Hazardous Occupation Training

Unit One:
Safety is No Accident
Statistics

• Accidents cause the death of more people aged 15-24 than all other causes

• **1 out of 5** farm accidents involve farm machinery

• Most farm accidents occur when the tractor is parked:
  - machine stopped, not running **27.5%**
  - machine stopped, running **20.0%**
Statistics

• 10-14 year old children operating tractors have a greater chance of having an accident on a tractor than any other age group.

• More than 1/3 of tractor fatalities involve young, extra riders. Most likely to be killed are young, extra riders between the ages of 1 and 10.
Improper Machine Operation Causes Accidents

• Many accidents are the result of incorrect man-machine reaction in a changing environment.

• Reaction time of an individual may change because of:
  - age
  - experience
  - health
  - attitude

• An overturn can occur in less than one second, while an operator’s reaction time may exceed that.
Youth Regulations

- Agriculture is now the most hazardous occupation, according to the United States Department of Labor.

- Regulations related to youth are included in the Fair Labor Standards Act, the Occupational Safety and Health Act (OSHA), and Worker’s Compensation Laws.
Fair Labor Standards Act

- Prohibits the employment of children under 16, without special permission, in occupations declared particularly hazardous by the Secretary of Labor.
- No minor under 16 may work during school hours except on the home farm for parents.
- Without special permission, no minor under 16 may work at any time in occupations declared particularly hazardous.
- Minors under 16 may work outside school hours in farm jobs not declared particularly hazardous.
- Minors over 16 may be employed on a farm at any time in any farm job.
Fair Labor Standards Act

Exemptions

• Minors 14 and 15 trained under the 4-H Federal Extension Service Program or the U.S. Office of Education Vocational Agriculture Training Program may work outside school hours on farm equipment on which they have been trained.

• If they have been instructed by employers on safe and proper operation of the equipment to be used.

• They are continuously and closely supervised or are checked by an employer at least midmorning, noon, and midafternoon.
Fair Labor Standards Act

• Regulations do not consider all farm jobs to be hazardous.
• Examples of farm jobs that are permitted include:
  - loading and unloading trucks
  - operating small tractors
  - processing and storing milk and dairy products
  - working with farm animals on the farm and at fairs
  - riding, driving, or exercising horses
  - handling irrigation pipes
Develop A Safety Attitude

- No one is immune to accidents
- No machine is completely safe
- Tractors are powerful machines that must be operated carefully
- One-third of all farm accidents are FALLS
- Many farm accidents involve misuse of agricultural machinery and tractors
Operate Activity Precautions

• STUDY the operators manual.

• LEARN how to use the tractor controls for safe operation.

• A tractor should only be operated by those who are responsible, have been instructed thoroughly in its operation, and have been authorized to operate it.

• Use mounting assist handles when getting on or off a tractor.

• Never attempt to start or operate a tractor except from the operator’s station.

• Release the park brake completely.
Operator Activity Precautions

• Never run the tractor engine in a closed building without adequate ventilation.

• Wait for a tractor to STOP before dismounting.

• Never leave the engine running while it is unattended.

• Shut off the engine and remove the ignition key.

• Always shut off the engine and apply the parking brake before getting off a tractor.
Protective Device Precautions

• Use warning devices (flags, SMV emblem, lights, etc.) when moving equipment on public roads. Remember that tractors are not designed for highway use.

• Use a flasher warning lamp when traveling on public roads, day or night.

• Use accessory lights and devices to provide adequate warning for other drivers when transporting or driving a tractor on public roads.

• Adjust rearview mirrors for favorable vision.

• Always carry a “charged” fire extinguisher.
Protective Device Precautions

• ALWAYS use a seatbelt when a tractor is equipped with ROPS (Roll over protection structure).
• Do not install a seatbelt on a tractor NOT equipped with ROPS.
• Carry a First Aid kit on every tractor.
• Be sure cab doors are securely latched when operating a tractor.
• Lock cab doors, if locks are furnished, when leaving a tractor or a self-propelled implement cab.
Maintenance and Adjustment Precautions

Poor maintenance or improper adjustment of a tractor or implement may result in a hazardous situation.

• Check coolant and engine oil levels, and perform any other necessary services, before starting the engine.

• Add coolant to the radiator only when the engine is stopped or slowly idling.

• Do not fill any fuel tank completely to the top if the tractor is to be exposed to the sun.

• When filling with diesel, never fuel while an engine is hot, while near an open flame, or when an operator is smoking.
Maintenance and Adjustment Precautions

• Before disconnecting hydraulic lines relieve all pressure. Before applying pressure to the system, be sure all connections are tight and that lines, pipes and hoses are not damaged.
• Check brakes and clutch for correct adjustment.
• Always keep the tractor brakes in good operating condition.
• Do not grease, oil, adjust, or repair a tractor or implement while in motion or while it is running. If adjustments must be made while the implement is in motion, have an adult make the adjustments.
• Clean dirt, trash, and grease from operators platform, pedals, steps, and steering wheel.
Maintenance and Adjustment Precautions

• Reduce tipping hazards by spreading wheels as far as your work permits.

