**Introduction**

In 1892, a man named John Froelich developed a successful tractor to power a grain thresher. By 1918, a PTO shaft was used to power equipment drawn behind the tractor. Before these time periods, farm work was done by hand, by horse, or by huge stationary steam engines.

You will be operating a tractor designed to accomplish greater amounts of work than ever thought possible in the early 1900s. The speed, power, flexibility, adaptability, and handling ease of modern tractors is what makes them valuable and indispensable for modern day farming. This task sheet describes agricultural tractors, with an emphasis on what tractors are designed to do.

**Tractor Types/Sizes**

Tractors have both narrow and wide front ends, use both wheels and tracks, and can be two-wheel drive, four-wheel drive, or articulated. A narrow front end ("tricycle") will be an older tractor, as they have not been produced this way since the 1960s. Articulated tractors are usually very large (at least 250 hp) and are usually operated only by very experienced farmers. Young and inexperienced tractor drivers usually operate tractors ranging from lawn and garden-size (~ 20 hp) to large two- and four-wheeled drive tractors (around 150 hp). Many older and smaller tractors will not have a rollover protective structure (ROPS), while most new tractors will have a ROPS and seat belt.

![Tractor Types/Sizes Image](image)

**Tractor Purposes**

Farm tractors were designed for four primary purposes:
1. Load Mover (High Lift)
2. Remote Power Source (PTO)
3. Implement Carrier (3 Pt. Hitch)
4. Transport Unit (Drawbar Unit)

Understanding that ordinary farm tractors are not recreational vehicles is very important. Farm tractors are not to be used for fun, play, or for mud-bogging or racing, unless specifically modified for that purpose. You must use the tractor only for work purposes. Other uses can increase the chance of injury to you or others, or to the tractor, implements, and other property.

**Learning Goals**

- To describe how tractors vary in size, shape and age
- To describe how tractors are designed for work

**Related Task Sheet:**
Tractor Hazards 4.2

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Cooperation provided by The Ohio State University and National Safety Council.
Tractor Characteristics

Here are some design elements of a tractor:

- Rear wheels adjustable for width
- “Turn-on-a-dime” steering
- High-powered engine with many gear ranges for relatively low speeds
- Great clearance beneath the tractor
- More weight over traction wheels
- Individual brakes for each rear wheel
- Adjustable drawbar hitch
- Power controls to increase pulling power
- Potential to add or subtract weights for ballast
- Hydraulic system for added power source
- PTO shaft to transfer power to towed machine
- Differential lock for added traction
- Adapted to carry or pull equipment
- Fitted with a Rollover Protective Structure (ROPS) or a Falling Object Protective Structure (FOPS)

Safety Activities

1. Take photos or video camera footage of tractors being used for the four intended purposes. Make a display for your club or classroom or employee lunch room where you work.
2. Collect newspaper and magazine articles on farm tractor safety. Share the main points of the articles with classmates.
3. Locate a farmer in your community who has been injured with a tractor or farm machine and see if they will discuss the incident with you.
4. Use the Internet to find information on tractor safety. Find articles that describe people injured by a tractor because they were not using it for its designed purpose.
5. Do a survey of tractors at area farms or at an equipment dealer’s lot and record how many tractors: a) have a tricycle or wide front end; b) have a ROPS with seat belt; c) have wheels or a track; if it has wheels, is it a two-wheel, four-wheel, or an articulated tractor? Also record the engine horsepower and tractor age.

References

Introduction
Tractors are a primary source of work-related injury on farms, however, not all of the injuries happen while the tractor is being used for work.

Nationally, nearly one-third of all farm work fatalities are tractor-related. Injuries occur for a variety of reasons and in a number of different ways. This task sheet will describe types of tractor hazards and the nature and severity of injuries associated with using farm tractors.

Hazard Groups
There are several hazards associated with tractor operation. Tractor hazards are grouped into the following four categories:

1. Overturns
2. Runovers
3. Power Take-Off Entanglements
4. Older Tractors

Each of these is discussed briefly in this task sheet. Other task sheets will cover some of these topics in more detail.

Overturn
Tractor overturns is one major hazard group and accounts for the most farm-work fatalities. Approximately 50% of tractor fatalities come from tractors turning over either sideways or backward. There are dozens of examples of tractor turnover situations. Most are preventable if operators follow good safe tractor operation practices. Some common examples of tractor overturns include:

- Turning or driving too close to the edge of a bank or ditch
- Driving too fast on rough roads and lanes and running or bouncing off the road or lane
- Hitching somewhere other than the drawbar when pulling or towing objects
- Driving a tractor straight up a slope that is too steep
- Turning a tractor sharply with a front-end loader raised high

A rollover protective structure (ROPS), a structural steel cage designed to surround the operator—particularly one that is built into an enclosed cab—can protect the operator from being killed when a tractor overturns. This is especially true if the operator has fastened the seat belt. Remember, though, that a ROPS can protect you from injury but cannot keep the tractor from overturning in the first place. This explains the importance of operating a tractor safely even if the tractor has a ROPS.
TRACTOR HAZARDS

Another runover incident involves the tractor operator either falling off the tractor as it is operating or being knocked out of the seat by a low-hanging tree branch or other obstacle. This most often happens on older tractors that do not have a ROPS and have an older seat that has no arm or back rest (often called pan seats). A person can more easily lose his or her balance and be knocked off or bounced out of a pan seat. An operator can also be run over while trying to mount or dismount a moving tractor. This type of incident can occur when the operator leaves the tractor seat without first shutting off the tractor and setting the brake or placing it in PARK, and the tractor moves unexpectedly. This may happen during the hitching and unhitching of equipment. Shut off the tractor before dismounting for any reason.

The third type of runover incident involves a person who is on the ground near a tractor. This may include the tractor operator who tries to start a tractor from the ground while the tractor is in gear. This usually involves an older tractor that can be started in gear or a newer tractor when an operator attempts to bypass a newer tractor’s safe start-up design. Bypass starting hazards are discussed in more detail in Task Sheet 4.8.

Small children, often under the age of 5, are sometimes run over by a tractor (and equipment) as it is moved around the farmstead. Often, the tractor operator is unaware that the child is near the tractor. A loud noise, such as the start up of a tractor, is often attractive to a young child, and he or she may run toward it as it starts or begins to move.

Runover

There are three basic types of tractor runover incidents. One is when a passenger (extra rider) on the tractor falls off. Extra rider incidents happen because there is only one safe place for a person to be on a tractor, and that is in the operator’s seat. Some new, larger tractors have an extra seat for temporary instructional purposes, but only if the tractor has an enclosed ROPS cab. The tractors that most young and inexperienced operators drive will have only one seat—the operator’s seat. Standing on the tractor drawbar, axle housing, side links of three-point hitches, rear-wheel fenders, and the area immediately around the operator’s seat are common locations unsafely occupied by extra riders. Extra riders rarely keep a tight handgrip on the tractor. Thus they can be easily thrown from the tractor.

Follow this rule! One seat on a tractor means one rider only– the operator. Keep all others away.

Figure 4.2.b. Tractor runovers have claimed many lives. Extra riders can slip from the tractor and be crushed before the operator can stop. Say no to your friends who want to hitch a ride.
Power Take-Off (PTO) Entanglement

The tractor power take-off (PTO) stub is another major hazard. The PTO stub transfers power from the tractor to PTO-powered machinery. The PTO stub normally turns between 540 and 1,000 revolutions per minute. At this rate, the stub is turning from 9 to 17 times per second. This is much faster than a human being can react if he or she is caught and pulled into or around the PTO stub or shaft. A person can have an arm or leg wrapped around a PTO stub shaft before they know they are in danger. A PTO master shield protects a person from the PTO stub. Some tractors have PTO stub guards that fasten to the PTO stub. All tractors should have a PTO master shield to protect the tractor operator and helpers.

Older Tractors

Older tractors should always be included when talking about tractor hazards. Many farm tractors still used for work may be 30 to 40 years old or older. These older tractors are often less safe to operate because they do not have modern safety features, and because some parts of the older tractor may not have been maintained in good working condition. A list of reasons why older tractors may be less safe to operate includes:

- Lack of ROPS and seat belt
- A seat without arm and back rests (pan seat)
- Seat does not adjust easily or at all
- Absence of a safety start system
- No bypass starting protection
- Rear brakes and brake pedals do not operate properly
- Front wheels do not turn as quickly as the steering wheel turns
- Tractor has no warning flashers or the flashers do not work
- PTO master shield is missing or does not offer adequate protection

Young and inexperienced workers may be given older tractors to operate in many cases. The older tractor is best suited for the types of jobs a young or inexperienced operator is hired to do. These tractors are best suited for raking hay, hauling wagons, and mowing fields or pastures. Young and inexperienced operators should be given newer tractors to operate when possible.

Figure 4.2.c. Power take-off stub and PTO shaft must be properly guarded to prevent entanglements. Locate the PTO area on every tractor you operate. Check whether or not that area is safely guarded.

PTO shafts kill or cripple countless victims. Some of these victims most likely live in your community.

Figure 4.2.d. Older tractors are often assigned to younger drivers to do less heavy chores. Raking hay, pulling wagons, and hauling feed to livestock does not require the most powerful tractor. Older tractors may have safety deficiencies due to age and missing safety features. This tractor does not have a ROPS or seat belt.
Safety Activities

1. Match the tractor hazard with the safety situation. (Some choices may be used more than once.)

   ___A. Overturn 1. High lift carried in raised position in transit
   ___B. Runover 2. Pet dog was tied to wagon
   ___C. PTO entanglement 3. Bypass starting
   ___D. Older tractor deficiency 4. PTO stub shaft missing
   ___ 5. Driving too close to ditch embankment
   ___ 6. A friend is helping to drop the hitch pin

2. Write a letter to your best friend explaining why you won’t let him/her ride on the fender of the tractor to go to the field to help you make hay.

3. Explain how people are run over when they choose to bypass the ignition switch to start the tractor engine.

4. Learn more about the hazards of bypass starting a tractor engine by contacting a tractor salesperson or mechanic.

References

1. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

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Credits


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Introduction

Farm families often provide much of the labor for the operation of the farm. Farm work may start early in a child’s life as a means of learning responsibility and contributing to the productivity of the farm. Tractor operation can come at an early age for many farm youth because tractors are a large part of how farm work is done. Tractor work can range from the simple to the complex.

This task sheet presents a Tractor Operation Chart as a guide to appropriate tractor work for young tractor operators.

Youth and Tractors

Examples of common jobs performed by youth operating tractors include:

- Mowing pastures, fields, yards and lanes
- Raking and baling hay and straw
- Towing hay and grain wagons between fields and storage
- Picking rocks and other obstacles from fields using a front-end loader
- Scraping manure from barn floors with a tractor-mounted blade
- Using the tractor to power augers and elevators during unloading operations
- Pulling old fence posts and tree stumps out of the ground with log chains

Several hazards can arise during the course of these and other jobs that involve tractor use. Many times the larger the tractor, the more complex the operation of that tractor becomes. Additionally, large and complex equipment may be attached to and powered by the tractor.

Young tractor operators do not usually have the experience needed to skillfully and safely operate large and complex combinations of tractors and machinery.

North American Guidelines for Children's Agricultural Tasks (NAGCAT) Tractor Operation Chart

Farm injury prevention specialists from the U.S. and Canada have developed consensus opinion that a guide to tractor operations by age groups is a way of matching youthful capabilities with tractor operation jobs. The NAGCAT chart is presented on the reverse side of this task sheet.

You can use this chart:

- To see if you have been doing jobs with the size tractor that matches your age
- To guide an employer in determining what they can reasonably expect a person of your age to do with various types and sizes of tractors

It is common for youths to be over confident in their ability to react safely to new or unexpected hazard situations with tractors.
### NAGCAT TRACTOR OPERATION CHART

Refer to the specific guideline for recommended supervision.

<table>
<thead>
<tr>
<th>Increased Complexity of Job</th>
<th>Size of Tractor</th>
<th>Lawan &amp; Garden (less than 20hp)</th>
<th>Small (20hp to 70hp)</th>
<th>Medium/Large (more than 70hp)</th>
<th>Articulated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating a Farm Tractor (no equipment attached)</td>
<td>12-13 years</td>
<td>12-13 years</td>
<td>14-15 years</td>
<td>16+ years</td>
<td></td>
</tr>
<tr>
<td>Trained Implement Fieldwork</td>
<td>12-13 years</td>
<td>12-13 years</td>
<td>14-15 years</td>
<td>16+ years</td>
<td></td>
</tr>
<tr>
<td>3-Point Implements Fieldwork</td>
<td>12-13 years</td>
<td>14-15 years</td>
<td>14-15 years</td>
<td>16+ years</td>
<td></td>
</tr>
<tr>
<td>Remote Hydraulics Fieldwork</td>
<td>14-15 years</td>
<td>14-15 years</td>
<td>14-15 years</td>
<td>16+ years</td>
<td></td>
</tr>
<tr>
<td>PTO-Powered Implements Fieldwork</td>
<td>14-15 years</td>
<td>14-15 years</td>
<td>14-15 years</td>
<td>16+ years</td>
<td></td>
</tr>
<tr>
<td>Tractor-Mounted Front-End Loader</td>
<td>14-15 years</td>
<td>16+ years</td>
<td>16+ years</td>
<td>16+ years</td>
<td></td>
</tr>
<tr>
<td>Working in an Orchard</td>
<td>14-15 years</td>
<td>16+ years</td>
<td>16+ years</td>
<td>16+ years</td>
<td></td>
</tr>
<tr>
<td>Working Inside Buildings</td>
<td>14-15 years</td>
<td>16+ years</td>
<td>16+ years</td>
<td>16+ years</td>
<td></td>
</tr>
<tr>
<td>Driving on Public Roads*</td>
<td>N/A</td>
<td>16+ years</td>
<td>16+ years</td>
<td>16+ years</td>
<td></td>
</tr>
<tr>
<td>Pulling Oversized or Overweight Load</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hitching Tractor to Move Stuck or Immovable Objects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simultaneous Use of Multiple Vehicles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional Persons Working on a Trailing Implement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pesticide or Anhydrous Ammonia Application*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Follow State/Province Laws

---

**Due to increased hazard and complexity, these jobs should not be assigned to children.**

---

### References
1. www.nagcat.org/Click on Guidelines/Select T1 Tractor Operation Chart, February 2013.
2. Cooperative Extension Service of your State’s Land Grant University.

