



CONNECTING IMPLEMENTS TO THE TRACTOR

HOSTA Task Sheet 5.1

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

"The owner says that I should be able to connect (hitch) the rake to the tractor and be in the nearby field within 5 minutes. It has been 10 minutes, and I still can't seem to get the drawbar of the tractor lined up with the hitch on the rake."

Can you steer in reverse? Can you use the clutch and brakes smoothly? If not, review the lessons on steering in reverse and moving and steering the tractor.

Do you understand where to hitch to the load to insure tractor stability? If not, review the lessons on tractor stability.

This task sheet provides an overview of safe and efficient hitching of implements to the tractor. See Task Sheet 5.2 or 5.3 for additional details.

Hitching and the Center of Gravity

In Task Sheet 4.12, *Tractor Stability*, you learned about the tractor's center of gravity and stability baseline. Tractor hitches are designed so the downward and rearward force during a pull are below the center of gravity (Figure 5.2.a.). To maintain tractor stability, the "angle of pull" should be kept as low as possible by hitching to the drawbar only.

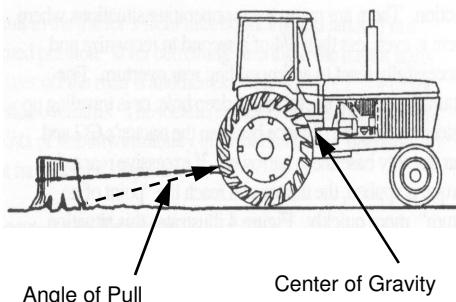


Figure 5.1.a. An example of safe hitching. The drawbar will lower if the front end lifts off the ground. This reduces the "angle of pull" and the risk of a rear overturn.

Pulling a load with the downward and rearward force above the tractor's center of gravity will result in a rear overturn. You must hitch only to the drawbar to prevent the tractor from rearing up and turning over. Even small lawn and garden-size tractors can flip rearward if not properly hitched to a load.



Figure 5.1.c. The tractor drawbar is the only safe place to connect a load. Do not hitch higher than the drawbar so all pulling forces stay below the tractor's center of gravity. For most operations, the drawbar should be placed midpoint between the rear tires to maximize pulling power. Hillside operations may require a drawbar adjustment to one side to balance the pulling forces.

**Hitch to the drawbar
only! Hitching
anywhere else can
result in rear turnover
and death.**

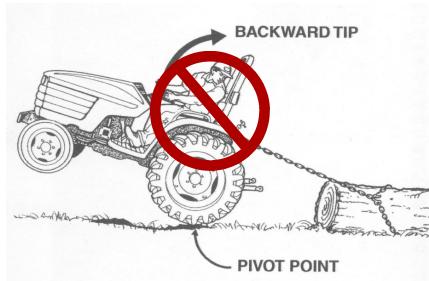


Figure 5.1.b. The log is fairly immovable. A chain hooked above the center of gravity of the tractor (e.g., top of 3-point hitch bracket), allows a rearward tip of the tractor. Improper hitching has overridden safe tractor engineering design. Many people have lost their lives as a result. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses*, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Learning Goals

- To safely connect an implement to the tractor's drawbar
- To safely connect an implement to the tractor's 3-point hitch

Related Task Sheets:

Tractor Stability	4.12
Using the Tractor Safely	4.13
Operating the Tractor on Public Roads	4.14
Using Drawbar Implements	5.2
Using 3-Point Hitch Implements	5.3



Figure 5.1.d. Tractor drawbars are designed at the correct height from the ground to keep the pull forces below the center of gravity. See Table 5.1.a. Only use the drawbar to tow a load. A swinging or floating drawbar permits adjustment of the center line of pull to be maintained even on a hillside.