• Before making battery adjustments on an engine or electrical system, disconnect the battery ground cable.

• **DO NOT** bypass the safety starter switch.
Tractor Motion Precautions

• When towing an implement or trailer, the hitched member should be pushing downward on the tractor drawbar.

• BEFORE starting a tractor in motion, look around carefully to ensure there are no people or obstructions in your path.

• The tractor speed on hillsides and curves should be reduced to minimize danger from tipping.

• Avoid sudden starts, excessive speed, and sudden stops when operating on hillsides, rough ground, and most off-the-road operations.

• Keep a firm grip on the steering wheel at all times, especially when operating at increased speed.
Tractor Motion Precautions

• Be extra careful when going down steep grades.
• Never shift to a low range when operating at a high speed.
• When moving on public roads, or from field to field, lock brake pedals together for simultaneous wheel operation when making a stop.
• Avoid uphill turns except at very low speeds.
• Reduce speed when traveling on rough roads.
• Reduce speed when making a turn, going downhill, or applying brakes.
• Always keep tractor in gear when going down steep hills.
Tractor Motion Precautions

• If a tractor is stuck, back up to prevent an upset.

• Towed loads that weigh more than twice the weight of the tractor should have brakes. If not, reduce speed and avoid inclines.

• Brake both wheels simultaneously when making emergency stops.

• Both a tractor and its attachments should be stopped and inspected for damage after striking a foreign object. Repair any damage before restarting and operating the equipment.

• Do not drive near the edge of a ditch or gully.
Tractor Motion Precautions

• When driving out of a ditch or gully, or up a steep hillside, engage the clutch slowly. Be prepared to disengage the clutch promptly if the front wheels rise off the ground. Observe the same precautions if the rear wheels become mired in soft ground or drop in a hole.

• Never try to start a tractor by towing. When towing a tractor, be sure all controls are in the position specified for towing.

• Before starting the tractor engine, be sure everyone is clear of the tractor and attached equipment.
Tractor Motion Precautions

• If a tractor is towed, run the engine, if possible, to activate the power steering and brakes. Have an operator steer and brake the tractor.

• Never tow a tractor faster than 5 mph.

• Never operate a tractor with a loose wheel, rim or hub.

• Never operate a ROPS-equipped tractor that has been righted after an overturn until the steel frame has been checked for damage.
Implement Precautions
Implement Precautions

• Never work under raised implements without safety supports.
• Never stand between a tractor and a machine when hitching unless all the controls are in neutral and the brakes are locked.
• Make sure all stabilizers are installed when using a hydraulic lift linkage.
• Use the drawbar in lowest position when hitching to a heavy load.
Implement Precautions

• When hitching equipment to the drawbar, back the tractor past the clevis. Then move forward so that, when making the connection, the tractor will be moving away from the equipment when the hitch pin is inserted.

• Shift the transmission into neutral and set the park brake before dismounting to hitch equipment.

• Be sure hitches and/or drawbars are properly stabilized before towing equipment.

• Pull only from the drawbar, NEVER hitch to an axle housing.
Implement Precautions

• When hitching a heavy, towed load to a tractor, always hitch to the drawbar. When using a chain, take up the slack in the chain slowly.

• Under no circumstances should anything be pulled from the lift shaft, lift arms, or 3-point hitch upper link. Hitch loads only at the drawbar or 3-point hitch draft links.

• If the front end tends to rise, install front end, or front wheel weights.

• Avoid heavily traveled roads when moving equipment, if possible.

• Never park or leave any hydraulically operated, mounted, or pulled implement in raised or up position.
Implement Precautions

• Before dismounting, stop the tractor, place the transmission in park, lower the implements to the ground, and shut off the engine.
• Do not overload tractor loaders. Carry the bucket low when loaded.
• Make sure safety stops are in position before working around or under the grain platform or corn head on your combine.
• Do not allow any workers or operators to mount or dismount from any tractor or implement while it is moving.
Power Takeoff Precautions

• Keep tractor and attachments in good operating condition and keep safety devices in place. Use guards as instructed in operator’s manual.

• Be sure PTO lever is in the OFF or disengaged position before starting an engine.

• Keep safety shields in place when using PTO.

• Always wear belted or relatively tight clothing when working around moving parts.
Power Takeoff Precautions

• Always make sure the engine is stopped, the PTO clutch disengaged, and the PTO shaft stopped before attempting to adjust an implement hitch or PTO hook-up or before attempting to clean out a PTO-driven implement.

• Never start a PTO-driven machine without making sure that no one is on it or close to it.

• Never install or remove a belt while the belt pulley is in motion.

• Remove the PTO master shield only when necessary. Always install the PTO guard on the power takeoff when the PTO is not being used. When the PTO is being used, be sure all PTO shields are in place on both the tractor and implement.
**Safety Symbols**

**Danger Signs** Danger signs must be used only where an immediate hazard exists. Danger signs must have red as the predominant color for the upper panel, black outline on the borders and a white lower panel for additional sign wording.

**Caution Signs** Caution signs shall be used only to warn against potential hazards or to caution against unsafe practices. Caution signs shall have yellow as the predominant color, black upper panel and borders, yellow lettering or "caution" on the black panel, and the lower yellow panel for additional sign wording. Black lettering shall be used for additional wording.