---

### Contact Information

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Introduction
Instruments, or gauges, on the tractor control panel tell the driver about the operating conditions within and around the tractor. All tractor drivers should know what instruments are available to indicate that the tractor is operating properly.

When tractor systems are not working properly, continued operation may cause costly repairs and possible injury.

This task sheet will identify and explain instruments and gauges commonly found on tractors. Using tractor Owners’ Manuals and obtaining the help of an experienced tractor operator will help you to learn the information in this task sheet.

Instruments and Gauges
Instruments can be warning lights, analog gauges, computer digital displays, buzzers, or standard gauges.

It is important for the beginning operator to develop the habit of regularly checking the instrument panel. Check the gauges:

- At start up
- At regular intervals during operation
- When changes occur in the normal sounds of operation

Abnormal gauge readings, plus changes in operating sounds, indicate that there is a problem. You should immediately stop the engine in a safe place, and seek help from the owner or an experienced operator.

Instruments you will use may include the following (there may be many more):

- Engine speed indicator (Tachometer)
- Oil Pressure Indicator
- Engine Temperature Indicator
- Fuel Gauge
- Air Filter Condition Indicator
- Transmission Temperature Indicator
- Hydraulic System Oil Level Indicator
- Hour meter
- Charge Indicator

Each of these instruments is important to the safe tractor operation as well as avoiding damage to the tractor. Other gauges may be found on the tractor you operate. Be sure to understand the meaning of all instruments, gauges and warnings before operating a tractor.

Learn which warning lights, gauges, and digital displays are on your tractor.

Figure 4.4.a. The modern tractor instrument panel may appear as complex as the cockpit controls of a jet airliner. The operator must know what each instrument or gauge is telling him/her about operating conditions.

Learning Goals
- To understand the instruments and gauges used to monitor the tractor’s operation and performance
- To be able to make operating decisions based upon the information and gauges provide to the operator

Related Task Sheets:
- Preventative Maintenance and Pre-operation Checks 4.6
- Fuel, Oil, and Coolant Levels 4.6.1
- Lead Acid Batteries 4.6.2
Tachometer (Engine Speed Indicator)

Engine speed must match the work being done to be safe and to avoid engine and driveline damage.

Tachometers show revolutions per minute (RPM). Engine RPM must be matched to the job being done. Incorrect RPM can lead to:
- Engine damage
- Driveline and PTO damage
- Hazardous situations

Low engine speed while in a high-gear and beginning to pull a heavy load can stall the engine.

High-engine speed with a low gear while attached to a heavy load can also create enough torque (rotational force) to tip the tractor backward. Accelerating quickly with a heavy load going up a slope can cause the tractor to rear up and tip backward.

Engine RPMs must also match PTO-driven machine requirements. Speed up the engine before engaging the PTO to operate an implement. Low-engine speed could stall the tractor. High-engine speed could shear off the implements safety shear pin if the pin was already under load. (Example: a plugged hay baler).

Follow the manufacturer’s recommendations for engine speed selection.
Charge Indicator and Oil Pressure Indicator

The charge indicator, or ammeter, shows whether the alternator or generator is charging the battery properly. Each time the tractor is started, the battery is discharged. During operation, the battery is recharged. Gauges will indicate + or - charge. Lights will show red at low charge. If the battery is discharging, find out the problem. The engine may not start the next time due to a low battery.

Oil Pressure Indicator (Oil Light or Gauge)

This indicator is important to the long life of an engine. If oil pressure falls because of an oil leak or low oil levels, the light or gauge shows you must stop the engine immediately. Never operate the engine with low oil pressure or oil levels. Oil lubricates the internal parts of the engine and prevents major repair expense.

Engine Temperature and Other Gauges

Engine Temperature Indicator

The engine must be cooled to prevent damage. Water-cooled engines can overheat if coolant is lost, radiators become clogged with debris, or the radiator leaks.

If the engine overheats, stop the engine, allow it to cool, then check for the problem. Never open the radiator cap while the engine is hot. Scalding from extremely hot water can result.

Fuel Gauge

Check the fuel gauge before leaving for the field. Running out of fuel is inconvenient. On some tractors, running out of fuel (diesel) means time-consuming bleeding of air from the fuel lines in order to be able to start the tractor again.

Other Gauges

Tractors may come equipped with instruments to monitor air filter conditions, transmission temperatures, hydraulic system oil levels, and of course hours of work (hour meter). Become familiar with all instruments before operating the tractor.
Safety Activities

Answer these questions

1. If you are operating the tractor in the field and the oil light comes on, what should you do?
   a. drive to the shop  
   b. stop and let the engine idle  
   c. shut down immediately  
   c. shut off the engine until it cools and then restart

2. What can happen if you remove a radiator cap from an overheated tractor’s coolant system?
   a. nothing  
   b. explosive pressure can hurt you  
   c. a fire may start  
   d. you can be scalded by hot steam

3. When pulling a heavy load of hay up a hill, which gear/RPM (engine speed) combination should you use?
   a. 5th gear/high RPM  
   b. lower gear with medium RPM  
   c. highest gear with lowest RPM

4. The letters RPM represent:
   a. ground speed measurement  
   b. oil pressure measurement  
   c. engine speed measurement

Activities:

1. Demonstrate to your teacher how many hours of use have been placed on the tractor by showing the hour-meter reading for that tractor.

2. Demonstrate to your teacher how to scroll through the various computer digital read-outs to show engine RPM, engine temperature, and hours of use information on that tractor.

References

1. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

2. Operator’s Manuals from various tractor manufacturers
**Learning Goals**

- To identify tractor controls by their color coding
- To identify what action will result when a control is moved in a particular direction

**Related Task Sheets:**
- Engine Stop Controls 4.5.1
- Ground Motion Controls 4.5.2
- Engagement Controls 4.5.3
- Positioning and Adjusting Controls 4.5.4

---

**Introduction**

To help tractor drivers identify controls and use them correctly, many tractor manufacturers use the same color code for specific tractor controls. The direction that you move controls have also become standardized.

Many older tractors do not have controls with uniform color coding. Sometimes those colors wear off or a control is replaced with a irregular color control knob. Moving a control that is not color-coded may not result in the expected operation.

This task sheet will identify the four main groups of tractor controls, their colors, and their direction of movement. Each group of controls will be discussed in more detail in their own task sheet.

**Controls and Colors**

The American Society of Agricultural Engineers (ASAE) has published standards for tractor controls (standards are widely accepted rules set in place by experts). The four main groups of color-coded controls are discussed below.

*Commit this color code to memory.* You will use this information to operate a modern tractor.

- **Color Coding for Controls**
  - STOP ENGINE—**RED** color
  - GROUND MOTION—**ORANGE** color (engine speed, PARK-Lock, transmission)
  - POWER ENGAGEMENT—**YELLOW** color (engage PTO or remote power sources)
  - POSITIONING and ADJUSTING—**BLACK** color (choke the engine, turn lights on)

Remember that older tractors may not use these colors, or you may not be able to see them. If the tractor you need to use does not have color controls, take time to learn about the controls on that tractor.

Fig 4.5.a. Know where each control is located and what it controls. Color codes will help you learn the function of each control.
Moving Controls

As a general rule, controls will function in the following way:

- To engage a foot brake, push in. To set a hand brake, pull up.
- A foot clutch is disengaged when it is pushed in and engaged when let up.
- A hand-operated engine speed control (throttle) increases the engine speed if the throttle is moved upward or forward. A foot-operated throttle increases speed as it is pushed forward or downward by toe pressure.
- The direction the tractor travels is controlled by specific forward and reverse gears or by directional controls. If a hand-operated directional control is used, the tractor moves in the same direction as the control is moved.
- The engine stop control is by key and by mechanical push-pull control. A key is always turned counterclockwise to stop an engine. A push-pull lever is always pulled out to stop the engine.
- Controls that lift or lower attachments or implements are generally pushed forward, down, or away for lowering, and pulled back, up, or toward you for lifting.
- A PTO is usually engaged when pulled up or pushed forward.

Safety Activities

1. Matching color with function. (Place the letter of the correct color next to the control function.)
   
   
   __Engage PTO A. Red
   __Lift a High-Lift Bucket B. Orange
   __Throttle Up C. Yellow
   __Stop the Diesel Engine D. Black

2. Identify as many specific controls as you can on one or more tractors, and group them by control function.
3. What will happen if you pull an orange-colored control in order to stop the tractor engine?

References

1. American Society of Agricultural and Biological Engineers, ANSI/ASABE, EP443.1 Color Coding of Hand Controls, St. Joseph, MI.
2. Owners' Manuals for Specific Tractors.

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Introduction

“How do I stop the engine?” What is a routine operation on one tractor can be a little confusing on a different tractor.

For many years, tractor manufacturers have used the same color for certain controls to help drivers identify controls and use them correctly. This task sheet discusses the “Stop Engine” control.

The Color Red

Red is the color code for the single purpose of “Stop Engine” control. Whether it is a gasoline engine tractor, a diesel engine tractor, or an alternative fuel engine, the color red indicates a stop engine function.

Gasoline Engine—Red letters on key switch.

Diesel Engine—Red fuel shut-off switch (Remember, most diesel engines are shut off with the fuel shut-off switch, not by the ignition key.)

Some Rules for “Red”

Here are a few more points to remember for the red engine stop control. If a mechanical push-pull fuel switch is used, it must:

- Be within 6 inches of the key switch
- Be pulled to stop
- Be labeled “Pull to Stop Engine”
- Remain in the stop position without continued effort

Key switch controls turn counterclockwise to stop the engine.

Some newer diesel engines are also stopped simply by turning the key counterclockwise to the off position.

Learning Goals

- To identify tractor engine stop controls used on modern tractors by their color
- To identify the results when an engine stop control is moved in a particular direction

Other related sheets:

Tractor Controls 4.5
Pictorial Study

Figure 4.5.1.b. Diesel engines are often stopped by shutting off the fuel flow from the fuel pump.

Figure 4.5.1.c. Key switch on lower left of older tractor. Push-pull switches may be found also.

Figure 4.5.1.d. Quiz time. What if the red color is missing on older tractors?

A similar colored control on an older tractor may not have the same result as the control on a newer tractor.

Safety Activities

1. Compare the ignition switch and stop engine control methods of diesel and gasoline engine tractors by tracing the wiring of each.
2. Find the oldest tractor model you can in your community, and determine if color-coding would indicate how to stop the engine. Record the following information:

<table>
<thead>
<tr>
<th>Tractor Model</th>
<th>Approximate Age of Tractor</th>
<th>Color-Coded Stop Control Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

References

1. American Society of Agricultural and Biological Engineers, ANSI/ASABE, EP443.1 Color Coding of Hand Controls, St. Joseph, MI.
2. Owners’ Manuals for Specific Tractors.
Introduction

“How do I get this tractor to move?” “How do I stop this operation?” For many years, tractor manufacturers have used the same color for certain controls to help drivers identify and use them correctly. This task sheet discusses “Ground Motion” controls.

The Color Orange

Orange is the color code for tractor ground motion controls. Ground motion controls include:

- Engine Speed
- Transmission Controls
- Parking Brake or Park-Lock
- Independent Emergency Brakes
- Differential Lock

You can easily become confused if you are not familiar with the tractor. Do not hesitate to ask for a demonstration of the controls and job you will be doing.

Some Rules for “Orange”

Here are more important points to remember for orange ground motion controls.

- Engine speed controls are operated with the right hand and/or right foot.
- Transmission gearshift patterns must be clearly and permanently identified.
- Differential lock controls are engaged with a forward or downward motion.
- Brake locks may be a mechanical lock on the drive train versus a lock on the axle.

Learning Goals

- To identify tractor ground motion controls by the orange color coding
- To identify what action results when a ground motion control is moved in a particular direction

Other related sheets:
Tractor Controls 4.5
**Pictorial Study**

1. Ask the farmer/owner if you can inspect all the tractors on a farm. Note the orange color-coded controls. What does each control do? Make a comparison of how older model tractor controls are identified for ease of recognition compared with newer model tractors.

2. Identify as many ground motion controls as you can on several different tractors. Compare their locations and the direction in which they are moved.

**Safety Activities**

**References**

1. American Society of Agricultural and Biological Engineers, ANSI/ASABE, EP443.1 Color Coding of Hand Controls, St. Joseph, MI.
2. Owners’ Manuals for Specific Tractors.

**Contact Information**

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**Credits**

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Introduction

“How do I get this implement to run? How can I stop this machine? Where is the PTO control for this tractor?”

For many years, tractor manufacturers have used the same color for certain controls to help drivers identify and use them correctly. This task sheet discusses the “Power Engagement” control.

The Yellow Color

Yellow is the color code for the controls which engage mechanisms using the tractor as a remote power source. The same color coding is used for self-propelled machines. Here are a few of the power engagement-type controls:

- PTO
- Cutterheads
- Feed Rolls
- Elevators
- Winches
- Unloading Augers

You can easily become confused if you are unfamiliar with a tractor. A quick review of the Owner’s Manual will help identify controls and their function. Do not hesitate to ask for a demonstration of the job you will be doing.

Some Rules for “Yellow”

Here are a few more points to remember for yellow power-engagement controls. These controls can be knobs, toggle or rocker switches, levers, or pedals.