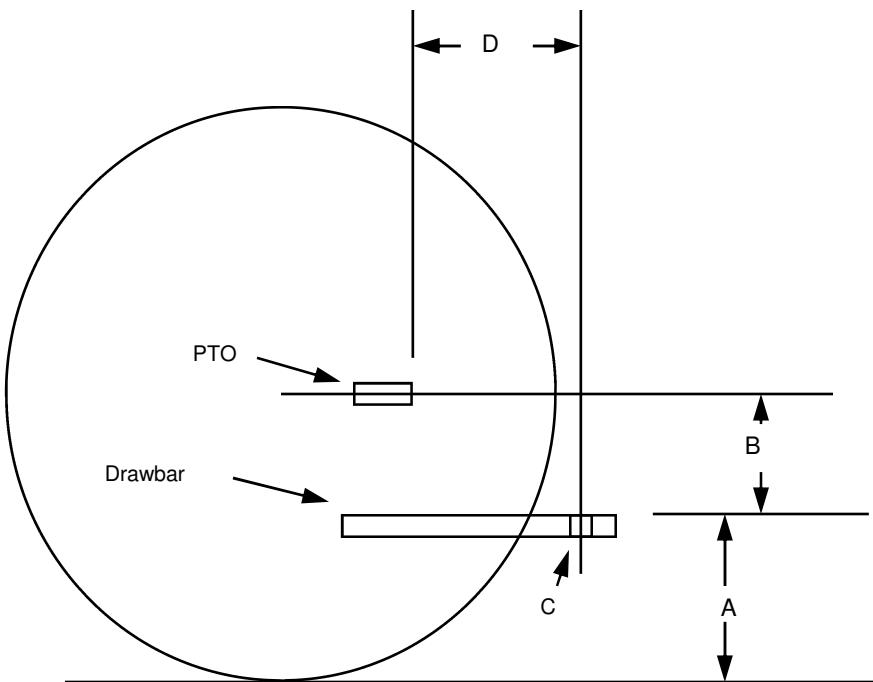


Figure 5.1.e. The tractor power take-off and drawbar position are designed with specific measurements for the size and horsepower rating of the tractor. The operator should not make changes to these design standards by changing the hitch point. Table 5.1.a lists the measurements and relationships at points A, B, C, and D above for each range of tractor size.

A bolt laying around the farm shop is not a substitute hitch pin!
Hitch pins are designed for specific drawbar loads and power ratings and must fit the drawbar hole.

Drawbar Hitch Category				
Item	I	II	III	IV
Tractor HP	20-45	40-100	80-275	180-400
Drawbar Height				
above ground (A)	15"+/-2"	15"+/-2"	19"+/-2"	19"+/-2"
Drawbar to PTO (B)	8"-12"	8" - 12.5"	8.5" - 14"	10" - 14"
Hitch-Pin Hole Size(C)*	1.1"	1.3"	1.7"	2.1"
Nominal Hitch Pin Size*	1.0"	1.2"	1.6"	2.0"
Drawbar Dimensions	(Thickness x width)			
	1-3/16"x2.0"	1-9/16"x2.5"	2"x3-3/16"	2-3/8"x 4-7/8"
Regular Size PTO				
Stub Shaft to Drawbar				
Hitch Hole (D)	14-20"	14-20"	14-20"	14-20"

* The measurement has been rounded to the nearest 1/10 (0.1) inch.
 Hitch pins must fit the hitch-pin hole without excessive movement.

Table 5.1.a. Drawbar Sizing and Positioning Standards (ASAE S482)

The 3-Point Hitch

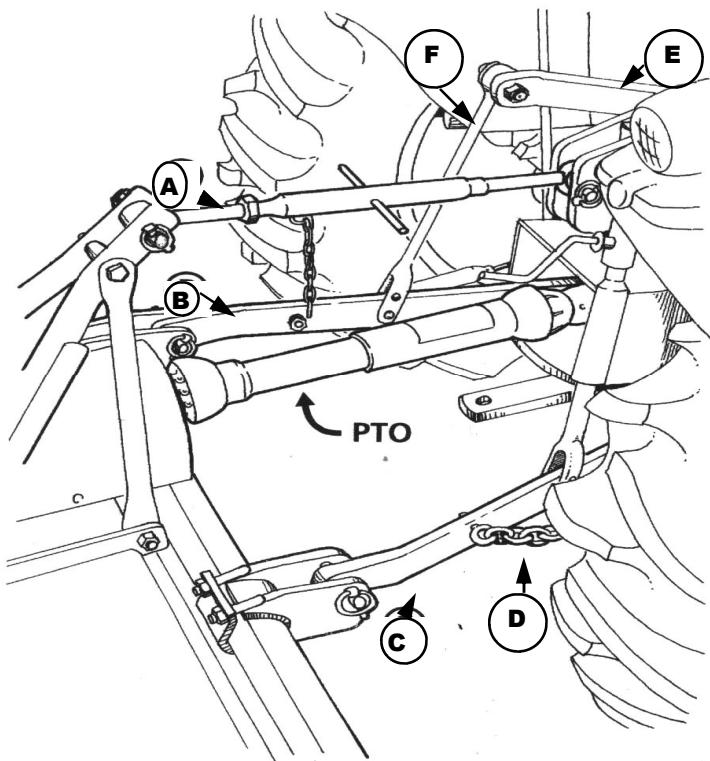


Figure 5.1.f. Parts of the 3-Point Hitch

- | | | |
|-------------|-----------------|---------------------------|
| A. Top Link | B,C. Draft Arms | D. Anti-sway bar or chain |
| E. Lift Arm | F. Lift Rod | |

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

Implement Hitching

Follow these steps for hitching to a drawbar: Also see Task Sheet 5.2.

1. Position the tractor to align the hole in the drawbar with the hole in the implement hitch. This is called spotting. You may need to practice this skill.
2. Stop the engine, put the tractor in park, or set the brakes.
3. Attach the implement using the proper-sized hitch pin and security clip.
4. Raise the implement jack stand and remove chock

blocks from the wheels.

5. Connect the PTO shaft, hydraulic hoses, and/or electrical connections as required. Refer to the appropriate task sheets on these subjects.