**Safety Instruction Signs** Safety instruction signs, when used, must be white with green upper panel and white letters to convey the principal message. Any additional wording on the sign shall be black letters on the white background.
Hazardous Occupation Training

Unit 2:
Instruments and Controls
The Tractor’s Nerve Center

This unit will focus on understanding and interpreting the various controls and instruments in the tractor.
Tractor Controls

A tractor operator must become familiar with the purpose and location of controls of the tractor before he or she can operate the tractor safely and efficiently.

A certain movement of a control produces a consistent and expected effect. The effect of control movement is clearly and permanently labeled.
Instrument Panels
Charge Indicator

• The charge indicator, or ammeter, indicates whether the alternator or governor is charging the battery properly.

• The indicator warning light comes on when the circuit is discharging and goes off when the charging rate exceeds battery output.
Coolant Temperature Indicator

• The coolant temperature indicator indicates an overheated condition, or it may be a temperature gage.

• A correctly operating thermostat keeps the engine at the proper temperature by opening and closing as a change in coolant circulation to the radiator is needed to maintain the correct temperature.

• In case of either low engine operating temperatures or excessively high temperatures, the cause should be corrected.
Oil Pressure Indicator

- The gage or light tells if oil pressure is developed in the system.
- The gage will show actual pressure; an indicator light goes off when oil pressure is above a predetermined level.
- An engine should never be run when low oil pressure is indicated or an unusual engine noise occurs.
Engine Speed-Hour Indicator

- Also known as: tachometer, speed-hour meter.
- Shows the engine speed, or revolutions per minute (r.p.m.), and also records the hours of engine operation.
- PTO speed is also indicated on the dial.
- Speed in mph for all forward gears is also indicated on this dial.
Fuel Gage

- Most tractors have a gage that shows how much fuel is in the tank.
- A good operator never lets the tank run dry. This particularly important if the tractor burns diesel fuel.
Other Instrument Panel Indicators

A tractor is a complex machine which may have several instruments or indicators to communicate with the operator. It is very important understand and be able to react to any sign of malfunction.

1. Transmission Oil Pressure
2. Hydraulic Oil Filter
3. Air Filter
4. Power Steering Indicator
5. Headlight Indicator
Tractor Function Controls

**Seat Adjustment**
- Not considered an operation control, but is vital for safe operation; seat should be adjusted so all controls are within easy reach.

**Starting The Tractor**
Controls vary with model and engine type; common controls are key switch, starter button, and fuel valve control; some tractors will not start unless the gearshift lever is in *neutral* or *park* position.

**Engine Speed Control**
- often called a *throttle*, but is actually a governor control on most tractors; may be a hand or foot throttle.
Tractor Function Controls

**Brakes**
May be mechanical or hydraulic; used in turning, stopping or parking the tractor.

**Differential Lock**
Is engaged by continually depressing a lever of foot pedal. The lock is released by depressing one or both brake pedals.

- The lock is for straight travel at low speeds.
- When engaged, it will not allow drive wheels to turn independently.
Tractor Function Controls

**Steering**
Hand wheels and levers are used to steer tractors; power steering requires less effort to operate the tractor; four-wheel-drive tractors may be wheel-steered, or steered by an articulated pivot at the center of the tractor.

**Hydraulic Controls**
Operated by activating a pump-valve remote cylinder (or motor) system

**Clutch**
A device for connecting and disconnecting power between the engine and the transmission or PTO.
Hazardous Occupation Training

Unit Three:
Maintenance and Safety Checks
Check Tractor Daily

Failure to check the tractor before using it each day can lead to a loss of operating time, expensive repairs, and even injury.

A daily maintenance and safety check is really preventative maintenance.

- Reduces tractor and machine stoppages or failure,
- Reduces operating costs,
- Reduces safety equipment hazards, and
- Increases service life.
Preventative Maintenance Schedule

• A permanent record of scheduled and completed service, repair, and maintenance should include:
  - scheduled maintenance by number of hours
  - seasonal or yearly scheduled maintenance
  - date and hours of machine operation when necessary or unscheduled service or repairs are completed
  - additional records should include fuel, oil, and repair costs
Maintenance Symbols and Charts

• Symbols on machine service diagrams or check charts are useful indicators of recommended preventative maintenance.

• There is no standardization among operator’s manuals, but the principle of maintenance symbols and/or charts is used in most operator’s manuals to guide the machine operator in servicing equipment.
Always Follow Operating Manual Instructions
Maintenance Operations

• Hydraulic System
  - four problem areas: not enough oil in the reservoir, filter dirty or clogged, connections leaking, and incorrect oil in the system

• Transmission
  - may be lubricated by oil which is also used in the hydraulic system
  - check oil level once a week, change at least every two years
  - change the filter in a new tractor every 50 hours
Maintenance Operations

• PTO - check the oil level every 50 hours and change yearly

• Cooling System
  - prevents overheating and regulates the operating temperature of an engine
  - parts include: radiator and pressure cap, fan and fan belts, coolant pump, engine coolant jacket, thermostat, connecting hoses and coolant
  - maintenance includes: checking coolant level, checking for leaks, changing the antifreeze, preventing corrosion, and cleaning or flushing the system
Maintenance Operations