1. PTO controls are designed to move to the rear or downward to disengage the PTO.
2. Horizontal-mounted rocker switches use the right side to begin normal machine operation.
3. Vertical-mounted rocker switches use the upper side of the switch to begin normal machine operation.

Learning Goals

- To identify tractor power-engagement controls on modern tractors by their color coding
- To identify what action results when a power-engagement control is moved in a particular direction

Related Task Sheets:

Tractor Controls

4.5
**Pictorial Study**

Figure 4.5.3.b. Most control levers are right-side mounted.

Figure 4.5.3.d. Rocker arm switches may be used. If you find a control feature with which you are unfamiliar, ask for instructions before operating costly equipment.

Quiz time? What if the yellow color is missing on older tractors? How would you find the PTO control? Make a sketch here of an older PTO control.

A similar colored control on an older tractor may not produce the same result as the control on a newer tractor.

**Safety Activities**

1. Ask the farmer/owner if you can inspect all the tractors on the farm. Note the yellow color-coded controls. What does each control do? Make a comparison of how older model tractor controls are identified for ease of recognition when compared with newer model tractors.

2. Identify as many power-engagement controls as you can on several different tractors, and compare their locations and the directions in which they move.

**References**

1. American Society of Agricultural and Biological Engineers, ANSI/ASABE, EP443.1 Color Coding of Hand Controls, St. Joseph, MI.

2. Owners’ Manuals for Specific Tractors.


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Introduction

“Every control knob seems to be black in color except that red, orange, and yellow one. I want to lift the scraper blade to clean the free stall alley like the owner told me to do. Let’s see…which one of these levers will I use?”

For many years, tractor manufacturers have used the same color for certain controls to help drivers identify and use them correctly. This task sheet discusses “Positioning and Adjusting” controls.

The Black Color

Black is the color code for the many controls which position or adjust tractor work accessories. A few of the positioning/adjusting controls are:

- Remote hydraulic control
- Implement hitches
- Unloading components on self-propelled equipment
- Engine chokes and steering column position
- Lights, flashers, and signals
- Cab comforts (fans, radio, etc.)

You can easily become confused if you are unfamiliar with a tractor. Do not hesitate to ask for a demonstration of the controls to use for the job you will be doing.

Some Rules for “Black”

Here are a few more rules to help you use the black color coded controls. These controls can be knobs, toggle or rocker switches, levers, or pedals.

1. Lift controls operated from the tractor seat must be clearly identified and are found on the right side of the cab.
2. Front-end loader controls must be located on the right side of the operator.
3. Foot controls must be pushed forward to lower equipment.

Learning Goals

- To identify tractor positioning and adjusting controls on modern tractors by their color coding
- To identify what action will result when a position/adjustment control is moved in a particular direction

Related Task Sheets:
- Tractor Controls 4.5
Pictorial Study

1. Ask a farmer/owner if you can inspect all the tractors on the farm. Note the black color-coded controls. What does each control do? Make a comparison of how older model tractor controls are identified for ease of recognition compared with newer model tractors.

2. Obtain a tractor’s Operator’s Manual and read the instructions for setting the 3-point hitch for depth control of plows or scraper blades.

Safety Activities

References

1. American Society of Agricultural and Biological Engineers, ANSI/ASABE, EP443.1 Color Coding of Hand Controls, St. Joseph, MI.

2. Owners’ Manuals for Specific Tractors.


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Introduction
Tractors are designed for multiple tasking (doing many jobs at once). Several functions may occur at the same time. A safe operator will be able to maintain control of each function. For example, you are mowing hay with a 12-ft. wide mower-conditioner. As you approach an uphill grade, you must downshift (ground motion control). A huge rock in the field also means you must raise the mower head to avoid damage to the knife guards and knife sections (machine positioning control). You are steering, shifting, and using remote hydraulic controls simultaneously. This task sheet will identify several important tractor controls and their direction of movement.

Control Devices and Functions
Tractor manufacturers have tried to help tractor drivers identify controls and use them correctly for many years. For example, specific controls are located on the same side of the operator’s seat and move in the same direction to obtain a desired effect. Similar to the color-coding of main groups of controls, many older tractors may have controls or directions of movements that are not the same as newer tractors.

Three common types of control devices are used on a tractor.

They are:
1. Foot Controls—Pedals
2. Hand Controls—Levers, toggles, switches, knobs, and buttons
3. Combination Hand and Foot—Engine throttles

These controls apply brakes, operate the clutch, speed the engine, change gears, lock the differential, steer, stop the engine, lift implements, engage the PTO, and control electrical and hydraulic flow. Computer functions are also part of the control panel on modern tractors.
Movement and Location of Controls

The same location and direction of motion for controls makes it easier to operate the tractor safely and efficiently. The ASABE standard for location and direction of motion for tractor controls is listed in the reference section. Below are the most common rules for the location and direction of motion for tractor controls, including some combinations of control functions. There are several exceptions to these rules. Study the Owner’s Manual for all the tractors you operate. Consult the tractor owner to be sure you know where a control is located and what happens when you move a control. Do this before operating the tractor.

Figure 4.5.5.b. Brake control—Foot brake pedals must be located on the right side. Push the brake forward and/or downward to engage. If a hand brake is provided, it can be on either side and must be pulled to be set. Brake locks may be lifted to be set.

Figure 4.5.5.c. Clutch control—A foot clutch pedal must be located on the left side. The pedal is moved forward or downward for disengagement. A hand-operated clutch can be located on either side and must be moved toward the operator to be disengaged.

Combination clutch and PTO control—A foot-operated combination will be on the left side and moved forward and/or downward to cause clutch and PTO disengagement.

Combination clutch and brake—A foot-operated combination will be found on the left side and moved forward and/or downward to cause clutch disengagement and brake engagement.

Figure 4.5.5.d. Power Take-Off (PTO) control—A hand-operated PTO control can be located on either side and will be moved upward or forward for engagement and rearward or downward for disengagement.

Figure 4.5.5.e. Engine speed control—The control is located on the right side. If the hand-operated control is located next to the tractor seat, the direction of motion must be forward or upward to increase engine speed and rearward or downward to slow engine speed.
If the hand-operated speed control is located near the steering wheel, the direction of motion must be rearward and/or downward to increase speed and forward and/or upward to slow engine speed.

If a foot-operated control is provided, it must be on the right side and moved forward and/or downward to increase speed.

A foot-operated combination direction and variable speed control(s) must be on the right side. If a single pedal is used, it must produce forward motion with a forward or downward toe motion, and move in reverse with a rearward or downward heel motion. If two pedals are used, the inner pedal must be moved forward or downward for forward motion, and the outer pedal must be moved forward or downward for backing up. Also, the forward or downward pressure on both pedals must increase speed and automatically return to a neutral position when a foot is taken off the pedal.

Figure 4.5.5.f. *Ground speed control*—A hand-operated forward-reverse (non-variable speed) directional control must be moved forward for forward travel and rearward for reverse. A hand-operated variable speed control must be moved forward and/or upward to increase speed and rearward and/or downward to decrease speed.

A hand-operated combination direction and variable speed control must be moved forward or away from the operator—from the neutral position—for forward travel and increasing speed. To reverse and to increase reverse speed, the control is moved rearward or toward the operator, from a neutral position.

Figure 4.5.5.g. *Differential lock control*—A differential lock must be moved forward or downward for engagement.

Figure 4.5.5.h. *Engine stop control*—A key switch must be rotated counterclockwise to stop the engine. A mechanical pull-push control must be within 6 inches of the key switch and pulled to stop the engine. Engine stop and ground speed controls that are combined into a single lever must move in the same direction to first slow ground speed and then stop the engine.

Figure 4.5.5.i. *Lift controls for implements or attachments*—Lift controls must be located on the right side. A hand-operated control must be moved forward, downward, or away from the operator for lowering, and backward, upward or toward the operator for lifting.
Safety Activities

1. Visit area farms or equipment dealers and review with the farmer or dealers how the major controls operate. Make a record of which ones follow ASAE standards for location and direction of motion.
2. Solve this word search puzzle on tractor controls and color coding.

Tractor Controls

Yellow Control

Black Control       Gearshift            Red Engine Stop
Brakes       Lift Control         Throttle
Differential      Orange Control    Yellow Control
Foot Pedal       PTO

Words to Use:
Black Control       Gearshift            Red Engine Stop
Brakes       Lift Control         Throttle
Differential      Orange Control    Yellow Control
Foot Pedal       PTO

References
1. American Society of Agricultural and Biological Engineers, ANSI/ASABE, S335.4 Operator Controls on Agricultural Equipment, St. Joseph, MI.
2. Various Owners’ Manuals for Specific Tractors

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Introduction
Operational symbols were designed to promote and improve tractor and equipment use and safety in the agricultural workplace. Operational symbols were developed to show tractor and equipment operating functions. Operation symbols are pictures used to transmit information with minimal use of words and are displayed in a standard way.

This task sheet discusses uniform, tractor operation symbols that workers on farms should recognize and understand. Use Owners’ Manuals to learn more about these symbols.

Tractor Operation Symbols
Symbols are designed to draw your attention to operating functions and alert you to malfunctions. These symbols may be found on agricultural, construction, and industrial equipment. Owners’ Manuals detail operating symbols of particular importance to your tractor or machine.

Symbols quickly help a person to recognize a function or malfunction. Learn what each symbol communicates. This information can help you prepare for work or respond to a malfunction. Use the reference section to find a complete exhibit of tractor and equipment operation symbols.

This symbol represents diesel fuel. Be sure of which fuel you are putting into the tank. From this pictorial, can you identify the type of fuel pump and the type of fuel supplied?

This symbol serves as a reminder to use the seat belt. A tractor equipped with a ROPS can save your life when used with the seat belt.

This symbol is an ALERT for a malfunction. Alert symbols usually are found in conjunction with another symbol.

Learning Goals
• To recognize the messages that tractor operation symbols are conveying in normal tractor use
• To recognize the messages that tractor operation symbols are conveying in order to react to possible malfunctions

Other related sheets:
Hazard Warning Signs 2.8
Tractor Instrument Panel 4.4
Tractor Controls 4.5
Operating Symbols

During tractor operation, these symbols will indicate what to do or what is happening.

**Oil Light or Gauge**

This symbol will show you what the engine speed is.

The PTO symbol indicates an engaged/disengaged function.

The engine oil pressure and ammeter symbols are used to draw your attention to malfunctions during operations. An oil pressure gauge that begins to show red lighting is an indication to stop the engine immediately. A red glowing ammeter light display indicates the battery is not charging properly. The operator could still use the tractor with a low battery, but the problem must be fixed soon.

**Speed Range**

The throttle symbol reminds us of the slow turtle and fast rabbit story, or speed control.

An oil light or gauge that indicates low oil pressure is a message to stop the engine immediately. Major repairs will occur if you do not react.

Figure 4.5.6.c. This symbol shows the only recommended lift point to attach a chain for moving a heavy weight. Damage or injury can occur if any other lift point is used.
**Other Operation Symbols**

This symbol shows engine coolant level. If an oil drop was shown in the center of the engine block form, what would this symbol represent?

This symbol indicates that the resulting operation will tilt the high-lift bucket to the rear.

This symbol represents the clutch. If you do not know how the clutch engages the transmission to the engine, find someone who can explain this operation to you.

Some symbols may be more difficult to understand. This sign tells you that this is an engage control function. Recall that engagement controls are yellow in color. Remote power operation occurs.

**More Operation Symbols**

You may need to use the accessories on a tractor. Operation symbols will be found on the equipment as well as on the tractor.

This symbol indicates that the resulting operation will raise the high-lift bucket. This is a positioning and adjusting control symbol.

This sign tells you this is a disengage control function. Engagement controls are yellow in color.

You may not encounter all the symbols used, but you should study them for future reference.

In the space above, draw an operation symbol that would show someone that the engine oil filter needs to be checked. Check the asae.org website to compare the standard to what you have drawn.

Figure 4.5.6.d. Older tractors will not have operation symbols. What will you find on this tractor to tell you the information you need about oil pressure and engine temperature?
**Safety Activities**

1. List the top 5 operating symbols you would locate and respond to before you start a tractor. Tell why you think these 5 symbols are important. (There is no wrong answer for this discussion.)

2. You are assigned to rake hay in a field one mile from the farm shop. The engine oil pressure light comes on. Draw the symbol that shows this malfunction.

3. In problem 2, what should be done with the tractor when the problem is observed?
   - a. drive it back to the farm shop
   - b. continue to rake hay
   - c. shut down immediately
   - d. let the tractor idle while you use the cell phone to notify the owner of the tractor

4. A tractor you are using begins to show a low-battery charge problem. What should you do?
   - a. return to the shop area without finishing to rake the hay
   - b. shut down immediately
   - c. return to the shop area after finishing to rake the hay
   - d. none of these

5. Use the Internet website shown in the reference section to locate the ASABE Graphic Symbols for Operator Controls and Displays on Agricultural Equipment section. Print out this information to share with your class, group, or club. (There are 32 pages to print. Ask your leader or instructor for permission to print first.)
**Introduction**

John is a part-time farmer. Two years ago he purchased a small utility tractor with backhoe and scraper blade for $12,000. He wanted to push snow, clean the barn, and do odd jobs on his property. While driving his tractor down the road, the engine overheated, began to make noise, lost power, and shut down. A neighbor stopped by and John asked, “What could be the problem?” He was already pouring water in the radiator. “Could it be the hydrostatic transmission?” he asked as he checked that dipstick.

The neighbor suggested the engine oil, but John didn’t know where to find that dipstick, which turned out to be hidden by the high-lift arms. The dipstick registered no oil at all.

Performing tractor maintenance is a critical task for every tractor operator. This task sheet discusses the proper way to maintain a tractor to avoid costly and unnecessary repairs.

**Pre-Operation Checks**

A good operator uses a daily checklist of items and systems to inspect before starting the tractor. This is often called a pre-operation checklist. Many drivers write down what needs to be inspected and then check off the list as they examine each item.