Follow these steps for hitching to a 3-point hitch attachment: Also see Task Sheet 5.3.

1. Move the stationary tractor drawbar forward for clearance.
2. Position the tractor so the pin holes of the draft arms are closely aligned with the implement hitch points.
3. Raise or lower the draft arms

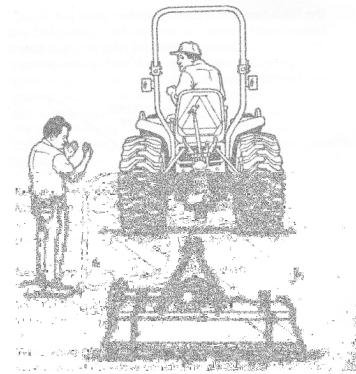


Figure 5.1.g. Never let another person stand between the tractor and the implement during hitching. Too fast of an approach or the operator's foot slipping from the clutch can lead to injury or fatality to the person standing nearby. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.*

to match the implement hitch points.

4. Stop the engine, securely park the tractor, set the brakes.
5. First attach left draft arm to the implement hitch point using the proper size hitch pin and security clip. Right arm is adjustable and is connected next.
6. Remount and start the tractor to use the hydraulic system to raise the lift arms if needed.
7. Match the top link of the 3-point hitch to the implement's upper hitch point. Raise the lift arms to lengthen, or drive ahead with implement down to shorten to adjust if needed. The implement may not be level if the upper link has been adjusted too many times. If it is out of level, the machine may not work properly *If you cannot level the machine, ask for help.*
8. Securely attach the upper hitch pin with the proper size hitch pin and security clip.

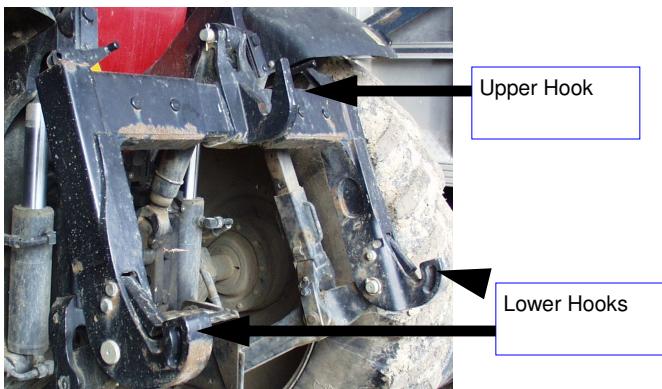


Figure 5.1.h. Heavy-duty quick-attach couplers are mounted on to the tractor's 3-point hitch and can safely handle large 3-point hitch implements without a person moving between the tractor and the implement. See the circled areas which show these hook and latch points. Refer to the Owner's Manual for additional instructions on their use or have a qualified operator demonstrate to you the correct procedure to use a quick-attach coupler.

Safety Activities

1. Practice backing a tractor with a drawbar to an implement to "spot" the hole in the drawbar to the hole in the implement tongue. You should be able to perform this skill with a minimum number of changes of direction to be a proficient tractor operator.
2. Practice backing a tractor with a 3-point hitch to an implement to adjust the pin hole in the draft arms to the lower hitch pins on the implement's 3-point hitch attachment. As you become more able to align these points, securely park the tractor. Attach the draft arm hitch pins, restart the tractor, adjust the draft arms to align, and connect the upper link point. You should be able to perform this skill with a minimum change of direction to be a proficient tractor operator.
3. On a tractor you can easily measure, take measurements and record the following:
 - a. distance from ground to drawbar _____ inches
 - b. dimensions of drawbar (width and thickness) _____x_____ inches
 - c. hitch-pin hole opening in drawbar _____ inches
 - d. vertical distance from drawbar to center of PTO stub shaft _____ inches
 How do these measurements compare with the standards shown on Table 5.2a?
4. Using a battery-operated toy truck or tractor, devise a place to hitch a load at a point above the toy's axle. Make a sled from sheet metal or cardboard, and attempt to pull a load of small objects such as nuts, bolts, etc. What happens as the toy attempts to pull the load? Change the height and length of the angle of pull, and record the reaction of the toy truck or tractor to the changes made.

References

1. American Society of Agricultural and Biological Engineers, ANSI/ASABE, S482 Drawbars, St. Joseph, MI.
2. American Society of Agricultural and Biological Engineers, ANSI/ASABE, S217 Three-Point Free Link Attachment, St. Joseph, MI.
3. Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Contact Information

National Safe Tractor and Machinery Operation Program
 The Pennsylvania State University
 Agricultural and Biological Engineering Department
 246 Agricultural Engineering Building
 University Park, PA 16802
 Phone: 814-865-7685
 Fax: 814-863-1031
 Email: NSTMOP@psu.edu

Credits

Developed by WC Harshman, AM Yoder, JW Hilton and D J Murphy, The Pennsylvania State University. Reviewed by TL Bean and D Jepsen, The Ohio State University and S Steel, National Safety Council.
 Revised 3/2013

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.