- Tires
  - Tires are often abused and last about 1/3 the normal life expectancy
  - The key to tire maintenance is to ensure correct inflation and ballast, and use the tires properly
  - Correct inflation ensures proper traction, flotation, and support of loads, and prevents excessive flexing which reduces cracking of the sidewalls
  - Check tires when cold, and never bleed air out of tires when warm or hot
  - When you change tires, machines should be blocked to eliminate movement
Maintenance Operations

• Air Cleaner
  - system includes: precleaner, prescreener, and a dry or oil bath filter
  - should be cleaned as recommended, or more often if under dusty conditions

• Battery
  - check electrolyte every 50 hours
  - clean the terminals and wash off the battery top every 250 hours
  - check the charge with a battery hydrometer every 250 hours
  - observe precautions when using jumper cables
Maintenance Operations

- Clutch-Free Travel
  - May burn out if free play is restricted
- Crankcase Oil
  - helps keep the engine clean, reduces friction, and carries away some of the heat produced in the cylinders
  - if the oil level is low, the tractor will overheat, causing extensive damage
  - use the dipstick to check the oil level daily
- Fuel System
  - fill tank with clean fuel
  - service fuel filters regularly
Daily Maintenance Check

A daily maintenance checklist includes:

1. Fuel supply
2. Radiator coolant level
3. Tire pressure
4. Battery fluid level
5. Crankcase oil level
The Safety Check

As a tractor is serviced, check for safety hazards as well.

- Loose belts
- Worn, broken, or damaged parts
- Trash or dirt accumulation
- Seat position and security
- Steering connections
- Hitch (including drawbar pin)
The Safety Check

- Condition of attached or mounted equipment
- Tires and wheels
- Platform
- PTO Shields
- Steps and Handholds
- Brake pedal lock function
- Ignition wiring
Hazardous Occupation Training

Unit Four:
Starting and Stopping Tractors
Unit Overview

This unit will cover general information about starting and stopping tractor engines.

The operators manual should be studied for specific instructions.
Starting Procedures

Procedures vary for different types of engines. General rules are:

- Make a daily maintenance and safety check.
- Take your position in the operators seat.
- Adjust the seat to allow correct operation of all controls, and fasten your seatbelt.
- Check controls for neutral position
  1. Gearshift or shift lever to PARK
  2. PTO clutch lever
  3. Hydraulic levers
  4. Rock shaft down
Starting Procedures

- Check that all people are clear of the area.
- Depress clutch pedal.
- Open throttle one-third to one-half.
- Turn switch to ON position
- Turn switch to START position. Do not crank engine for more than 10 to 30 seconds.
- After engine starts, check indicator lights which should no longer be glowing.
- Allow engine to warm up at a moderate speed: 800-1000 r.p.m.
Starting a Gasoline Engine

• The gasoline engine has been phased out of tractors since the 1960’s as diesel engines provide better fuel economy and improved performance under heavy loads.

• The choke may be used when starting gas engine to cut air intake, but should be shut off once the engine starts.

• Excessive choking may cause fuel to dilute the oil.

• DO NOT try to bypass the safety starter switch.
Starting a Diesel Engine

• The diesel engine is most common in farm tractors and self-propelled implements.

• Diesels need help in starting, particularly in cold weather.

• A glow plug may be used to heat the air going into the combustion chamber.

• Some models have a device which injects a small amount of ether after the first few turns of the engine.

• If a diesel engine is in daily use, a 115-volt electric coolant heater is preferred, especially in temperatures below zero degrees Fahrenheit.
Starting a Diesel Engine

- Between zero and forty degrees, starter fluid will help engines start more readily.
- It should be injected through the manufacturer’s starting fluid system.
- Crank the engine for 10-20 seconds until smoke comes from the exhaust, then inject starting fluid into the engine air intake system, and continue cranking the engine.
- An adaptor cover should be in place to keep dirt out of the starting fluid system.
If an Engine Fails to Start

• A starting motor should not be run for more than 30 seconds at a time.
• After 30 seconds of cranking, turn the switch to OFF and let the starting engine cool.
• After about four tries, the cause of failure to start should be investigated.
• FLOODING should be avoided by not over choking the engine.
Engine Warm Up

• Refer to the Operator’s Manual for the proper warm up time before placing the engine under full load.

• Ways to warm up the engine:
  - run at moderate engine speed with less than full load.
  - drive the tractor to the field at moderate engine speed.
  - operate at one gear lower than usual for 30 minutes.
Stopping the Engine

• If an engine is shut off before proper cooling, valves may be warped or other parts may overheat and be damaged.

• General procedures for stopping engines:
  - declutch and shift transmission to park or neutral
  - reduce engine speed and let the engine run at fast idle for a few minutes (800-1500 r.p.m.)
  - make sure all integral and trailed implements are in lowered position
  - set the brakes
  - shut off the engine
Stopping the Engine

1. Gasoline Engines: Turn key switch to the OFF position.

2. Diesel Engines: Move throttle shut-off lever or stop knob to OFF position and turn the switch key to OFF.

   • Remove the switch key.
Hazardous Occupation Training

Unit Five:
Tractor Safety on the Farm
Unit Overview

This unit will emphasize safe operation of tractors and machines on the farm.