Things to check include:

- Fuel level
- Coolant level
- Engine oil level
- Hydraulic oil level
- Battery condition
- Lug nuts and wheels
- Tire condition
- Loose or defective parts
- SMV emblem
- Fluid leaks
- Operators platform/steps
- Seat/Adjustment
- Seat belt
- Fire extinguisher
- Lighting/Flashers
- Visibility from operator’s seat

**Some Practical Hints**

Here are several things to look for as you perform a pre-operation check:

- Low tires and leakage from the valve stem
- Oil or hydraulic leaks on the ground beneath the tractor
- A frayed or worn fan belt
- Corroded battery terminals
- Loose bolts or lug nuts on wheels
- Dirty cab windows that obstruct your vision
- Headlights or warning lights with broken bulbs or glass
- An SMV emblem that is faded or distorted in either color or shape
- A fire extinguisher with a pressure gauge in the “recharge” range
- Several tools or supplies on the operator platform

**Learning Goals**

- To conduct pre-operation checks on a daily basis to reduce repair costs and downtime

**Related Task Sheets:**
- Fuel, Oil, Coolant Levels 4.6.1
- Lead Acid Batteries 4.6.2
- Tire and Wheel Condition 4.6.5
- The Operator Platform 4.6.6
Safe Starts

Some newer utility or lawn tractors may have safety start systems. If so, the owner should also have in good working order one or both of the following items:

Seat Switch/Safety Interlock that prevents starting the tractor if the operator is not in the seat
Neutral-Start Safety Switch that prevents the tractor from starting if the tractor is in gear

Safety Activities

1. Make a chart of maintenance items to be done on your tractor. Use the following format, or develop your own chart. If you have a computer, make a spreadsheet or database project to help with maintenance records.

   **Tractor Maintenance Log**

<table>
<thead>
<tr>
<th>Date</th>
<th>Item Checked</th>
<th>Problem Found</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>

2. Help someone change the oil and oil filter on a tractor.
3. Help someone change an air filter on a tractor.
4. Call a tractor dealer/service center, and ask for any maintenance charts or record forms that they can send to you.
5. Memorize the “pre-op” checklist, and recite this list as you conduct a pre-operation inspection for your class or an interested adult.
6. Math Problem: You forgot to check the engine oil in the tractor before starting. When the oil light came on, you continued working. Now the engine must be rebuilt to the amount of $5000. This is the only tractor that can pull the forage harvester and chop 40 acres per day for the next 5 days. An estimated nutrient loss value of $10 per acre will occur due to the delay in harvest. Calculate the dollar loss to the producer.

References

2. Owners’ Manuals for specific tractors.

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Introduction

A tractor is a huge investment to make farm work more efficient. Even a mid-size tractor may cost $40,000 or more.

The tractor must be kept in top operating condition. Downtime for engine and tractor repairs are costly. An engine rebuild may cost over $5000 in parts and labor. A crop in the field may be lost because of harvest delays. Crop losses can lead to increased costs to purchase replacement feeds or protein supplements.

Therefore, tractor and equipment pre-operation checks are an economic necessity. A damaged engine or an empty fuel tank at the farthest field from the barn is no excuse for the skilled operator.

This task sheet discusses the importance of checking the fluid levels of the

- fuel
- coolant, and
- oils

before you touch the tractor ignition switch. Developing this habit will help you to understand that the tractor engine is ready for field work.

What to Do

Introduction

Figure 4.6.1.a. Before driving the tractor to the field, check for the possibility of an empty fuel tank. If you run out of fuel during a workday, you are causing downtime losses.

What to Do

Figure 4.6.1.b. Check the fuel level.

Figure 4.6.1.c. Check the oil level.

Figure 4.6.1.d. Check the coolant level with the engine cold.

Learning Goals

- To understand how to check fuel levels of common engines (alternative fuels excluded here)
- To safely check coolant levels of liquid cooled engines
- To correctly check oil levels of any engine

Related Task Sheets:

Tractor Instrument Panel 4.4
Why You Should Check Fuel, Coolant and Oil Levels

Fuel

Check the fuel level before leaving the barnyard or shop area. You cannot assume that someone else has done this job. Failure to check the fuel level may result in lost field time. Or it may result in the need to mechanically bleed air from diesel fuel lines in some older tractors.

Be sure you do not fill diesel fuel tanks with gasoline and vice versa.

Oil

Oil bathes metal surfaces to prevent the heat of friction from damaging the moving parts. Low engine oil allows engine parts to overheat, expands them, and “seizes” the engine. Overfilling the engine oil results in oil seal damage.

Use the oil dipstick daily to prevent engine damage.

Coolant

Coolant fluid (water and antifreeze) carries engine heat away from the engine. Air flowing across the radiator then reduces the coolant temperature. Lack of coolant causes overheating of the engine. Water used as a coolant by itself will cause rust in the water pump.

Check coolant levels while the engine is cold to prevent severe scalds.

Safety Activities

1. Park the tractor at the farthest field from the barn, and time your walk back to the farm shop or fuel area. This is wasted time or downtime when cropping work could be completed.
2. Call a tractor dealer’s service department to ask about the cost to rebuild a tractor engine damaged from lack of oil. Provide this information to your class and instructor.
3. Using a hydrometer (device to measure specific gravity of coolant or antifreeze for level at which the liquid would freeze), test engine coolant for level of temperature protection that coolant would provide.
4. Explain the meaning of the term “oil viscosity.”
5. Describe the difference between diesel fuel and gasoline. How does the storage of these fuels differ?

References

1. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.
3. Owners’ Manuals of Several Tractors.

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Introduction

Lead acid batteries provide a source of electrical current to start an engine and power tractor accessories, such as lights, emergency flashers, instrument panel gauges and meters, computerized digital read-outs, and other machine functions. Tractor electrical power may be used to operate and monitor functions of towed equipment.

Battery electrical current results from a chemical reaction produced by sulfuric acid and water mixture. This chemical solution, called electrolyte, can burn your skin and eyes. The energy produced is stored as positive (+) and negative (-) electrical charges on the battery plates. An explosive gas is produced by this reaction as the battery charges and discharges.

Modern tractors may have one or two batteries to provide current to the starting motor (starter).

Correct battery care and use will provide countless starts of the tractor engine in a safe manner.

This task sheet discusses battery construction, battery hazards, and battery care and safety.

Parts of a Battery

<table>
<thead>
<tr>
<th>Battery Part</th>
<th>What it Does</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Case</td>
<td>A container to hold the battery acid solution and electrical storage plates</td>
</tr>
<tr>
<td>Battery Plate</td>
<td>Holds electrical charges (+) and (-)</td>
</tr>
<tr>
<td>Terminals</td>
<td>Connected to the storage plates and become the connecting points for battery cables leading to the starter (+) and the ground (-)</td>
</tr>
</tbody>
</table>

Use of safety goggles and protective clothing is a must when working with a lead acid battery.

Learning Goals

- To identify battery parts and functions
- To become familiar with hazards of lead acid batteries
- To use safe practices in working with and caring for batteries

Related Task Sheets:

Using a Battery Charger  4.6.3
Using Jumper Cables  4.6.4
### Battery Hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Definition</th>
<th>Safety Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPLOSIONS</td>
<td>Battery acid produces hydrogen gas, which is explosive. A spark can lead to fire (dust, chaff, etc., around the battery) or explosion of hydrogen gas from the battery itself.</td>
<td>Check fluid level often to prevent gas buildup. Maintenance of fluid levels reduces the space in a battery where gases can accumulate.</td>
</tr>
<tr>
<td>CHEMICAL BURNS</td>
<td>The electrolyte solution in a battery is caustic to the skin and eyes and can burn holes through clothing.</td>
<td><strong>Use splashproof safety goggles and rubber gloves.</strong> Keep the battery posts clean of corrosion.</td>
</tr>
<tr>
<td>ELECTRICAL SHOCK</td>
<td>The electrical charge of a battery may be only 12-26 volts, but with the effects of the ignition coil on spark ignition engines may produce voltages in the range of 100,000 volts. You can receive a severe shock. Wiring and electrical parts can be damaged.</td>
<td>Keep tools and parts away from the positive (+) terminal. It is best to remove the ground cable first when removing a battery or working on any part of the electrical system. When replacing the battery, connect the ground cable last.</td>
</tr>
</tbody>
</table>

### Battery Safety Practices

1. Check battery fluid levels often. Low electrolyte levels increase the space where hydrogen gas can accumulate.
2. Prevent electrical sparks by keeping tools and parts away from the positive (+) terminal. The battery cable leading to the starter is usually the positive, or “hot” wire. Cap it with an insulating material when working near it.
3. When removing a battery for replacement or bench work, remove the ground cable first.
4. When replacing a battery, install the ground cable last.
5. Use safety goggles, long sleeves, and rubber gloves when refilling battery liquid. Distilled water is recommended for the refill. Any clean water can be used in an emergency if the battery is nearly dry.
6. Keep battery terminals clean of corrosion for best electrical contact. Prevent the corroded material from getting on your skin or in your eyes.
7. If you spill battery acid on your skin, flush it off with water immediately.
8. If you splash battery acid in your eyes, flush with warm water for at least 15 minutes. Seek medical attention.

### Safety Activities

1. Check the fluid (electrolyte) level in your family’s car, truck, riding mower, or tractor if it has fluid fill caps. If there are no fill caps, observe how the battery is checked for electrolyte. Use eye and skin protection.
2. With the help of an adult supervisor, clean the battery terminals of a corroded battery by removing the battery cables (ground cable first and positive or “hot” cable last). Use a battery terminal cleaner or mixture of baking soda and water. Re-attach battery cables with the “hot” or positive first and the ground cable last.
3. Search the Internet to learn more about batteries. One source is www.ACDelco.com. You can also use www.ask.com to ask questions about the batteries, their construction and operation.

### References

1. www.ACDelco.com
3. www.ask.com

### Contact Information

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Introduction

If batteries are not cared for properly (see Task Sheet 4.6.2.), or if they are nearing the end of their useful life expectancy, a 60-month guaranteed battery, which has 54 months of use, you can expect that the battery may fail to start the tractor. Many times that failure will come at the onset of cold weather when greater current demands are placed on the battery. Batteries can also lose a charge when not used for extended time periods.

Often the battery can be recharged to prolong its usefulness.

This task sheet discusses the correct procedure to charge a 6- or 12-volt battery. For other voltage situations, consult the battery manufacturer’s recommendations or your tractor Operator’s Manual. Some chargers can also be used to jumpstart a battery.

Battery Charging Procedures

Typical Hookup - Charging Negative Ground Battery in Vehicle

![Battery Polarity: A battery has two poles or posts. The positive battery post is usually marked POS, P, or (+) and is larger than the negative post which is usually marked NEG, N, or (-).](image)

Tools You Will Need:
- Safety glasses
- Approved battery charger
- Wrenches to remove battery cables
- Battery terminal cleaner
- Rubber gloves

Learning Goals
- To safely use a battery charger to charge a weak battery
- To use all safety procedures to prevent chemical burn, explosion or fire, and electrical shock

Related Task Sheets:
Lead Acid Batteries 4.6.2
Using Jumper Cables 4.6.4
Steps in Charging a Battery

If the tractor has a negative ground (most tractors do, but if you are not sure have it checked).

**STEP 1. CONNECTING THE CHARGER TO BATTERY:**
- If the charger has a switch with an OFF position, it MUST be set to OFF.
- The AC power cord to the charger MUST be unplugged.
- Connect the POSITIVE (RED) charger clip to the POSITIVE post of the battery.
- Next connect the NEGATIVE (BLACK) charger clip to the frame or engine block away from the battery.

**CAUTION:** Do not connect clip to carburetor, fuel lines, or sheet metal body parts. Connect to a heavy gauge metal part of the frame or engine block. This prevents sparks at the battery terminals, which can ignite hydrogen gas produced by the battery during a rapid charging situation.

**STEP 2. TURNING THE CHARGER ON:**
- If equipped with a voltage switch, set the switch to the voltage of the battery (normally 6 to 12 volts).
- If equipped with a rate switch, set the switch for the desired charge rate: normally 2, 6, 12, 30 amps.
- If equipped with a timer, set the timer to the charge time desired.
- Plug the AC cord into a grounded outlet. Stand away from the battery.
- Do not touch the charger clips when the charger is on.
- The charger should now be on and the ammeter showing the rate at which the battery is charging.
- The initial rate may be somewhat higher or lower than the charger’s nameplate rating depending on battery condition and AC voltage at the outlet.

**STEP 3. TURNING THE CHARGER OFF:**
- Set the selector switch to OFF.
- Unplug the AC power cord from the outlet.
- Remove black charger clip connected to frame. If charging a battery outside of a vehicle, remove clip connected away from battery.
- Remove clip connected to positive battery post.

Safety Activities
1. With the help of an adult mentor, use a battery charger to charge a weak battery as described in this task sheet.
2. Use the Internet site www.autoeducation.com to ask questions about charging a battery.
3. Identify all the ways a battery’s posts may be labeled to identify the positive and negative battery poles.

References
1. www.ask.com
2. www.autoeducation.com
3. www.battery-chargers.com
4. www.autobatteries.com

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Introduction

If batteries are not cared for properly (see Task Sheet 4.6.2) or if they are nearing the end of their useful life expectancy, (e.g., a 60-month guaranteed battery which has 54 months of use), the battery may fail to start the tractor. Many times battery failure will come at the onset of cold weather.

Batteries can also lose a charge when not used for extended time periods. Using a booster battery and jumper (booster) cables to start the tractor, truck, or car may be necessary.

This task sheet discusses the correct procedures to boost or jumpstart a 6- or 12-volt battery to start an engine. For other voltage ratings, consult the tractor’s or battery’s Owner’s Manual or manufacturer recommendations.