USING DRAWBAR IMPLEMENTS

HOSTA Task Sheet 5.2

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

Several agricultural implements are ground-driven (the power comes from the wheels turning on the ground). Use of the PTO is unnecessary. If you stop moving forward with these implements, the machine stops operating. The beginning tractor operator is often assigned to hitch to and use these types of drawbar implements.

A qualified operator should demonstrate how to safely use equipment before expecting you to operate the equipment successfully.

This task sheet will focus on towed equipment which is ground-driven. Other task sheets will provide information regarding PTO and hydraulic and electrical connections between the tractor and the implement.

Hitching Review

Follow these steps for drawbar hitching to an implement equipped with a height positioning jack:

1. Back to the correct position to align, or “spot,” the hole in the drawbar with the hole in the tongue. (Figure 5.2.a.)
2. Stop the engine, securely park the tractor, and set the brakes.
3. Dismount from the tractor to adjust the implement tongue height using the support jack.

4. Remount and start the tractor to make final adjustment to the “spot.” If necessary stop the engine, securely park the tractor, and set the brakes.
5. Attach the implement using the proper hitch pin and security clip, and move the jack to the transport position.

Hitching Safely

Backing a tractor in reverse to connect an implement can be an easy and safe task. Figure 5.2.a. shows how to spot the hitch to the drawbar. The caption explains how “spotting” to the drawbar can create a hazard.

Practice backing the tractor to align the drawbar with the implement hitch or tongue. You should not need more than three changes of direction to do this job.

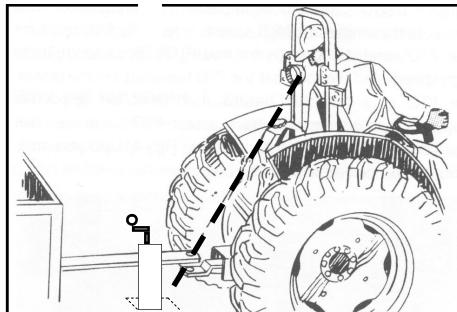


Figure 5.2.a. If the tongue of the implement is not adjusted for the height of the drawbar, the drawbar can push the implement to the rear, knock the jack stand over, or harm someone standing behind the implement. Take a preliminary measurement of the drawbar height and the implement tongue before hitching makes aligning the two points much easier. A stable jack stand should be used. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses*, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.



Figure 5.2.b. If you need help to hitch to a machine, insist that the helper stand off to the side of the operation. Many people have been crushed between tractors and machines trying to help connect the machine to the tractor. This picture shows an unsafe act. Can you explain what is unsafe?

If your foot slips
from the clutch
while hitching to a
machine, a helper
could be crushed.

Learning Goals

- To safely attach implements to a tractor's drawbar
- To safely use drawbar implements during transport, field use, turns, and backing operations

Related Task Sheets:

Moving and Steering the Tractor	4.10
Using the Tractor Safely	4.13
Operating the Tractor on Public Roads	4.14
Connecting Implements to the Tractor	5.1

Using Ground-Driven Machinery

Disks, harrows, hay rakes, windrow inverters, and older manure spreaders are a few of the ground-driven implements assigned to beginning tractor operators. Use them safely by remembering these points.

1. Make sure you know how wide the machine is compared to the tractor.
2. Be sure the machine width is reduced to the “transport” position for travel on public roadways.
3. Shift the machine to the wider “field” position when ready to use it.

4. Stop the engine, securely park the tractor, and set the brakes before dismounting to engage the machine operation mechanism (levers, pins, etc.) allowing the wheels to turn the machine.
5. Pay attention to field boundary fences and obstacles before you begin field operations.
6. Allow plenty of space at ends of rows or fields to turn the equipment without “jacking.”
7. Be sure to return the implement to the transport position before using public roads or passing through narrow farm gates.



Figure 5.2.c. Implements can be wider than the tractor in transport or road position. Passing through farm gates or using public roadways can create a hazardous situation.

If you have never used a particular implement, ask for a demonstration before you try the job.

Safety Activities

1. Practice spotting the tractor drawbar to the tongue of the implement so that you can hitch to a machine quickly and safely.
2. Demonstrate the safety procedures to use when backing a tractor to hitch a machine by showing a helper where to stand to safely help you spot the drawbar and implement tongue.
3. Inspect the ground-driven machines you may use to learn:
 - a. how they are moved from transport to field position and vice versa.
 - b. what mechanism is used to engage the ground wheels with the turning parts of the machine.
4. Check the machinery and tractors you may use for the hitch pins that will be used. Are they available, of the proper size, and have a securing clip? Where are the hitch pins stored on the farm?
5. Practice raising and lowering the various jack stands you find on agricultural equipment.