The safe operation of tractors and machinery depends on three factors:

1. Operator
2. Machine
3. Environment
A Safe Worker

• A safe farmer doesn’t abuse livestock, tractors, or machinery.

• A safe farmer keeps the farmstead neat.

• A safe farmer has a positive attitude toward farm management and safety and owns safe, efficient, and well-maintained farm equipment.
A Worker’s Safety Attitude

• The correct attitude can be more important for success than skill, aptitude, or experience.

• Developing the right attitude toward safety will not guarantee that accidents won’t happen, but it is an important step in the right direction.
Characteristics of a Safe Worker

• Mature in judgment and sense of responsibility.
• Observes safety precautions.
• Do not take chances.
• Uses up-to-date safety equipment.
• Has concern for the safety of others.
• Maintains a safe environment.
• Plans ahead; does not rush through jobs.
Characteristics of a Safe Worker

• Is proud of what is being done and works to the best of his/her ability.
• Knows how machines operate and how machines will respond in given situations.
• Practices regular maintenance of machines and keeps them in good repair.
• Knows the limits of his/her capabilities and works within those limits.
• Recognizes hazards.
Personal Protective Equipment

• PPE should always be worn when needed to prevent or reduce personal injury if an accident occurs or environmental hazards exist.
• When needed for certain jobs, protection should be provided for the:
  Head - Bump caps
  Lungs - Dust mask, chemical cartridge, gas mask
  Hands - Gloves
  Eyes - Safety glasses/goggles
  Feet - hard-toed shoes, puncture and slip-proof soles
  Ears – Protection to reduce noises to 85 decibels or less
Use of Time

• It is important to complete jobs on time without hurrying.

• A worker needs:
  - time to think
  - time to react
  - time to eliminate hazards

• Workers also need time to take a break from work in order to be efficient and safe. This helps them remain alert, increase the amount of work completed, and reduce accidents.
A Safe Tractor

• A safe machine is:
  - Properly serviced
  - Properly repaired, and
  - Properly equipped
Fire Extinguishers for Flammable Fuels

- Flammable liquids are involved in tractor fires (Class B fires).
- They can be controlled by foam, carbon dioxide, or dry chemical extinguishers.
- Tractor owners should have a type B fire extinguisher on every tractor and self-propelled machine. Every operator should know how to use them.
- Never use water on a Class B fire.
First-Aid Kit

• A suitable first-aid kit should be stored in a dust-proof container and mounted on every tractor.

• Always try to mount the first-aid kit so that it can be reached when standing on the ground.
Mounted Implement Safety
Mounted Implement Safety

- All mounted implements should be properly maintained and operated.
- Both integral and semi-mounted machines should be checked regularly for safety hazards.
- All mounted implements should be checked for loose link pins and cracked or broken brackets which could cause machine failure.
Tractor Stability

- The safe operator must always be concerned about keeping the tractor in a stable position, whether working in a field or operating on a highway.

- The most stable position is when the tractor is operating with its center of gravity at the lowest position above the ground.

- The operator should:
  - have the wheel spacing set as wide as practical for the work being done
  - use front-end and rear wheel weights to prevent the front end from raising without causing unnecessary slippage.
Tractor Stability

• Dual wheels contribute significantly to the maintenance of stability of a tractor on sloping land.

• Several factors contribute to loss of stability:
  - traveling along the highway with the bucket of the power loader raised too high.
  - mounting large liquid fertilizer or chemical sprayer tanks either beside the front wheels or behind the rear wheels.
  - use of implements that tend to raise the center of gravity unless balanced by wheel weights, tire ballast, or front-end weights.
Base of Stability

Fig. 5-6a. Diagram showing the base of stability for tricycle (cultivar-type) and utility, 4-wheel agricultural tractors.
Tractor Stability

• When a tractor is in operation, additional forces besides gravity contribute to the tendency to overturn:

  1. Centrifugal force
  2. Rear axel torque
  3. Leverage
Tractor Stability

• Overturn
  – When a tractor tips, the center of gravity moves toward the stability base line. When it moves across the base line, the tractor will overturn, regardless of whether the center is to the rear, side or front of the tractor.

• Always remember the reaction time in overturns is short.
Overtum Factors

Fig. 5-7. Left—Reaction time in backward tip is short.
Right—Side tips are aggravated by dynamic forces acting on a tractor in a turn.
Tractor Stability

- Other precautions necessary for safe operation:
  - avoid sharp, fast turns on sloping land.
  - when operating on a highway and the tractor accidentally slips off the road grade, guide the tractor into the ditch rather than attempting to turn back onto the road in order to avoid a side tip.
  - avoid attempting to start up a steep slope with a tractor under load.
  - do not try to drive forward out of a ditch or up a very steep slope. Instead, attempt to back out, or up.
  - avoid hitting obstructions with the rear wheel when operating at 10-20 mph.
Stability baseline in overturn