Jumpstarting a tractor:
The red cable goes to the POSITIVE (+) battery terminal, and the black cable goes to the NEGATIVE (-) battery terminal on the good (charged) battery.

Battery Jumping Diagram

![Battery Jumping Diagram](image)

Figure 4.6.4.a. Battery Polarity: A battery has two poles or posts. The positive battery post is usually marked POS, P, or (+ or red) and is larger than the negative post, which is usually marked NEG, N, or (- or black). Connect positive to positive and negative to negative terminals to jumpstart the battery.

Tools you will need:
- Safety glasses
- Approved booster cables of 4-, 6-, or 8-gauge wire. Lighter wire (higher wire gauge number) will not carry enough current to jumpstart the battery.
- Wrenches to remove battery cables
- Battery terminal cleaner
- Booster battery usually from another tractor or vehicle.
- Rubber gloves

Learning Goals
- To safely use booster cables to jumpstart a weak battery
- To use all safety procedures to prevent chemical burn, explosion or fire, and electrical shock

Related Task Sheets:
- Lead Acid Batteries 4.6.2
- Using a Battery Charger 4.6.3
Steps to Jumping a Battery

Jumpstarting an engine with a drained battery is the same whether the drained battery is in a tractor, truck or car. Normally, you will use another tractor, truck or car battery to try and start the tractor with the drained battery.

IMPORTANT: Most vehicles have negative ground batteries. Be sure both the drained battery and the booster battery have negative grounds.

Follow these steps for jumpstarting a tractor with a drained battery:

1. Pull the tractors next to each so they are not touching, and turn off both ignitions.
2. Connect the positive (+, yellow or red) clamp of the jumper cable to the drained battery's positive terminal.
3. Connect the other positive (+, yellow or red) clamp of the cable to the positive terminal of the booster battery.
4. Connect the negative (- or black) clamp of the cable to the negative terminal of the booster battery.
5. Connect the other negative (- or black) clamp of the cable to the vehicle's engine block or other metal surface of the tractor to be started away from the drained battery. This serves as your ground or connection point.

CAUTION: Do not connect clamp to carburetor, fuel lines, or sheet metal body parts. Connect to a heavy gauge metal part of the frame or engine block.

6. Make certain all cables are clear of fan blades, belts and other moving parts of both engines and that everyone is standing away from the vehicles.
7. Start the tractor with the booster battery.
8. Allow 1-5 minutes for the drained battery to accept a charge.
9. Try to start the tractor with the drained battery.

IF VEHICLE STARTS:
Allow the engine to return to idle speed. Remove the cables in the reverse order that you put them on.

1. Remove the negative (- or black) clamp from the frame of the vehicle with the drained battery.
2. Remove the negative (- or black) clamp from the booster battery.
3. Remove the positive (+, yellow or red) clamp from the booster battery.
4. Remove the positive (+, yellow or red) clamp from the formerly drained battery.

IF ENGINE DOES NOT START:
Wait a few moments and try again. If it still doesn’t start, check for other problems.

Safety Activities

1. With the help of an adult mentor, use booster cables to boost a weak battery.
2. Use the Internet site www.autoeducation.com to ask questions about boosting a battery.
Learning Goals

- To identify faulty tire and wheel situations and take corrective action to remedy the problem

Related Task Sheets:

Preventative Maintenance and Pre-operation Checks 4.6

Introduction

Tractors are traction machines! Better traction comes from good tires.

Tractor tires can cost several hundred dollars each. Estimates show that tractor tire repair and replacement comprise nearly 30% of the total repair costs during a tractor’s lifetime.

You are responsible for protecting this valuable traction component. This task sheet discusses tractor tire and wheel conditions for safe tractor operation.

Tire Basics

These simple activities can extend the life of tractor tires:

- Check tire pressure regularly.
- Use wheel weights to reduce excess slippage, which can damage the tire.
- Drive carefully to avoid damaging objects.
- Make tire repairs promptly.

Tire and Wheel Hazards

Tractors are not built for high speed. High speeds on paved roads reduce tire life. Unpaved roads can do the same and also increase the chance for large stones to damage the tire as well.

Foreign objects can puncture tires. All farms have their share of sharp rocks, hidden field objects, and construction debris. Fields near rural roads may have glass bottles and metal cans which can cut tires. Be alert for those objects which can damage tires.

Improper use can ruin tires. Turning too tight and gouging the tire into towed equipment leads to cut tires. Most tractors have no shock absorbers; so the tire must absorb all ground shocks. Tire sidewall breaks can occur when objects are impacted.
Tire and Wheel Defects

Fig. 4.6.5.b. Worn treads and dry rot make for poor traction and risk for downtime due to a blowout.

Fig. 4.6.5.c. Damaged rims from careless use may cause damaged tire beads and flat tires.

Fig. 4.6.5.d. A leaking valve stem released calcium solution which rusted the rim. A major expense will be incurred, as well as a severe safety hazard in using this tractor.

Tractor tires are expensive. They may cost hundreds of dollars to repair or replace.

Safety Activities

1. Call a local tire dealer who specializes in tractor tires, and ask for the price of a tractor tire that fits your tractor. For comparison purposes, call several dealers.

2. Have an adult mentor, leader, or teacher show you how to check air pressure in a calcium-filled tractor tire.

3. Find out how much a rear tractor tire weighs when it is filled with a calcium solution. You can use the Yellow Pages of the phone book to find a tractor tire repair service or tire dealer.

4. Ask a local tractor tire dealer what the recommendations are for filling tractor tires with liquid ballast (calcium solution, or similar solution).

5. Learn about the purpose of tractor ballast.

References


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**Introduction**

If you compare the tractor operator platform to the cockpit of a jet fighter plane, both the tractor and jet fighter have:

- Steps to climb on board
- Adjustable operator seat with seat belt
- Multiple controls at hand and foot positions
- High visibility from the operator’s seat

Keep these similar work areas free of obstructions for safe operation.

Could the pilot of the jet plane be able to fly to our defense in a moment’s notice if:

- The steps were covered with mud and manure?
- The cockpit was filled with chains, grease guns, tools, and hitch pins?
- The windows were covered with pesticide spray drift or other materials?
- The pilot could not reach the controls because of a poorly adjusted seat?

This task sheet discusses the need for a clear tractor operator platform and an adjustable seat to safely reach the operating controls.

---

**Operator Platform Workplace**

- The tractor platform serves as the cockpit of this farm tool.

---

**Learning Goals**

- To understand the need to keep steps and platform clear of tools and debris at all times
- To adjust the tractor seat and seat belt to safely reach all controls while your seat belt is buckled

**Related Task Sheets:**
Preventative Maintenance and Pre-Operation Checks 4.6
Seat Adjustment

Each person who operates the tractor will be a different size and weight. Check and adjust the seat adjustment so that you can comfortably reach all controls.

Seat controls may be levers or knobs and will be black in color. They may:

1. Release the seat to tilt it away from rain if the tractor is sitting outside.
2. Position the seat higher, lower, closer, farther, or to a different tilt position from the steering wheel and foot pedals.
3. Adjust the seat for the weight of the operator.
4. Be sure the seat belt is also adjusted for the seat.

Safety Activities

1. Select any tractor at the farm where you work, and clean the tractor steps and platform. List how many different objects you can find there.
2. Use the NIOSH website to locate data on injuries due to falls in agricultural work. Are falls from getting on or off tractors considered a problem? If so, describe how serious it is.
3. Conduct a farm survey in the area with the help of your club or class members to determine how many tractors have seats or seat belts that can be easily adjusted.

References

1. www.cdc.gov/niosh/injury/trauma
2. Owners’ Manuals for Specific Tractors.
3. Farm and Ranch Safety Management, John Deere Publishing, 2009. Illustrations reproduced by permission. All rights reserved.

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Learning Goals

• To safely start and stop the engine of a gasoline tractor
• To safely start and stop the engine of a diesel tractor
• To explain the differences between gasoline and diesel engines

Related Task Sheets:
- Tractor Instrument Panel 4.4
- Engine Stop Controls 4.5.1
- Mounting and Starting the Tractor 4.8

Before You Start the Engine

Review gasoline engine operation:
- Starter motor spins the engine
- Fuel and air mix enters combustion chamber; spark plug ignites mix
- Engine starts

OR

Review diesel engine operation:
- Starter motor spins the engine and activates the fuel pump
- Fuel droplets are sprayed into super hot combustion chamber
- Engine starts

For both engines make a pre-operation check:
1. Check oil, fuel, and coolant level (cold engine only)
2. Check the tires
3. Check the controls for neutral positions

For all engines, avoid bypass starting. Many tractors have had their safe start systems bypassed. This is an unsafe practice. If the tractor is in gear, the tractor will move forward and crush you. Start the tractor from the seat only. The bypass starting hazard is discussed in Task Sheet 4.8.

STARTING AND STOPPING DIESEL AND GASOLINE ENGINES

HOSTA Task Sheet 4.7

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction

Starting an engine is more than turning the ignition key. The safe operator is prepared to think clearly and to react to all the conditions surrounding the tractor being operated. Tractors may vary in design and layout of the instrument panel and ignition system, but starting and stopping gasoline and diesel engines involves only slightly different procedures. This task sheet discusses how to start and stop both diesel and gasoline tractor engines.

Do not start any engine inside a building—gasses may kill you.
STARTING AND STOPPING DIESEL AND GASOLINE ENGINES

To stop the gasoline engine:
1. Throttle back to idle speed.
2. Place tractor in PARK or neutral and set brakes.
3. Turn off ignition key, and remove the key to prevent accidental starting by an untrained person.
4. If parking on a hill, place the transmission in a low gear with brakes set.

Follow these steps after you have fastened your seat belt.

1. Push the clutch in, and check that the tractor is in a neutral gear.
2. Adjust throttle to 1/3 open.
3. Choke the engine on cool days.
4. Turn starter key to “on.”
5. Check indicator lights/gauges for oil pressure, temperature, and electrical charge.
6. Turn key to “start” position, but do not hold the key there for extended periods of time. This can burn up the starter motor or drain the battery of its charge.
7. Re-check gauges—especially the oil gauge.
8. Warm up the engine at 800-1000 RPMs for a few minutes.

A cold engine must be choked to start easily. Choking increases the fuel to air ratio during cold weather.

Starting and Stopping Gasoline Engines

To stop the gasoline engine:
1. Throttle back to idle speed.
2. Place tractor in PARK or neutral and set brakes.
3. Turn off ignition key, and remove the key to prevent accidental starting by an untrained person.
4. If parking on a hill, place the transmission in a low gear with brakes set.

Follow these steps after you have fastened your seat belt.

1. Push the clutch in, and check that the tractor is in a neutral gear.
2. Adjust throttle to 1/3 open.
3. Choke the engine on cool days.
4. Turn starter key to “on.”
5. Check indicator lights/gauges for oil pressure, temperature, and electrical charge.
6. Turn key to “start” position, but do not hold the key there for extended periods of time. This can burn up the starter motor or drain the battery of its charge.
7. Re-check gauges—especially the oil gauge.
8. Warm up the engine at 800-1000 RPMs for a few minutes.
Start/Emitting LEAP

Starting and Stopping Diesel Engines

Follow these steps after you have fastened your seat belt.

1. Push the clutch in, and check that the tractor is in a start or neutral gear.
2. Adjust throttle to 1/3 of the working range.
3. On cold days, turn ignition key to warm the glow plug (glow plugs pre-heat the combustion chamber air). Do not use an ether starter fluid.
4. Check indicator lights/gauges for oil pressure, temperature, and electrical charge.
5. Turn key to “start” position, but do not crank the engine for more than 10-30 seconds to avoid damage to the starter or running down the battery.
6. Re-check gauges—especially oil gauge.
7. Warm up the engine at 800-1000 RPMs for a few minutes.

To stop the diesel engine:

1. Throttle back to idle speed.
2. Place tractor in PARK or neutral and set brakes.
3. Turn off ignition key, and remove it to prevent accidental starting by some untrained person.
4. Pull the “red” fuel pump shut-off control rod.
5. If parking on a hill, place the transmission in a low gear with brakes set.

Turning the key to the “off” position usually does not stop a diesel engine. You must shut off the fuel pump also.
Safety Activities

1. Using the procedures listed earlier, practice starting and stopping gasoline and diesel tractor engines.

2. Trace the linkage of the choke lever on the gasoline engine from the carburetor to the instrument panel. Draw a sketch of that linkage path.

3. Trace the linkage of the diesel fuel flow from the fuel tank to the fuel pump to the injectors. Draw a sketch of the linkage which leads from the fuel pump to the “red” fuel shut-off switch located on the operator’s platform or instrument panel.

4. Answer these questions:
   A. True or False? Gasoline engines do not give off dangerous fumes.
   B. Choking an engine to start it on a cold morning means:
      1. Holding the key in the start position for as long as it takes.
      2. Providing more fuel than air for better ignition.
      3. Gassing the engine by pumping the throttle.
      4. Pouring extra fuel into the air cleaner to start the engine.
   C. Diesel engines do not have spark plugs. How is diesel fuel ignited in the cylinder?
   D. Why should a cold engine be allowed to warm up before pulling a heavy load?
   E. What can happen to the tractor’s parts if you crank the starter motor too long?
   F. True or False? Diesel engines do not give off carbon monoxide.
   G. True or False? Diesel engines give off carbon dioxide gasses.
   H. What are the lethal gasses given off by a gasoline engine called?
   I. Where are glow plugs found, and what do they do?

References

Introduction
Safe tractor operation includes climbing onto the tractor in a safe way. Many operators have bruised shins and broken bones from slipping and falling while recklessly climbing or jumping onto tractors. Specific tractor pre-operation checks have been discussed, but there are other items to consider to safely start the tractor. This task sheet identifies the safe way to mount a tractor and the starting procedures to use.