References

1. Safety Management for Landscapers, Ground-Care Businesses, and Golf Courses, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.
2. Operators' Manuals for Tractor and Machinery.
3. American Society of Agricultural and Biological Engineers, ANSI/ASABE, S485 Jacks, St. Joseph, MI.

Contact Information

National Safe Tractor and Machinery Operation Program
The Pennsylvania State University
Agricultural and Biological Engineering Department
246 Agricultural Engineering Building
University Park, PA 16802
Phone: 814-865-7685
Fax: 814-863-1031
Email: NSTMOP@psu.edu

Credits

Developed by WC Harshman, AM Yoder, JW Hilton and D J Murphy, The Pennsylvania State University. Reviewed by TL Bean and D Jepsen, The Ohio State University and S Steel, National Safety Council.
Revised 3/2013

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.



USING 3-POINT HITCH IMPLEMENTS

HOSTA Task Sheet 5.3

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

Once you can successfully connect an implement to a tractor's 3-point hitch, you are ready to start using the machine. Some machines are powered by the PTO, while others are ground-driven (the power comes from the wheels turning on the ground). A qualified operator should demonstrate how to safely use equipment before expecting you to use the machinery.

This task sheet discusses 3-point hitch equipment which is both ground- and PTO-driven. Later task sheets will provide information regarding hydraulic connections and electrical connections between the tractor and the implement.

Hitching Review

Follow these steps for connecting implements to a 3-point hitch.

1. Remove the drawbar, or move the drawbar forward or to the side for clearance.
2. Back the tractor so the pin holes of the tractor's draft arms are nearly aligned with the implement's lower hitch pins. See Figure 5.3.a.
3. From the tractor seat and using the hydraulic lift controls, raise or lower the draft arms to match the implements lower hitch pins. See Figure 5.3.a.



Figure 5.3.a. Back slowly to the implement to be attached. Using the hydraulic controls, raise or lower the draft arms to nearly match the implement's lower hitch pins.

4. Stop the engine, securely park the tractor, and set the brakes.
5. Attach each draft arm to the implement, and secure with the hitching pins and security clips. See page 2, Figure 5.3.c.
6. Remount and restart the tractor, and slowly raise the tractor's draft arms with the hydraulic lift controls to closely align the upper hitch points.
7. Stop the engine, securely park the tractor, and set the brakes.
8. Attach the tractor's upper hitching point of the 3-point hitch to the top hitch point of the implement with the proper size pin and securing clip. See page 2, Figure 5.3.d. The upper link may need to be lengthened or shortened to fit. Ask for help if there is a problem you cannot solve.

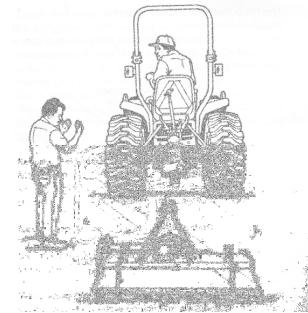


Figure 5.3.b. When connecting drawbar implements, never let a helper stand between the tractor and 3-point hitch implement. Crushing injuries and death can result. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses*, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Do as many hitching operations as you can with the engine shut off and the tractor securely parked.

Learning Goals

- To safely connect a 3-point hitch implement
- To safely use a 3-point hitch implement
- To safely disconnect a 3-point hitch implement

Related Task Sheets:

Stopping and Dismounting the Tractor	4.9
Moving and Steering the Tractor	4.10
Using the Tractor Safely	4.13
Operating the Tractor on Public Roads	4.14
Connecting Implements to the Tractor	5.1
Making PTO Connections	5.4



Figure 5.3.c. On both the left and right sides of the implement, insert the draft arm attachment pin of the tractor into the pin holes of the implement's lower hitch assembly. Secure the hitch with the proper size hitch pins and security clip.

Figure 5.3.d. After adjusting the upper link of the tractor's 3-point hitch to align with the upper hitch point of the implement, secure the equipment with the proper size hitch pin and security clip. The circled area indicates where the upper link may be adjusted for fit. The implement must be in a level position after the connection is made. See Task Sheet 5.2.

The 3-point hitch works because the three hitch pins secure the implement to the tractor. Do not use chains or other temporary pins to attach the implement.



Figure 5.3.e. A firm grip will be needed to press in on the detent lock of the PTO shaft. This lock engages the groove in the stub shaft to secure the PTO driveline shaft to the stub shaft. Other forms of locking the PTO shaft will be found in Task Sheet 5.4.

3-Point Hitches and PTOs

After connecting the implement to the tractor, power is needed to operate the machine if it is not ground-driven. A PTO driveline, hydraulic motors, and electrical devices are used. The PTO is the most common source of remote power. Three examples of PTO-driven implements that a young agricultural worker may use or assist in using include: rotary mowers (bush hogs), fertilizer spreaders (spin spreader), and post hole diggers.

To attach the PTO shaft of a 3-point hitch implement, follow these steps.

1. Connect the 3-point hitch of the implement using the approved steps to align the hitch and to park the tractor securely.
2. Attach the implement driveline shaft to the PTO stub shaft of the tractor.

