer would use to clean up an oil, antifreeze, or fuel spill. Write the procedures in outline form.
6. Define these terms:
 - a. sanitize
 - b. acid compound
 - c. alkaline compound
 - d. hydrated lime

References

1. Farm and Ranch Safety Management, John Deere Publishing, 2009.

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ANIMAL, WILDLIFE, AND INSECT RELATED HAZARDS

HOSTA Task Sheet 3.14

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Farm work may bring you into contact with animals on the farm, as well as, wildlife that may occupy the same area. Sometimes these contacts can be hazardous.

Understanding the risks of these exposures is important. Some animal health problems can be transferred to humans. Farm workers may unexpectedly encounter potentially hazardous animals, snakes and insects.

This task sheet discusses animal, wildlife, and insect related hazards.

Zoonoses

Definition: Zoonoses is the term that denotes diseases that can be transmitted between vertebrate animals and humans. These diseases can be transferred in several ways.

Direct Animal Contact

Animal manure, urine, bedding, and products (raw meat, unprocessed milk, hides, hair, etc.) can serve as a source of human infection. Disease causing organisms and disease carrying insects can be found in and on these products.

Animal manure contains bacteria from the animal's digestive system. *E. coli*, a bacteria, is found in manure. This bacteria can cause intestinal disease, with nausea and general feelings of ill health.

Animal products such as meat and milk can carry microorganisms that can cause disease. Meat can be a source of *Salmonella* or *Listeria*, both of which are bacterial organisms. These organisms can cause fever, nausea, vomiting, and diarrhea. Processing or pasteurization is used to control and eliminate these micro-organisms.

Animal hides and hair may harbor insects that can carry disease, bite, or sting a person. Workers who must handle raw animal products are placed at risk for exposure to insects and ticks (See Page 3).

Infections of the animal's reproductive tract can be transmitted to people who assist with the birthing of calves, piglets, lambs, and foals. Sterile, disposable gloves should be worn to protect against harmful organisms. Such organisms can enter the body through cuts and scratches. Just as importantly infection from a person's hands can enter the animal's reproductive tract and cause disease to the animal.

Indirect Animal Contact

Soil, plants, and water can be contaminated by animal wastes. Surface water (streams and ponds), as well as water wells and reservoirs, can be contaminated with animal waste. Avoid drinking such water to reduce your exposure to potential health risks..



Figure 3.14.a. Cattle can transmit ringworm, rabies, and other micro-organisms to humans.

Ringworm is an example of a zoonotic disease

Learning Goals

- To understand the hazards of zoonotic diseases, wildlife, and insects to the worker.

Related Task Sheets:

The Work Environment

1.1

First Aid and Rescue

2.11

Working with Livestock

3.4

Insects and snakes are found in the fields and barns where farm employees work.

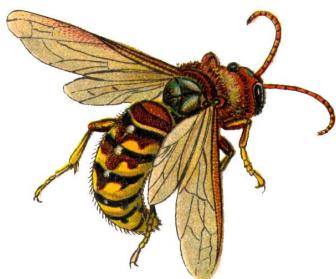


Figure 3.14.b. Stinging insects and poisonous reptiles are found throughout the United States. Each geographic area may have its own set of insect and snake species which may be hazardous.

Stinging Insects and Poisonous Snakes

Stinging Insects

Wasps, hornets, bees, and other stinging and biting insects, as well as, spiders and tarantulas are found throughout America. Many a farm worker has been stung by one or more of these pests with various reactions.

Insect bites create health problems for some people. Allergic reaction to the sting or bite is one such reaction. *Anaphylactic shock* is caused by insect venom and is a serious medical emergency.

Anaphylactic shock is characterized by swelling of the throat which can cause suffocation and a sudden decline in blood pressure. Both of these can cause death. A person who has such a reaction must be taken

immediately to emergency medical care.

Poisonous Snakes

Various species of poisonous snakes are found throughout the United States. Rattlesnakes, copperhead snakes, and others pose little danger to most people if they are left alone in their surroundings. They are generally found away from human populations, so most workers will not often encounter a snake.

Occasionally a farm worker may encounter a snake that may strike. Farm work in seldom used barns, along fences, and near woodlots can bring the worker into a surprise encounter with a snake. Quick identification of the snake as poisonous or harmless is necessary.