Safe Tractor Mounting
Establish yourself as a good tractor operator by using these procedures each time you climb onto and sit down on a tractor seat.

- Keep the operator platform free of tools, equipment, mud or other debris.
- Use handholds and steps as you mount the tractor. Try to keep three points (two hands and one foot or two feet and one hand) on the tractor at all times.
- Adjust the seat and steering wheel (if necessary).
- Adjust and buckle the seat belt (if the tractor has ROPS).
- Check the major controls (PTO, hydraulics, gearshift stick) for the neutral (or PARK) position.

Before You Start the Engine
The safe operator will then think about and check many things before turning the key.

1. Is the area immediately around the tractor clear of persons and animals?
2. Is the tractor inside a building? If yes, is the building as open as possible to avoid a carbon monoxide fume buildup?
3. Do you understand the tractor’s instrument panel?
4. Have pre-operation checks been made?

Now you are ready to start the tractor.
Bypass Starting Dangers

Safety start systems have been in tractors for many years. The most common example of the safety start system is when the gearshift must be in neutral and the clutch must be depressed for the tractor to start. Some newer tractors may also have a switch in the seat that prevents the tractor from starting if the operator is not sitting in the seat. Safety start systems encourage operators to start their tractors while in the tractor seat—the safe place to be.

There are ways to bypass safe start systems. Unfortunately, the same operator who makes this mistake in judgment is also the operator who misjudges the location of the gearshift and has the tractor in gear while attempting to bypass start the tractor. The result is a tractor that lurches forward with the rear wheel running over and crushing the operator. Every year, experienced and inexperienced tractor operators die from bypass starting. Do not be one of them!

Safety Activities

1. Practice your safe mounting technique in front of a parent, instructor or classmate. Explain each step as you complete it.
2. Visit area farms and equipment dealers, and record how many tractors have some type of safety start system. See how many different systems you can find.
3. What are the dangers of bypass starting?

References

1. Owners’ Manuals for Specific Tractors.
2. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.
Introduction

Stopping and shutting off a tractor at the end of a day or for an extended period of time involves some specific procedures. Safe tractor operation includes climbing down from the tractor in a safe way. Many operators have ended up with twisted or broken bones from slipping and falling while recklessly jumping off tractors. This task sheet identifies safe tractor shutdown procedures and the safe way to dismount from a tractor.

Shutting Down the Tractor

At the end of a day, there are many things to think about as you prepare to park and shut the tractor off for a period of time or for the night.

- **Engine cool down**—Manufacturers suggest cooling the engine for several minutes at a fast idle (800-1200 RPM) to prevent internal damage to hot engine parts. While letting the engine idle to cool, check all systems on the tractor. Then stop the engine.

- **Hydraulic system**—Even if you did not use the hydraulic system recently, static pressure keeps hydraulic lines pressurized. Work the hydraulic controls to relieve that pressure. It will be easier to attach the hydraulic lines later.
  - Stop and park on the most level ground possible. Set the brakes (both brakes should be locked together) or place the gearshift in PARK.
  - Lower all attached equipment to the ground.
  - Place all controls and switches in an off, neutral, or locked position.
  - Chock wheels if a heavy load is attached to the tractor to prevent runaways.

Figure 4.9.a. To prevent falls, use the handholds and footsteps provided to dismount from the tractor. Falls while dismounting account for many farm injuries each year.

Stopping the tractor is more than turning the ignition key to the “off” position.

Learning Goals

- To know safe tractor shutdown procedures
- To learn to dismount a tractor safely

Related Task Sheets:
- Starting and Stopping Diesel and Gasoline Engines 4.7
- Mounting and Starting the Tractor 4.8
Safe Tractor Dismounting

The keys to safely dismounting are:

- Keep the operator platform free of tools, equipment, mud or other debris.
- Face the tractor, and use handholds and steps that are provided. Try to keep three points (two hands and one foot or two feet and one hand) on the tractor at all times.
- Take the key with you. Untrained operators, children, and visitors cannot accidentally start the tractor if the keys are removed.

Safety Activities

1. Practice your safe tractor shutdown procedure in front of a parent, instructor or classmate. Explain each step as you complete the procedure.
2. Ask the tractor owner(s) what policy they have for removing the keys from tractor ignition switches when the tractor is not in use.
3. If chock blocks are not available for wagons and implements at home, manufacture chock blocks in your school shop or home shop area.

References

1. Owners’ Manuals for Specific Tractors.
2. Farm and Ranch Safety Management, John Deere Publishing, 2009

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Introduction

A safe and effective tractor operator can move the tractor in the proper direction and maneuver around field obstacles without damage. A well-trained operator can:

- Start the tractor moving without stalling, jerking, or lunging
- Steer the tractor with attached implements in and around buildings, fences, and crops without damage to the tractor, equipment, or property

Important: Tractors are traction machines. They are not made for speed or for fun. “Popping the clutch” or doing “wheelies” to show off can result in damage, injury or death. You must be able to move the tractor without rearing up the front end of the tractor.

Important: Tractors and implements are wider and longer than cars. You must judge how much room you need to turn or to drive between objects.

This task sheet discusses moving and steering the tractor by smoothly engaging the drive train and paying attention to the space occupied by the equipment.

Before the Tractor Moves

Do you know what makes the tractor move forward or backward?

The power train provides a means of transmitting power from the engine to the point of use (drive wheels). The mechanism that functions as a switch to disconnect the rotating crankshaft of the engine from the transmission gears. It may be a clutch, a hydraulic device, or an electro-hydraulic mechanism. These serve three purposes:

- Allow for a smooth start
- Interrupt power while changing gears
- Interrupt power when stopping

There may be a foot control pedal or hand control lever(s)/joysticks to control tractor movement. Remember that these are orange color-coded controls. Ask for help if you do not understand the task.

Learning Goals

- To move a tractor without stalling or jerking through proper use of the clutch control pedal or lever
- To steer a tractor without damaging the tractor or towed or attached machine

Related Task Sheets:

- Ground Motion Controls 4.5.2
- Operating a Manual Shift Transmission 4.10.1
- Tractor Transmissions 4.10.2
- Operating the Tractor on Public Roads 4.14
- Connecting Implements to the Tractor 5.1
Transmission and clutch types you may use

Transmissions can be divided into three general categories. They include:

- Manual shift transmissions, where the operator uses one or more shift levers to change gears and power range.
- Hydrostatic transmissions, where the operator pushes a control lever or pedal which engages a hydraulic pump to a hydraulic motor which turns the drive wheels.
- A combination of gear driven and hydraulically-assisted transmissions, where the transmission speeds can be altered by lever or button control and the direction of travel changed by way of a shuttle shift lever (reverser). These units may have a clutch pedal for stopping movement.

Tractor manufacturers may use combination of clutches and transmission controls, therefore you must be willing to ask your supervisor how to operate the specific model of tractor.

Skills for moving the tractor

Before attempting this skill, examine the Operator’s Manual and have a qualified operator demonstrate what you must do.

To start moving the tractor:

1. Check the controls as you have learned in Task Sheet 4.5.2, adjust the seat, and fasten the seat belt.

2. Start the engine with the brake and clutch fully depressed. You may need to be in PARK or a neutral-start position on many tractors.

3. Select a low starting gear to begin moving the tractor with or without a load.

4. After checking the area around the tractor, increase engine speed slightly; slowly engage the transmission until you feel the tractor begin to move.

5. Release the clutch and brakes fully when you are moving. Partial engagement (riding the clutch) can heat and place wear on the clutch parts.

6. Increase speed and change gears as the task requires.

7. To stop movement activate the clutch control pedal or lever and apply the brakes.

8. When stopped place the shift lever in the Park position. Lock the brakes.

Use speeds appropriate to the task. Excessive ground speed can affect the operation of towed equipment.
Steering Involves Many Concepts

Steering involves several concepts each dealing with spacing. You must have knowledge of the:

- Width and length of the tractor.
- Width and length of the tractor and an attached implement.
- Space needed to corner the tractor and equipment around a building or object.
- Differences in the turning radius of narrow front-end versus wide front-end tractor steering.
- Individual wheel brakes on the tractor that can also be used to steer or control slippage on steeper slopes.

Brakes can help make steering corrections in tight places. Since the tractor’s brakes may be used to brake each wheel separately, they can be used to make slight steering adjustments. Do not overdo this practice, as brakes can wear out quickly.

Caution: Lock brakes together for highway travel. Pushing one brake at high speeds can cause the tractor to be thrown sideways resulting in a side overturn.

Cornering

Before attempting this skill, have a qualified operator demonstrate what you must do before you attempt cornering. Each tractor and implement will occupy a different space and corner differently as well. Know the relationship between the tractor and any towed implement. Too tight of a turn can cause the implement to pinch and possibly tear the tractor tire.

To turn a corner with the tractor and towed implement:

- Move as far away from a building and object as the roadway will permit.
- Drive in a long arc around the corner to prevent jack-knifing the tractor and machine.
- Observe the inside turning radius of the tractor and implement. Too tight of a turn can cause damage to the tractor, the tires, or to the towed equipment.
- As you complete the turn, observe the outside or opposite side of the tractor to be sure it has clearance from any other objects.
Safety Activities

For Moving and Steering the Tractor:

1. On the tractor to which you are assigned, learn where the ground motion controls are found. This includes:
   - Clutch control pedal or lever
   - Gear shift pattern
   - Shuttle shift and/or shift lever

2. In a large open area, practice starting a tractor, moving it forward, and slowly steering it in a figure 8 pattern. Then place the tractor in reverse gear and slowly back through the figure 8 pattern. Use a low range gear and a low-speed throttle adjustment.

3. Ask an experienced operator to show you how to move a tractor and implement uphill and downhill from a standing start.

For Steering the Tractor:

1. Use a 4-H or FFA Tractor Driving Course layout to practice driving a tractor through the course. You can also use the Driving Course Exam Layout from this program or develop your own challenging course.

2. Complete the obstacle course by using the reverse gear and backing through the course using the tractor alone.

3. Make the obstacle course a little larger (Use the course lay-out guide to determine the size of the driving course as described in the NSTMOP Program); repeat the practice with a tractor towing a two-wheeled implement.
   As you develop skill, reduce the size of the opening and practice further. You may make the course smaller as you achieve greater skill.

References

1. Farm and Ranch Safety Management, John Deere Publishing, 2009. Illustrations reproduced by permission. All rights reserved.
2. Operator’s Manual for the model tractor you will operate

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OPERATING A MANUAL SHIFT TRANSMISSION

HOSTA Task Sheet 4.10.1
NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Introduction
To many people this is called a “stick shift”. A gear shift lever on the tractor operator’s platform allows the operator a choice of gears and speeds. The tractor operator must manually shift the gears to change speeds of the tractor. There is a skill involved in doing this task. If done properly a smooth change is noticed; if done improperly, gears will clash and transmission wear will increase.

This task sheet will assist the operator in being able to move a manual shift equipped transmission tractor smoothly with minimal transmission gear wear or damage.

How it works
When you push in on the clutch pedal you are disengaging the friction disk (clutch plate) that turns between the transmission and the engine. This allows the engine to continue to run, but the gears will stop turning.

As the gears slow down, the gear shift lever can be used to slide other gears into place to change direction (reverse) or change ground speeds. There may be only a few choices such as: reverse, 1st gear, 2nd gear, and 3rd gear, or twice as many gear choices if the tractor is equipped with a high and low range (using a second shift lever) transmission.

Gear shift pattern
As you sit in the operator’s seat, find the gear shift lever. Notice that it operates within a notched device that holds the gear shift in that position until you wish to change gears. You may find that this notched part has a lettered decal or numbers embossed into the steel case or in the shift lever knob. Sometimes these are worn to the point you cannot see them. Usually the gear shift pattern resembles the letter H. (Figure 1 A,B, and C)

If you cannot see a pattern, ask your supervisor to show you. If no one is available to show you the gear shift pattern follow these steps:

1. Hold the brake tight.
2. Place the tractor in a gear while releasing the clutch slowly to see what direction or speed begins to occur. Try each gear.

Learning Goals
• To be able to select and use the various gears of the standard shift transmission effectively without damage to the tractor.

Related Task Sheets:
Moving and Steering the Tractor 4.10
What gear should I use?
The tractor is a traction machine. This means that we are using the tractor to pull a load. Driving fast is not the proper choice for a heavy load.

Tractors work more efficiently in a higher gear with a reduced throttle setting. When pulling a light load use a higher gear and reduce the throttle to maintain the desired ground speed. This is difficult to do when using the PTO (power take-off) since most PTO driven machines must be operated at a rated speed to perform properly. Engine speed/PTO speed is often displayed on the tractor instrument panel. Ask for help to understand the gear to select.

Moving the tractor

With the clutch and brake pedals pushed down to disengage the transmission and engage the brakes and with the tractor engine running, increase engine speed slightly and slowly let out on the clutch pedal until you feel movement; then slowly let off the brake pedal at the same time. When you are moving take your feet off the pedals because partial pressure on the clutch pedal (riding the clutch) will cause wear on the clutch plate and bearings in the transmission case.

To change gears, reduce engine speed, press in on the clutch pedal, move the gear shift lever to the next higher or lower gear and slowly release the clutch pedal. Gear up or down as needed. Be prepared to use the brakes if needed.

Clashing gears means you are not timing engine speed with gear shifting movements.

Safety Activities

1. Locate the gear shift pattern decal or marking on the tractor you will operate. Was it easy to find? Was it worn off?
2. Sit in the operator’s seat; push in on the clutch pedal and practice shifting the gears in the pattern shown.
3. If the gear shift pattern markings are gone; ask the supervisor to show you the shift pattern.

References
1. Google search, how to drive a manual transmission vehicle
Learning Goals

- To emphasize the need for ongoing training in the many types of transmissions found on farm tractors.