Here are some suggestions to make connecting the PTO easier.

- A. Align the implement PTO shaft splines with the splines of the stub shaft of the tractor. See Task Sheet 5.4.
- B. Press the detent lock (Figure 5.3.e) inward as you slide the implement shaft onto the tractor PTO stub shaft.
- C. Slide the implement shaft forward far enough to make sure the detent lock has snapped into the lock position.



Figure 5.3.f. To attach the PTO shaft, you will be operating in a crowded space. Be sure the tractor engine is shut off and is securely parked.

Hitching Precautions for 3-Point Hitch Drawbars

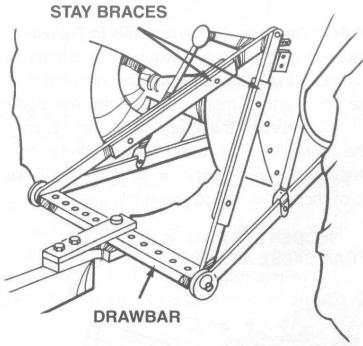


Figure 5.3.g. Stay braces prevent the 3-point hitch drawbar from being lifted too high. *Safety Management for Landscapers, Grounds-Care Businesses, and Golf Courses*, John Deere Publishing, 2001. Illustrations reproduced by permission. All rights reserved.

Never pull a load with the 3-point hitch drawbar more than 13-17 inches above the ground or the pulling forces will be higher than the tractor's center of gravity. A rear overturn hazard may develop as the tractor moves forward.

Using the 3-Point Hitch Implement

Ground-driven 3-point hitch implements are often assigned to the beginning tractor operator. A few ideas are presented here to help you safely operate these implements.

- Make sure you know how wide the machine is compared to the tractor.
- Be sure the machine is in “transport,” or “up” position for travel on public roadways.

- Lower the machine to the “field” position when you are ready to use it. This keeps the load pulling below the center of gravity.
- Engage the machine operation mechanism (levers, pins, etc) for the wheels to power the machine if you are using a ground-driven machine. A qualified operator should demonstrate this procedure for each machine.
- Begin field operation of the machine by paying attention to field boundary fences and obstacles.



Figure 5.3.h. If the 3-point hitch is equipped with an extension to the lower draft arm, release the lock and pull or extend the draft arm extension to the rear before nearing the implement to be attached.

Lift the 3-point hitch implement from contact with the ground before turning, backing or transporting.



Figure 5.3.i. The telescopic extension to the draft arm is fully extended. In some cases, this must be done to align with the lower lift points of the 3-point hitch implement. Be sure the extension is pushed back into the draft arm until locked into place when you are finished attaching the implement.

Safety Activities

1. Practice spotting the tractor 3-point hitch draft arms to the 3-point hitch attachment points of the implement for quick and safe hitching.
2. Demonstrate the rules you will use when backing a tractor to connect to a 3-point hitch implement by showing your helpers where to stand to safely assist you in spotting the 3-point hitch to the implement.
3. Inspect the ground-driven machines you may use to learn:
 - a. how are they moved from transport to field position and vice versa, if applicable?
 - b. what mechanism is used to engage the ground wheels with the turning parts of the machine?
4. Inspect all hitch pins and security clips on 3-point hitch attachments. Did you find any problems or missing hitch pins?
5. Inspect a 3-point hitch quick attaching coupler for cracks or damage to upper and lower lift hooks. Report any problems to your employer, mentor, leader or instructor.

References

1. Safety Management for Landscapers, Grounds-Care Businesses and Golf Courses, 2001, 1st Edition, John Deere Publishing, Moline, Illinois.
2. [www.nagcat.org/Click on Guidelines>Select item T4 from Tractor Fundamentals, 3-Point Implements \(hitch/unhitch\), July, 2012.](http://www.nagcat.org/Click on Guidelines>Select item T4 from Tractor Fundamentals, 3-Point Implements (hitch/unhitch), July, 2012.)
3. Operators' Manuals for specific tractors and equipment.

Contact Information

National Safe Tractor and Machinery Operation Program
The Pennsylvania State University
Agricultural and Biological Engineering Department
246 Agricultural Engineering Building
University Park, PA 16802
Phone: 814-865-7685
Fax: 814-863-1031
Email: NSTMOP@psu.edu

Credits

Developed by WC Harshman, AM Yoder, JW Hilton and D J Murphy, The Pennsylvania State University. Reviewed by TL Bean and D Jepsen, The Ohio State University and S Steel, National Safety Council.
Revised 3/2013.

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.



MAKING PTO CONNECTIONS

HOSTA Task Sheet 5.4

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

After spotting the hitch to connect the tractor to the implement, the operator must attach the PTO shaft of the tractor to the implement by way of the implement input driveline (IID). See Task Sheet 5.4.1. These connecting shafts can be heavy, greasy, and difficult to manipulate in the cramped space between the tractor and the equipment. The youthful operator must have a strong grip and will often have to work at an awkward angle. *Check the NAGCAT website to determine if you can handle the task of PTO connection.*

This task sheet discusses PTO design and how to make PTO connections through knowledge of that design.