Poisonous snakes have a angular head with a pit in front of the eyes. If such a snake is encountered

these are recommended actions:

- Slowly back away from the snake.
- Make no sudden or threatening moves.
- Report the incident to others who may have to work in the same area.

If a snake bite occurs, the following ideas can prevent the wound from become more serious than it need be:

- Allow bite to bleed freely for 15-30 seconds.
- Clean and disinfect the area.
- Stay calm.
- Get assistance to travel to emergency medical care.

Be aware of snake habitats and watch your movements carefully.

Rabies

Rabies is a viral disease of mammals. It is transmitted through the bite of an infected animal. Most cases of rabies come from wild animals such as raccoons, skunks, bats, and foxes. Cats, cattle, and dogs can also become infected.

Rabid animals appear to be confused, paralyzed, excitable, and frothing from the mouth.

The best way to prevent rabies is to avoid animals that show strange behavior. Report such animals to your employer or parents.

If bitten by an animal that is suspected of having rabies, kill the animal if need be, handle the animal carcass with disposable gloves, and submit the animal for post-mortem testing. A person who has been exposed to rabies will need medical treatment quickly.



Figure 3.14.c. Raccoons are common carriers of rabies. If you find these animals acting abnormally around humans be alert for the danger of a rabid animal bite.

Lyme Disease

Ticks often attach themselves to warm-blooded animals and feed on their blood. Their blood filled bodies are commonly found on dogs (dog tick) and deer (deer tick). These same ticks can also attach and feed on human blood.

Ticks are often found on people who have been walking in tick infected areas. Adult ticks wait on host weed species and pass on to warm-blooded hosts as they pass by.

Deer ticks are common in the northeast United States. Deer ticks can be found on deer hunters who are processing the animals. Deer

ticks may carry Lyme disease and must be removed immediately.

Lyme disease, first reported in the Lyme, Connecticut, has spread nationwide. It affects people who have been bitten by a deer tick, but failed to notice the insect attached to their bodies. At least 48 hours of infectious contact will result in the onset of the disease. Lyme disease left untreated can cause a rash and flu-like symptoms followed by loss of coordination, memory loss, irregular heartbeat, and arthritis. Lyme disease is rarely fatal however.

Lyme disease is preventable. These considerations will reduce the risk of Lyme disease exposure.

- Wear light colored clothing when in infested areas (to be able to see the tick)
- Tuck pants into socks to keep ticks out
- Use an insect repellent approved for tick control to treat clothing before going into woods or fields.
- Avoid weedy, brushy areas that may harbor ticks
- Check your body for ticks when returning home

**Deer ticks
carry Lyme
disease.**



Figure 3.14.d. Deer harbor a tick that can carry Lyme disease. Hunters who bag a deer should take precautions to avoid becoming infested. Inspect your body after handling infected deer during processing.

Safety Activities

1. Use the Internet website of your state Land Grant University's Entomology Department to locate pictures of stinging insects. Make a collage of the insects that you have seen, or that have stung you. Place a label on the insect picture to identify it.
2. Interview 25 persons to determine how many have had an allergic reaction to an insect sting. From the percentage of persons calculated to be allergic, determine how many people that may be in the United States if the total population is estimated to be a total of 300,000,000 people. How many people may have this allergic reaction. (This is not a scientific study.)
3. Word Search. Draw a line through as many words about zoonotic diseases and their carriers as you can find. Use the word list. Words may be horizontal, vertical, diagonal, frontwards, and backwards.

R	A	B	C	B	T	A	M	O
I	R	D	R	A	T	I	A	Z
N	A	E	B	T	T	R	L	X
G	B	F	G	T	I	E	A	X
W	I	N	S	E	C	T	R	S
O	E	H	I	R	K	C	I	I
R	S	U	R	I	V	A	A	T
M	J	K	L	A	M	B	N	E
P	A	R	A	S	I	T	E	S

Use these words: parasites, bacteria, ringworm, rabies, malaria, virus, snake, tick, insect, rat, bat.

References

1. Safety and Health for Production Agriculture, ASAE Textbook Number 5, Dennis J. Murphy, American Society of Agricultural Engineers, St. Joseph, MI.
2. The Internet. Type a key word on animal health, wildlife, insect, or disease into the search box and scroll for the sites you wish to visit.

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