Related Task Sheets:
- Moving and Steering a Tractor 4.10
- Operating a Manual Shift Transmission 4.10.1

Introduction

“Jump on that tractor and move it to the next farm down the road” said the supervisor. That should be a simple task for anyone who has driven a tractor. Maybe not! Tractor transmissions have come a long way since the manual stick shift. This task sheet briefly discusses tractor transmissions. There are many transmission types and combinations on the market and newer ones are introduced regularly. The operator should be trained on each tractor with a different transmission that he or she is expected to operate.

Advice for beginners

With the many variations in transmission shift patterns, ask the tractor dealer, or employer to show you how the tractor is effectively shifted for various tasks.

Use the Operator’s Manual for the specific tractor to learn more about the transmission use.

Use an Internet search tool such as “Google” to help you understand a specific type of transmission.

To prevent injury to yourself or others, and to prevent damage to the tractor or other property, ask for training before using the tractor.

Manual Transmissions

There are many “stick shift” tractors still in use and entry level employees may be assigned to these tractors until experience is gained.

Review Figure 4.10.s.a. for a reminder of what a stick shift gear pattern may look like, as well as where the gear shift lever is located.

The gear shift lever and high-low range shift is normally found on the transmission housing and between the operator’s legs.

See Task Sheet 4.10.1, Operating a Manual Shift Transmission for more information.
Transmissions other than standard or stick shift

Changing gears with a stick shift is inefficient. Tractor manufacturer’s developed a means of “shifting on the go” to improve tractor efficiency and increase operator comfort. The clutch pedal may still be used to disengage the clutch between the transmission and the engine, but chances are the newer model tractors will not use a pedal for shifting gears at all. Once on the move the simple movement of the power (gear) shift lever gives a greater range of power and speed.

There are many variations shown here. You must become familiar with the transmission you will be using. Study the Operator’s Manual and ask for assistance from a knowledgeable person.

Figure 4.10.2.c. Look on the left side of the steering column. The shuttle shift lever, sometimes called the reverser, allows for ease of changing direction without using the clutch. This lever may serve as the positive park to be used with the parking brake. Some may have to be in a neutral position for the tractor to start. This may be the only time that the clutch pedal is used.

Figure 4.10.2.d. The clutch pedal on the left side of the floor may be used only to start the tractor and may not be used again until stopping.

Figure 4.10.2.e. A single orange colored proportional travel lever (shift lever) may be used to move the tractor forward or in reverse. There may be an adjustment knob or button built into the shift lever to further set the range of power and speed. The foot and hand accelerator are orange colored also.

Figure 4.10.2.f. The tractor should always be left in the positive park position with the parking brake locked (circled). The shift lever is moved from “P”, park, to forward or reverse position. A range of numbers and/or letters (1-2-3-4, A-B-C-D) provides the power and speed ranges for the task.

Always look for the “orange” colored controls. Some may be faded or nearly invisible.
It is wise to ask for a demonstration of how the transmission of the tractor works. Tractors are a large investment which can be damaged if not used properly.

The newer model tractor transmissions not only combine hydraulic power with a synchronized gear train, but have added an electronic monitoring system to further make for efficient, fuel-saving usage. Here are a few of the possibilities:

- Electronic monitoring of 100 checks per second to modify tractor engine speed in relation to power requirements of the job.
- A de-clutch button to enable gear shifting on the go without depressing the clutch pedal. It conveniently allows the operator to increase transport performance and comfort, helping to save additional time.
- Electro-hydraulic Hi-Lo range selection with the push of a button.
- Standard creeper range for work where slower speeds are required.

Continued transmission evolution expected
Safety Activities

1. Locate the speed and power shift control lever on the tractor which you will operate. Was it easy to find? What color is that control lever? Was the color worn to the point that you could not tell what color it was?

2. Sit in the operator’s seat. Is there a clutch pedal? Can you move the speed and power control lever(s) while the engine is not running? Can you locate the shuttle shift, or reverser lever? Where is the shuttle shift, or reverser lever?

3. Try starting the tractor. Did it start when you followed the directions in the Operator’s Manual? If it did not start, can you explain why it did not start?

4. On late model tractors, use the Operator’s Manual to locate information that would tell you what speed and power setting to use for various field operations. Answer these:

<table>
<thead>
<tr>
<th>Field work to be done</th>
<th>Transmission setting</th>
<th>Engine RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Light load</td>
<td>_______________</td>
<td>___ _____</td>
</tr>
<tr>
<td>B. Heavy load</td>
<td>_______________</td>
<td>___ _____</td>
</tr>
</tbody>
</table>

References

1. Operator’s Manuals from various tractor manufacturers, specifically the tractor which you will operate.
2. Internet sources for various tractor manufacturers.
3. Knowledgeable, trained individuals who can demonstrate how and why the transmission is used for a specific tractor.

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Introduction
Being able to steer the tractor in the proper direction of operation without damage to the tractor and machinery is important. The safe and effective tractor operator can make the tractor move where it is supposed to go.

Not all operations will be in a forward direction. You must be able to operate the tractor and equipment in the reverse direction. Hitching to equipment, backing equipment, unloading crops, and even storing machinery is done in reverse.

Reverse travel and steering is generally done without looking at the direction of the steered wheels. These wheels will usually be out of your line of sight. You must master the concept that the steered wheels are pointing the rear of the tractor in the direction you want it to go.

To back safely, check your line of travel, back slowly, and have someone help direct you if needed.

This task sheet instructs how to correctly steer a tractor in reverse. Master this task without any equipment hooked to the tractor before beginning to back a two-wheel or four-wheel machine or implement.

Reverse Direction Hazards
People, animals, or other objects may be in the line of travel. As you look from the front of the machine to the rear, you may lose sight of such obstacles. Skid loaders and industrial equipment have reverse gear alarms to warn others, but tractors usually do not.

Workers who help you by hitching the implement to the tractor can be crushed if your foot slips from the clutch pedal, if you are driving too fast in reverse, or if you fail to steer in the correct direction in reverse. Do not permit the helper to go between the tractor and implement to be hitched before you stop the tractor and turn off the engine.

There is a tendency to shift slightly from the operator’s seat when looking to the rear. You must stay in good contact with foot and hand controls to be safe.

Learning Goals
- To safely drive a tractor in reverse gear to a specific location with few directional corrections
- To spot the tractor drawbar to the hitch of the machine with no more than three changes of direction

Related Task Sheets:
- Mounting and Starting the Tractor 4.8
- Stopping and Dismounting the Tractor 4.9
- Moving and Steering the Tractor 4.10
Tips for Backing a Tractor With an Implement

Follow these safety tips when driving a tractor in reverse without an implement:

1. Be sure seat and controls are adjusted for you.
2. Be sure all persons, animals, and objects are clear of the tractor.
3. Engage the clutch slowly, use a low engine speed, and maintain foot contact with the clutch and brake.
4. Turn the top of the steering wheel in the direction you want the rear of the tractor to move. Move the steering wheel to the left if you wish to move the rear of the tractor to the left. If you wish to move the rear of the tractor to the right, move the steering wheel to the right.
5. To back with a two-wheeled implement, you must use the rear of the tractor to force the implement to go where you want it. To move the implement to the left, steer the tractor to the right. To move the implement to the right, steer the tractor to the left. This must be done slowly.

Safety Activities

1. With a clutch-type tractor, practice pushing the clutch in all the way and then releasing the clutch slowly to get the feel of the clutch pressure. Do this without starting the tractor; then practice this task in a clear area with the engine running.
2. Practice starting a tractor, moving it forward, slowly steering in a figure 8. Place tractor in reverse gear and slowly back in a figure 8 pattern. Use a low-range, low-throttle adjustment.
3. Ask an experienced operator to demonstrate how to back a two-wheeled implement.
4. Practice turning and backing with a two-wheeled implement attached to the tractor.

References

Introduction

No other machine is more identified with the hazards of farming as the tractor. Nearly 50% of tractor fatalities come from tractor overturns. Tractors are used for many different tasks. Because the tractor is a versatile machine, operators sometimes stretch the use of the tractor beyond what the machine can safely do. For example, an operator may turn a corner too quickly for the tractor to stay upright. The use of a rollover protective structure (ROPS) and a seat belt can save your life if a tractor overturns while you are driving.

This task sheet explains the four major reasons and forces that allow tractors to overturn, gives rules for how to prevent tractors from overturning, and discusses the use of tractor ROPS with a seat belt.

How Tractors Overturn

Center of gravity (CG). A center of gravity is the point where all parts of a physical object balance one another. When you balance a pencil on your finger, you have found the pencil’s CG. This is the part of the pencil that is resting on your finger. On a two-wheel drive tractor, CG is about 10 inches above and 12 inches in front of the rear axle. Figure 4.12.a shows the normal position of a tractor’s CG.

Look at Figure 4.12.b. This shows that the CG is inside a tractor’s stability baseline. Drawing a line to connect all the wheels of the tractor as the wheels set on level ground forms a tractor stability baseline. The line connecting the rear tire ground contact points is the rear stability baseline. The lines connecting the rear and front tire on the same side are the right and left side stability baselines. Front stability baselines exist but have limited use in tractor overturn discussions.

There are two very important points to remember about tractor CG and stability baselines:

- The tractor will not overturn if the CG stays inside the stability baseline.
- The CG moves around inside the baseline area as you operate the tractor.

As you can see in figure 4.12.b, a wide front-end tractor provides more space for the CG to move around without going outside the stability baseline.

Related Task Sheets:
- Agricultural Tractors 4.1
- Tractor Hazards 4.2
- Moving and Steering the Tractor 4.10
- Using the Tractor Safely 4.13
- Operating the Tractor on Public Roads 4.14
**Reasons the CG Moves Around**

There are five main reasons why a tractor’s CG moves outside the stability baseline.

1. The tractor is operated on a steep slope.
2. The tractor’s CG is raised higher from its natural location 10 inches above the rear axle.
3. The tractor is going too fast for the sharpness of the turn.
4. Power is applied to the tractor’s rear wheels too quickly.
5. The tractor is trying to pull a load that is not hitched to the drawbar.

**How Center of Gravity and Centrifugal Force Result in an Overturn**

When a tractor is on a slope, the distance between the tractor’s CG and stability baseline is reduced. Figure 4.12.c shows how this occurs. On steep slopes, the tractor is already close to an overturn. A small bump on the high side, or a groundhog hole on the low side, may be all that is needed for the tractor to overturn.

Centrifugal force (CF) is the outward force nature exerts on objects moving in a circular fashion. During tractor overturns, CF is that force trying to roll the tractor over whenever the tractor is turning. Centrifugal force increases both as the turning angle of the tractor becomes sharper (decreases), and as the speed of the tractor increases during a turn. For every degree the tractor is turned tighter, there is an equal amount of increased CF.

The relationship between CF and tractor speed, however, is different. Centrifugal force varies in proportion to the square of the tractor’s speed. For example, doubling tractor speed from 3 mph to 6 mph increases the strength of CF four times \((2^2 = 2 \times 2 = 4)\). Tripling tractor speed from 3 mph to 9 mph increases CF nine times \((3^2 = 3 \times 3 = 9)\).

Centrifugal force is what usually pushes a tractor over when the tractor is driven too fast during a turn or during road travel. During road travel, rough roads may result in the tractor’s front tires bouncing and landing in a turned position. If the tractor starts to veer off the road, over correction of steering can result in side overturns. Centrifugal force is often a factor in tractor side overturns. When the distance between the tractor’s CG and side stability baseline is already reduced from being on a hillside, only a little CF may be needed to push the tractor over.

Engaging the clutch of a tractor results in a twisting force, called torque, to the rear axle. Under normal circumstances, the rear axle (and tires) should rotate and the tractor will move ahead. If this occurs, the rear axle is said to be rotating about the tractor chassis. If the rear axle cannot rotate, then the tractor chassis rotates about the axle. This reverse action results in the front end of the tractor lifting off the ground until the tractor’s CG passes the rear stability baseline. At this point, the tractor will continue rearward from its own weight until the tractor crashes into the ground or other obstacle. See Figure 4.12.e.
The CG of a tractor is found closer to the rear axle than the front axle. A tractor may only have to rear to about 75 degrees from a level surface before its CG passes the rear stability baseline and the tractor continues flipping over. This position is commonly called the “point of no return.” As Figure 4.12.e shows, this point can be reached more quickly than an operator can recognize the problem.

Common examples of this type of tractor overturn are: the rear tires are frozen to the ground; tires stuck in a mud hole; or tires blocked from rotating by the operator. Rear overturns can also happen on a slope if an operator applies too much power too quickly to the rear axle. When a tractor is pointed up a slope, there is less rise needed to reach the point of no return because the CG has already moved closer to the stability baseline. Figure 4.12.f shows how this occurs.

When a two-wheel drive tractor is pulling a load, the rear tires push against the ground. At the same time, the load attached to the tractor is pulling back and down against the forward movement of the tractor. The load is described as pulling down because the load is resting on the earth’s surface. This backward and downward pull results in the rear tires becoming a pivot point, with the load acting as a force trying to tip the tractor rearward. An “angle of pull” is created between the ground’s surface and the point of attachment on the tractor.

A tractor, including the drawbar, is designed to safely counteract the rearward tipping action of pulled loads. When loads are attached to a tractor at any point other than the drawbar, the safety design of the tractor for pulling loads is defeated.

The heavier the load and the higher the “angle of pull,” the more leverage the load has to tip the tractor rearward. Figures 4.12.g, 4.12.h, and 4.12.i. show important information about safe hitching points.

Figure 4.12.f. When a tractor is pointed up a slope, the CG is closer to the rear stability baseline.