PTO Stub Shaft Design

PTO Speeds: Tractor PTOs are designed to rotate at 540 rpm or 1000 rpm. Shiftable, dual-speed PTOs may reach a maximum design speed of 630 rpm or 1170 rpm.

PTO Splines: By counting the number of splines, or teeth on a PTO stub shaft, the beginning operator can identify the speed of the PTO shaft in rpm. A 540 rpm PTO shaft will have 6 splines or teeth. A 1000 rpm PTO shaft may have 20 or 21 splines or teeth.

The faster the PTO speed, the more teeth that are used to make the PTO connection between the tractor and the implement.

PTO Sizes: PTO stub shaft diameter for a 540 rpm shaft is 1 3/8 inch. The 1000 rpm stub shaft with 21 splines or teeth is 1 3/8 inch. The 1000 rpm stub shaft with 20 splines or teeth has a diameter of 1 3/4 inch.



Figure 5.4.a. The 540 rpm PTO stub shaft has 6 splines or teeth and is 1 3/8 inch in diameter. *Farm and Ranch Safety Management*, John Deere Publishing, 1994. Illustrations reproduced by permission. All rights reserved.

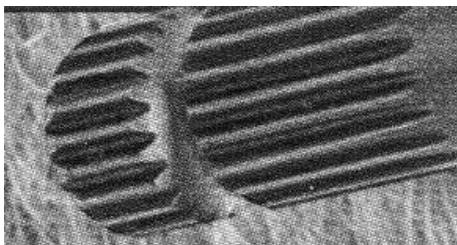


Figure 5.4.b. The 1000 rpm PTO stub shaft has either 20 splines or teeth with a 1 3/4 inch diameter or may have 21 splines or teeth with a 1 3/8 inch diameter.

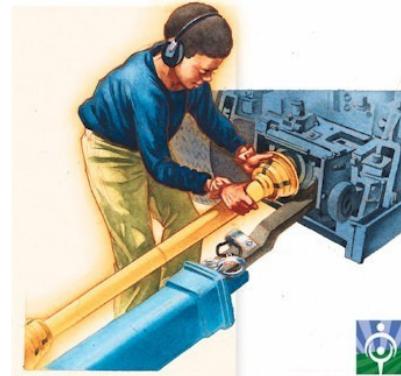


Figure 5.4.c. NAGCAT recommends that youthful farm workers wear snug-fitting clothes, non-skid shoes, and hearing protection while working around machinery. The youth's ability to lift and connect the PTO shaft must be evaluated by an adult who understands the physical development of children.

540 rpm PTOs have 6 splines or teeth.
1000 rpm PTOs have 20 or 21 splines or teeth.

Learning Goals

- To be able to attach the PTO driveline between the tractor and the implement

Related Task Sheets:

Reaction Time	2.3
Age-Appropriate Tasks	2.4
Mechanical Hazards	3.1
Using 3-Point Hitch Implements	5.3
Using Power Take-Off Implements	5.4.1

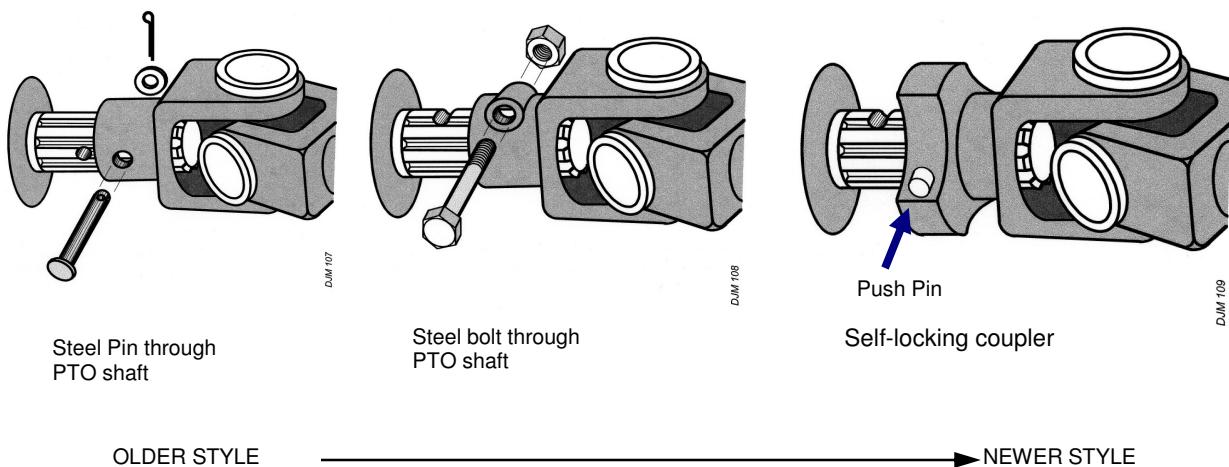


Figure 5.4.d. Various means to secure the PTO shaft to the stub shaft have been used over the years. Besides those connection methods shown above, another popular style is the push pin detent locking type shown in Figure 5.5.e. All types of locking device areas must be guarded as they are wrap points where the operator can become entangled in the PTO.