Fig. 5-6b. When a tractor tips, the center of gravity moves toward the stability base line. When it moves across the base line, the tractor will overturn, regardless of whether the center is to the rear, side, or front of the tractor.
Fig. 5-8. Location of the center of gravity (center of weight) of a farm tractor.
Roll-Over Protection Structures

- ROPS are designed to be used with a safety belt to protect tractor operators in case of accidental overturn.
- ROPS provide a “critical zone” of protection for the operator.
- There are two types of ROPS for use on agricultural tractors:
  1. two-post
  2. four-post
- Overhead protection may be provided by structure or a safety cab
Roll-Over Protection Structures

- The ROP structure should provide a clear line of vision in all directions for the tractor operator.
- A suitable ROPS is designed to withstand forces from a 180 degree overturn or the total weight of the tractor.
- Some commercially produced cabs do not meet ROPS standards.
- After a rollover, the protective frame or cab must be replaced in its entirety.
- A homemade ROPS may provide a false sense of security for the operator.
A Safe Environment

• A tractor operator must be able to cope with man-made and naturally occurring events in his/her environment.

• A person can control some hazards and should learn to avoid those which he can’t control.
Manmade Hazards

- Farms have a surprising number of hazards which have been tolerated through the years.
  - Poor housekeeping (junk, debris, etc.)
  - Restricted travel ways (lanes, alley, gates, doors)
  - Excessive speed
  - Overloaded equipment or tractors
  - Poor ventilation in buildings
  - Faulty equipment
  - Poor support of raised equipment
  - Improper tool use
Manmade Hazards

- Improper machine use
- Servicing or adjusting a machine in motion
- Improper shielding of moving parts
- Incorrect hitching of loads to tractors
- Disregard for precautions of chemical use
- Allowing extra riders or small children in the work area
- Improper fuel storage and handling
- Adding unauthorized equipment or gadgets
Common Hazards

There are many hazards related to machinery stability and specifically to overturns.

**Situations which could cause a tractor to overturn:**
- Front end is higher than back end
- Front end is lower than back end
- Tractor is operating perpendicular to the slope on a steep incline
- Rear (drive) wheels are immobilized
- Mounted load is carried too high
- Load shifts on loader
- Weight of mounted tool shifts the center of tractor weight
Common Hazards

Situations which could cause a tractor to overturn:

(continued from previous slide)

- Excessive speed
- Tractor wheels are adjusted too narrow for job
- Ballast is not correct
- Hitch is not correct height
- Load is hitched to tractor at other than correct drawbar location
- Clutch is engaged too quickly
- Brakes are not applied evenly
- Equipment fails and load shifts
Hazardous Occupation Training

Unit Six:
Tractor Hitches, PTO and Hydraulics
Unit Overview

• This unit will emphasize the use of hitches, Power Take Off (PTO), and hydraulic power application systems.

• Tractors are designed to tow farm implements using a 2 or 3-point hitch, or directly from the tractor drawbar.

• Power is transferred to implements through a PTO or a hydraulic system.
The Drawbar

• Tractor drawbars are designed to permit maximum pull of towed loads in a safe manner.

• The stationary, or fixed drawbar of most tractors is extendable backward or forward.

• Swinging drawbars swing in the direction of turn when a tractor is maneuvered, and may be locked into place.
The Drawbar

- When the 3-point hitch is to be used, the drawbar may be moved forward to allow more clearance for mounted implements.
- The drawbar should be positioned so that the PTO shaft is as straight as possible.
- All implements have a small sign on or near the PTO shielding, indicating the operating speed of the PTO.
The Drawbar

- Some tractors have hydraulic control of drawbar height. These hitches should be locked in the correct position when pulling heavy loads.
- Drawbars may be rigid or allowed to swing freely from the front pivot pin.
- A swinging drawbar is attached by a hinge pin in front of the rear wheels near the center of pull of the tractor.
Drawbars

• Swinging drawbars should always be secured when pulling implements on roads or for PTO operation.

• Implements should always be pulled from the tractor drawbar or mounted and pulled from the tractor 2-point or the 3-point hitch, if so equipped.

• A load to be pulled should never be attached at any other point on a tractor.
Drawbar

- Raising the drawbar excessively to increase traction results in increasing the possibility of an overturn to the rear.
- All implements are pulled with the least amount of power when pulled straight ahead.
- Hitch points of a tractor and implement should be adjusted so they are in the line of pull.
- The line of pull extends from a tractor’s center of pull to the center of resistance of the implement.
Hitch Points

Draw Bar
Drawbar

• When hitching to a towed implement, a tractor should be backed into correct position.
• Accidents frequently occur as one worker hitches implements to a tractor being driven by someone else, often caused by:
  • Improper or lack of communication
  • Poor vision capabilities
  • Lack of attention
• Standard hand signals have been developed to avoid accidents when a tractor is backed into position.
Hand Signals

<table>
<thead>
<tr>
<th>HAND SIGNALS</th>
<th>SLOW IT DOWN - DECREASE SPEED</th>
<th>THIS FAR TO GO</th>
<th>MOVE OUT - TAKE OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAISE EQUIPMENT</td>
<td>Move toward me - follow me</td>
<td>STOP</td>
<td>STOP THE ENGINE</td>
</tr>
<tr>
<td>START THE ENGINE</td>
<td>Come to me</td>
<td>Speed it up - increase speed</td>
<td>Lower equipment</td>
</tr>
</tbody>
</table>
Drawbar

• Perhaps the safest way to team up when hitching machinery to a tractor drawbar is to back the tractor to the implement and shift the tractor to neutral before allowing a helper to try to attach the implement to the drawbar.