Figure 4.12.e. The point of no return is reached in 3/4 of a second. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Figure 4.12.g. Only hitch to the drawbar. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Figure 4.12.h. Never hitch to the top link of a 3-point hitch. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Figure 4.12.i. The angle of pull should be kept to a minimum.
Protect Yourself in a Tractor Overturn

The rollover protective structure (ROPS) and seat belt, when worn, are the two most important safety devices to protect operators from death during tractor overturns. Remember the ROPS does not prevent tractor overturns, but can prevent the operator from being crushed during an overturn. The operator must stay within the protective frame of the ROPS (Zone of Protection) in order for the ROPS to work as designed. This means the operator must wear the seat belt. Not wearing the seat belt may defeat the primary purpose of the ROPS.

A ROPS often limits the degree of rollover, which may reduce the probability of injury to the operator. A ROPS with an enclosed cab further reduces the likelihood of serious injury because the sides and windows of the cab protect the operator. This assumes that cab doors and windows are not removed.

To prevent tractors from overturning in the first place, follow the safety recommendations that are illustrated in Task Sheet 4.13.

Note: ROPS are available in folding and telescoping versions for special applications, such as orchards and vineyards and low-clearance buildings. Some ROPS may be a protective frame only and not an enclosed cab.

Safety Activities

1. Use a toy scale model or a full-size tractor to illustrate the five main reasons tractors overturn.
2. Invite a farmer whom you know who has survived a tractor rollover to speak to the class about the experience.
3. Conduct a survey of area farm people to find out instances of tractor overturns in the last five years. How many overturns resulted in a fatality? How many survived an overturn? Did a ROPS play a role in their

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.cdc.gov/Type agriculture tractor overturn hazards in search box/Click on 1.67 Tractor Overturn Hazards, August 2002.

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Introduction
Tractors can be operated safely if they are used as designed and operated following recommended practices.

There are an estimated 300 farm tractor fatalities each year. Read these short examples.

- Teenager killed using tractor to spotlight deer in the woods.
- Man killed when tractor rolled onto him while dragging logs in the woods.
- Grandfather killed, but passenger grandson lives when tractor goes over an embankment while going for a fun ride.
- Tractor overturns while towing stalled pickup full of firewood.
- Tractor upsets sideways while high lift bucket is in a raised position while traveling across a rough slope.

This task sheet will identify several proper and improper uses of tractors.

Proper Use Defined
Tractors are made to work, not to be treated as ATVs, four-wheelers, dune buggies, or as other recreational vehicles.

Tractors serve four purposes:
1. They are a remote power source.
2. They carry/pull machines.
3. They move loads.
4. They transport materials.

If you are not sure of a specific use for your tractor, consult the Owner’s Manual.
Proper Use Means Avoiding Improper Use

Figure 4.13.b. Tractors are designed for the operator only. No passengers allowed!

Figure 4.13.c. Tractors provide remote power to machinery. This turning shaft, the PTO, must be guarded to prevent entanglement hazards such as this.

Figure 4.13.d. Hitch loads only to the drawbar. The drawbar has been engineered to pull heavy loads without risking a rear overturn hazard. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Figure 4.13.e. If you are stuck or need to be towed, you will need help from a second tractor. Use the strongest and best tow strap, cable, or chain that is available. Hitch only to the drawbar. The best advice for a young operator is to get adult help to pull the disabled or stuck tractor. Farm and Ranch Safety Management, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.
Figure 4.13.f. Avoid ditch embankments. Tractors are heavy and embankments can give way. For example, if the ditch is 6 feet deep, stay back at least 6 feet. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses*, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Figure 4.13.g. High speeds while making a turn can cause a sideways overturn. Make sure brakes are locked together. Reduce speed before entering the turn. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses*, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Figure 4.13.h. Avoid obstacles as you operate the tractor. Some tractor operators will check the field before beginning the operation. Stumps, rocks, animal dens, etc., can upset a tractor.

Figure 4.13.i. Tractors are powerful, but each one has a limit to its pulling power. Overloading a tractor could stall the engine, but rearward overturns can occur as well. *Farm and Ranch Safety Management*, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.

Figure 4.13.j. Field conditions pose special hazards to tractor operation. The operator must know where these obstructions and depressions are located. *Farm and Ranch Safety Management*, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.

Figure 4.13.k. When operating a high-lift bucket with a load or without a load, keep the bucket as low to the ground as possible while in transport. Sideway overturns are possible if you try to travel with the bucket in the up position. *Farm and Ranch Safety Management*, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.
Safety Activities

1. Start a collection of farm accident reports from magazines, newspapers, and farm newsletters.

2. Using a camera or video recorder, take photos or video film of unsafe tractor use situations. Make a display for your club, classroom, employee room or farm shop.

3. Try this Word Search Game to find words related to proper tractor use. Words or phrases may be spelled forward, backward, up, down, or diagonally.

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

   Use this word list: attitude, safety, guards. no riders, overturn, alert, low speed, pto

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Credits
This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under Agreement Nos. 2001-41521-01263 and 2010-41521-20839. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.
**Introduction**

Today’s farmers are traveling more miles than ever before on public roads to plant, grow, and harvest crops. Slow-moving tractors and implements are no match for the general public’s high-speed travels. Most crashes between farm equipment and motor vehicles occur during daylight and in good weather. You can never let your guard down when traveling on a public road with farm equipment.

This Task Sheet discusses operation of the tractor and equipment on public roads.

**Movement Hazards**

These traffic situations are created by operating tractors on public roadways.

- Pulling slowly onto roads with long and heavy loads
- Slow tractor travel speeds
- Left turns across traffic into narrow field lanes
- Swinging into the left lane to make a right turn into a field
- Wide machinery being transported
- Potential for spilled loads

All rules of vehicle safety, as well as all rules of courteous driving, must be followed to prevent traffic problems.

**Obeying the Law**

Each state varies in their highway regulations regarding the ages and places where one may operate a farm tractor. States seldom require a driver’s license for a tractor, but many do limit 14- and 15-year-old drivers to crossing over public roadways only or to operating equipment on roads that bisect or adjoin their farm.

Check with your local state police to learn more about the laws in your area.

You must also obey all traffic laws and signs as well.

**Learning Goals**

- To understand the difference between farm equipment road use and normal highway vehicle road use
- To use all safe and courteous traffic driving practices to prevent farm equipment and motor vehicle crashes

**Related Task Sheets:**

- Safety and Health Regulations 1.2
- Reaction Time 2.3
- Hand Signals 2.9
OPERATING THE TRACTOR ON PUBLIC ROADS

standards? If not, can the equipment be improved with retrofit kits of lights and reflectors?

Although not included in the ASAE standard, rotary beacons and back-up alarms are optional accessories which may be add-ons depending upon your needs. If accessories have been added, they should be in working order.

American Society of Agricultural Engineers (ASAE) Standards for lighting and marking are summarized in Table 4.14.a. Most farm equipment delivered from the factory today will have used these standards. Does the equipment that you will use measure up to these standards?

Using the proper lighting and marking standards gives motorists ample warning that farm equipment is using the public roadway.

Lighting and Marking

Using the proper lighting and marking standards gives motorists ample warning that farm equipment is using the public roadway.

Although not included in the ASAE standard, rotary beacons and back-up alarms are optional accessories which may be add-ons depending upon your needs. If accessories have been added, they should be in working order.

Table 4.14.a. Recommendations from ASAE for lighting and marking.

<table>
<thead>
<tr>
<th>Item</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
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<td>Two white lights mounted at the same level</td>
</tr>
<tr>
<td>Taillights</td>
<td>Two red lights mounted at the rear</td>
</tr>
<tr>
<td>Hazard Flashers</td>
<td>Two or more lamps with amber color to the front and red color to the rear</td>
</tr>
<tr>
<td>Turn Indicators</td>
<td>Two amber to the front and two red-colored lights to the rear mounted with flashers</td>
</tr>
<tr>
<td>SMV Emblem</td>
<td>One visible at 1000 ft. mounted to the rear and 2-10 ft. above the ground</td>
</tr>
<tr>
<td>Reflectors</td>
<td>Two red reflectors (on rear outside corners) and 2 yellow reflectors (on the front outside corners) of the machine</td>
</tr>
<tr>
<td>Conspicuity Material</td>
<td>Red retro-reflective and red-orange fluorescent color visible to mark the rear. Yellow retro-reflective material to mark the</td>
</tr>
</tbody>
</table>

Figure 4.14.b. Lighting and marking standards may or may not be the standards for your state. Check your state laws.

Figure 4.14.c. Be sure that a work light that points to the rear is off during road travel at night. Single white lights may not be recognized as slow-moving or as a tractor light. Also if SMV emblems are worn or obsolete, replace them with newer more reflective SMV emblems.

Figure 4.14.c. Be sure that a work light that points to the rear is off during road travel at night. Single white lights may not be recognized as slow-moving or as a tractor light. Also if SMV emblems are worn or obsolete, replace them with newer more reflective SMV emblems.

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Towing Safety

Figure 4.14.d. Secure hitch pins with locking clips as shown.

Figure 4.14.e. Use safety chains to insure load hitching safety when possible. Trucks pulling farm loads should have safety chains also. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Figure 4.14.f. SMV emblems are required on vehicles designed to travel less than 25 mph while occupying public roadways. SMV emblems should be visible from no less than 1000 feet to the rear of the tractor or towed implement. Therefore, mounting height may vary from 2 to 10 feet above the road surface. Replace faded, damaged SMV emblems.

General Practices for Tractors on Highways

Think about the following when traveling on the highway with farm machinery.

- Time of day–Is it possible to avoid the busy times of the day to move equipment? Hauling large loads during early morning or late afternoon while people hurry to and from work creates traffic problems for both of you. Moving loads after nightfall may be better timing, but lighting becomes a necessary consideration.

- Courtesy– Try to be as watchful of others as possible. Let the high-speed traffic go first. Your best manners on the highway will be the first safe practice to follow.

- Blind spots– Are there locations which pose problems with visibility? Avoid them if possible.

- Shifting loads– If you upset a load of hay, spill a load of manure or a tank of pesticide mixture, or coat the road with mud from the field, you are responsible for getting help for cleanup and alerting traffic to be cautious. If manure or chemical spills endanger waterways, notify your employer who may have reporting requirements with state environmental officials.

- Safe Equipment– Your walk-around inspection should have shown you if you have damaged equipment. Be sure damaged equipment does not create a road hazard. For example, a loose wheel on a hay rake could cause a disaster.

Pull completely off the road to let traffic flow past if possible. DO NOT SIGNAL THEM TO PASS YOU. Signalizing to motorists to pass makes you responsible for them.

Figure 4.14.h. Use accepted hand signals to inform other drivers of your intentions. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.
**Safety Activities**

1. Measure the length of the longest tractor and implement combination with which you will work. Then have someone time how long it takes you to move the front end of that tractor to the rear end of the towed implement past a point or across the highway in front of the farm. How many seconds did it take to cross the road? ___________seconds.

2. A car approaching the farm driveway is traveling at 60 mph. How many feet will that car travel in 1 second? ___________seconds.

   **Hint:** 60 mph = 1 mile/minute Calculate what distance in feet will be covered in 1 second. Remember that 5,280 feet equals 1 mile.

   
   $$1 \text{ mile} / \text{minute} = \text{__________ feet / second}.$$  

3. Multiply the answer (feet/second) in question number 2 by the time you recorded in question number 1.

   This is the distance the car going 60 mph will travel in the time it takes you to cross the road. Record the answer here. __________ Can you see that far as you pull out to cross the roadway?

4. Conduct a survey of the lighting, marking, and hitching of the tractors on your farm or farm of employment. Does it meet the safety requirements of your state?

5. Practice the hand signals for right, left, and stop that you will use while operating a tractor not equipped with turn signals.

**References**

1. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.
Introduction
Today’s farmers are traveling more miles on public roads than ever before to tend to livestock and plant, grow, and harvest crops. Slow-moving tractors and implements are no match for the public’s high-speed travels.

Most crashes between farm equipment and motor vehicles occur during daylight hours and in good weather. You must be careful when traveling on public roads with farm equipment. Tractors and equipment must be clearly identified as slow-moving vehicles using recognizable lighting and marking.

This task sheet discusses lighting and marking as it relates to moving tractors and equipment on public roadways.

Lighting and Marking
The American Society of Agricultural Engineers (ASAE) Standard for Lighting and Marking are summarized in Table 4.14.1.a. See the reference section to access the asae.org information.

Most farm equipment manufactured today will use this standard. Exceptions to the standard may occur with equipment manufactured outside the United States. Many states use a similar standard in their Motor Vehicle Codes to specify lighting and marking of slow-moving vehicles and farm equipment.

Lighting and marking on older equipment can be improved to meet this standard with add-on lights and reflectors kits.

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Table 4.14.1.a  Recommendations from ASAE for lighting and marking

Learning Goals
- To understand the recommendations for lighting and marking of farm tractors and machinery

Related Task Sheets:
- Safety and Health Regulations 1.2
- OSHA Act 1.2.2
- State Vehicle Codes 1.2.5
- Hand Signals 2.9
- Operating the Tractor on Public Roads 4.14
Is Your Lighting and Marking Adequate?

Highway transport of farm equipment at night requires lighting and marking. Older equipment must meet these requirements as well. The requirements are:

- Slow-moving speed shown by SMV emblem
- Extremities of width defined by side marker lights or decals
- Ability to warn of turns by recognizable signals

If the tractor and equipment or self-propelled equipment does not meet these requirements, the operator increases the risk of injury to him or herself and the public.

Safety Activities

1. Clean all the lights, SMV emblems, and reflective markers daily on the farm equipment you will operate.

2. Conduct an inspection of all tractors and equipment on a local farm. Make a list of lighting and marking deficiencies you find.

3. Use the website www.asae.org to learn more about machinery and equipment lighting and marking standards.

4. Using the Internet, search your favorite brand of tractor or machinery to access pictures that show the lighting and marking methods used. Do the methods meet the ASAE standards?

References

1. American Society of Agricultural and Biological Engineers, ANSI/ASABE, S279.12 Lighting and Marking of Agricultural Equipment on Highways, St. Joseph, MI.


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