• A helper should never have hands or fingers in or near a drawbar hole or implement hitch hole in such a way as to risk injury.
Drawbar

- When the drawbar pin is in place, it should always be secured by a locking device.

- **Caution:** If you plan to drive on a highway be sure to use safety chains, they are required.
Three-Point Hitches

• A 3-point hitch consist of two lower draft links and a center upper link.
• Load control results in transfer of implement weight and tractor front end weight to rear driving wheels for improved traction.
• Mounted implements are leveled laterally by adjusting the length of lift links.
Three-Point Hitches

• The adjustable top link of the 3-point hitch provides for front-to-rear, or *implement pitch* adjustment.

• Most hitches are equipped with sway blocks that are used to restrict side motion of 3-point hitch mounted implements.

• Some tractors are equipped with draft link extensions for easier implement attachments.
Three-Point Hitch
Quick-Attaching Couplers

• Quick-Attaching Couplers provide fast connection and release of implements.

• Be sure the latch locks over the implement hitch pin.

• When in use, attachment pins must be secured by a locking device.
Power Take Off Drives

• PTO types are:
  1. Continuous Running - operates when the master clutch is engaged
  2. Independent - power for the transmission and PTO is transmitted through separate clutches
  3. Transmission-Driven - power to operate the transmission and PTO is transmitted through the master clutch.
Power Take Off Drives

- Shields should always be kept in place when a machine is operating.
- Accidents occur due to incorrect shielding of moving parts.
- Machines should be stopped for lubrication and adjustment.
Hydraulics

High-Pressure Hydraulic Fluid
Hydraulics

- The hydraulic system provides power for steering, brakes, lifting and powering equipment.
- Some systems are independent while others provide power for several operations.
Remote Hydraulic Cylinders

- Hydraulic cylinders may be single-acting or double-acting.
- Single-acting- have one hydraulic line -may have a *breather* which allows air to leave or enter the cylinder
- Double-acting- have two hoses
Remote Hydraulic Cylinders

- Always secure cylinder mounting pins with locking devices.
- Use the flow adjustment to control the amount of oil in the system and the movement of the cylinder pins.
Remote Hydraulic Motors

• Remote hydraulic motors are driven by the flow of oil from the tractor hydraulic pump.
• Two oil lines are required: one high pressure, the other low pressure (return).
• Oil lines can be easily coupled or uncoupled.
Hydraulics Safety

• Machine stoppage and personal injury can be caused if secure cylinder mounting pins are not in place.

• Failure of the hydraulic system and accidental movement of control valves can be prevented if equipment is properly equipped with transport locks.
Hazardous Occupation Training

Unit Seven:
Tractor Safety on the Road
Unit Overview

- Tractors are not designed for highway use.

- This unit will explore highway regulations and safe highway operation.
Highway Travel
Tractors Are Not Designed For Highway Use

- The road speed of a tractor is much slower than that of automobiles and trucks.
- Approaching traffic cannot be heard, so tractor operators must rely solely on vision to warn of approaching traffic.
- Lack of stability combined with a high degree of maneuverability at highway speeds means that the tractor operator must be constantly alert.
Traffic + Tractors = Accidents and Injuries

- The speed differential and lack of safety protection can cause tractor operators to be thrown from tractor seats in collisions.

- Motor vehicle drivers who have been involved in accidents with tractors have reported that they failed to identify the tractor or were not aware of its presence until it was too late.
Traffic Accident Statistics

• On dry pavement a car needs 165 feet of stopping distance, and 61 feet of reaction distance.

• On wet pavement a car needs 250 feet of stopping distance, and 61 feet of reaction distance.

• It takes an automobile driver 4.75 seconds to stop, and 307 feet. During that time, the tractor will only travel 70 feet. If the driver of the vehicle does not see the tractor until he/she is within 237 feet, they will not be able to stop in time.
Traffic + Tractors = Accidents and Injuries

• Safety of motor vehicles, including tractors, begins with courtesy.
  - Avoid busy highways, even if extra distance is involved.
  - Drive on the shoulder of paved highways, if possible.
  - Do not drive with the tractor over part of the shoulder and part of the paved lane.
  - Do not force a line of cars or trucks to stay behind a slow moving tractor of machinery. If there is a suitable shoulder, pull over and let them pass.
  - Move equipment in daylight, when traffic is lightest.
  - Stay off roads after dark unless necessary.
Traffic + Tractors = Accidents and Injuries

- Do not allow extra riders. Do not allow inexperienced operators to drive on public roads.
- Follow the rules of the road when driving on highways.
- Keep tractors and machinery in good condition with hitching devices properly secured and with proper safety warning devices in place.
- Keep brake pedals correctly latched together and allow plenty of distance for stopping.
- Observe road travel precautions listed in the operator’s manual.
State Traffic Regulations and ASAE/SAE Standards

• State laws regulate tractor and machinery use on public highways.

• The American Society of Agricultural Engineers (ASAE) and the Society of Automotive Engineers (SAE) develop, adopt, publish, distribute, and maintain voluntary standards for the ag industry and consumers.
Typical Definitions

- **Vehicle** refers to any device which transports persons or property on a highway. It does not include devices moved by human power or used exclusively upon stationary rails or tracks.

- **Motor Vehicle** is every vehicle which is self propelled.

- **Street or Highway** means the entire width between property lines which is open to the use of the public for vehicular traffic.

- **Operator** means every person, other than a chauffeur, who is in physical control of a motor vehicle upon a highway.
Typical Definitions

**Implement of Husbandry** means every vehicle designed for agricultural purposes and exclusively used by the owner in the conduct of his agricultural operations.

Also includes:
- portable livestock loading chutes, provided that they are not used on the highway for the purpose of transporting property.
- any vehicle principally designed for agricultural purposes which is moved during daylight hours.
SMV Emblem

- When driving on a highway at a speed less than 25 mph, every farm tractor, or tractor with towed equipment or self-propelled implement of husbandry must be identified with an approved reflective device, commonly known as a Slow Moving Vehicle Emblem. If operating above 25 mph, the reflective device should be removed or hidden from view.
SMV Emblem
SMV Emblem

Description: The symbol is a fluorescent yellow-orange triangle with a dark red reflective border.

Mounting: The emblem should be mounted at a central spot on the rear of the vehicle point up in a plane perpendicular to the direction of travel, plus or minus ten degrees. It should be unobscured and two to six feet above the ground.

- The emblem cannot replace tail lamps, reflectors, flashing lights or warning flags, and is not to be used as a clearance marker for wide equipment.
Flashing Amber Lights

• Any tractor with towed equipment, or self propelled implement of husbandry when operated on a primary or secondary road, or highway, at a speed less than 25 mph, shall be equipped with and display an amber flashing light visible from the rear at any time from sunset to sunrise.

• At least two amber flashing warning lights in compliance with SAE J974 shall be as widely spaced laterally as is practicable from vehicle centerline, and as far to the rear as is practicable visible from both front and rear, and symmetrically mounted at least 42 inches high as measured to the lamp axis. Lamps shall flash in unison 60-85 times/minute.
Maximum Allowable Length

Kansas law provides that no combination of vehicles coupled together shall exceed a total length of 65 feet. (K.S.A. 8-1904 (c)).

Headlight Requirements

All vehicles operating on roadways are required to have white light headlamps visible from a distance of 400 feet.
Rearview Mirror

- Ag equipment equipped with a cab should have at least one rearview mirror.
- This is not required by law.
Reflectors

- At least two red reflectors visible to the rear shall be mounted to indicate as nearly as possible, the extreme left and right projections.

- At least one amber reflector visible to the front shall be positioned to indicate the extreme left projection of the implement or equipment.

NOTE: Red reflectors do not take the place of tail lights!
Rules of the Road

- A vehicle shall be driven on the right half of the roadway on all roadways of sufficient width, except as follows:
  - when an obstruction exists, or
  - when overcoming and passing a vehicle, or making a left turn at an intersection, alley, private road, or driveway.

- Remember, rules that apply to vehicles, also apply to farm vehicles and implements.
Attaching Points

• The implement must be attached to the towing vehicle at a point designed for attachment.

• If there is an auxiliary attachment system available it must be attached.
Road Speed

- Vehicles should not be driven at such a slow speed that they block normal or reasonable flow of traffic, unless it is necessary for safety, or is in compliance with the law.

- Law enforcement has the right to enforce this.
Spilling Materials on Highway

• Before driving on a highway, loads must be secured so that they do not drop, sift, or leak.

• Sand may be dropped for traction, and water or other such substances may be sprinkled in order to clean the highway.
Turn Signals

- Turns should be made in a safe manner after giving an appropriate signal to anyone who may be affected by the movement (i.e., Pedestrians, other motorists, etc.)

- Signals must be made continuously for at least 100 feet in advance if the speed limit is 45mph, and 300 feet in advance if the speed limit is above 45 mph.
Turn Signals

Signal Devices
- white, yellow, or amber lamps should be visible on the front of the vehicle
- red, yellow, or amber lights should be visible on the back of the tractor.

Hand or Arm Signals
- Left Turn- Hand and arm extended horizontally.
- Right Turn- Hand and arm extended upward.
- Stop or Speed Decrease- hand and arm extended downward.
Yielding Right-of-Way

• The driver of a vehicle must stop before crossing a sidewalk.
• Oncoming traffic on the street or highway onto which a vehicle is turning has the right-of-way.
Wide Equipment

Wide implements with raised wings or gangs have a high center of gravity and tend to be unstable during transport. When traveling on a highway with wings or gangs raised or folded, secure and lock them in an upright position.
Remember

Rules of the road that apply to passenger vehicles, also apply to tractors and other self-propelled agricultural vehicles being driven on roadways.