**PTOs must be
guarded to
prevent an
entanglement
hazard.**



Figure 5.4.e. The push pin detent lock on the PTO driveline has a metal rod which fits in the PTO stub shaft groove to secure it. A firm grip is needed to press the pin. Do you have enough hand strength to push this pin in all the way?

Connecting the PTO

Follow these steps to attach the PTO shaft of a 3-point hitch implement.

1. Connect the tractor to the drawbar or to the 3-point hitch of the implement using the approved steps. See Task Sheets 5.1, 5.2, and 5.3.
2. Attach the PTO shaft of the implement to the PTO stub shaft of the tractor.

Here are some suggestions to make the PTO connection easier.

- A. Align the driveline PTO shaft splines with the splines of the stub shaft of the tractor. If the splines will not align, try turning the tractor PTO stub shaft slightly, or use the implement flywheel to move the implement's PTO shaft. Have this procedure shown to

you if necessary.

- B. Press the detent lock push pin inward (Figure 5.4.e) as you slide the implement shaft onto the tractor stub shaft.
- C. Slide the implement shaft forward far enough to make sure the detent pin has snapped into the lock position.

PTO Care and Use

Dirt and grease can make the PTO shaft difficult to grasp and connect. Keep the PTO shaft off the ground. Wipe the excess grease from the PTO shaft with a cloth.

Important: A new PTO shaft has paint inside the splines. This may prevent the shaft from fitting over the PTO stub. The paint must be removed.

PTO Phasing

Older PTO shafts can be separated or pulled apart. The two parts are made so that one part fits into the other. The PTO must be able to telescope in and out to permit machine operation over irregular terrain. If the parts become separated, they must be re-assembled “in phase” to avoid placing extra strain on the universal joints. Many shafts are designed to prevent this from happening.

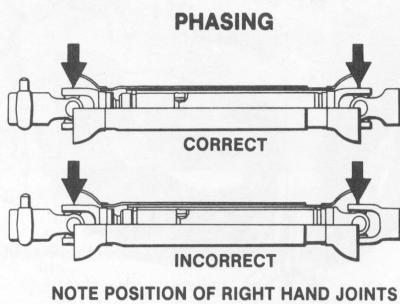


Figure 5.4.f. The upper portion of the drawing illustrates a correctly placed universal joint. You may wish to check the phasing on a PTO shaft.

NAGCAT Guidelines

NAGCAT recommendations for connecting and disconnecting a PTO shaft are shown in this section. These recommendations were developed by a knowledgeable group of safety experts as a means of helping parents to match youthful agricultural workers with the tasks that are appropriate to their development.

The PTO guidelines are presented here.

Adult Responsibilities:

- Be sure implement is in working order.
- Be sure that all safety features are in place.
- Be sure the work area has no hazards.
- Be sure the youth has long hair tied up out of the way, has non-skid shoes, and snug-fitting clothes. Hearing protection is recommended as well.

The adult in charge should also evaluate you using the following questions:

1. Can the youth drive the tractor skillfully?
2. Can the youth hitch and unhitch implements?
3. Does the PTO shaft weigh more than 10-15% of the youth's body weight? To avoid back injury, this should be the maximum weight you should be asked to lift.
4. Can the youth follow a 5-step process?
5. Has the youth been trained in proper lifting techniques?
6. Has an adult demonstrated connecting and disconnecting a PTO?
7. Can the youth do the job 4 or 5 times under direct supervision?
8. Can an adult provide the recommended supervision?

Your experience level may be acceptable to you, but proof of your expertise should be evaluated by a qualified tractor operator.

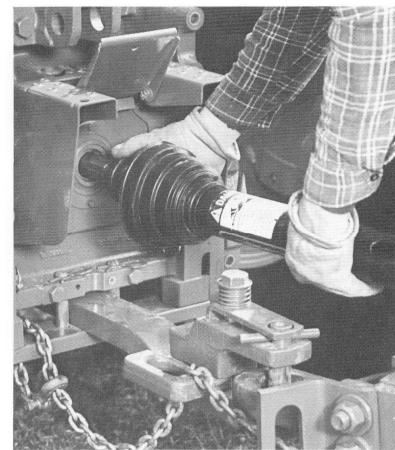


Figure 5.4.g. This is what the task of connecting a PTO looks like. You must lift a heavy object at an awkward angle while squeezing in the lock mechanism detent pin. Watch someone else connect a PTO several times before doing this job. Continue practicing connecting a PTO on your own with supervision.

**Connecting a
PTO shaft will
be easier
after
practicing
the job
several times.**

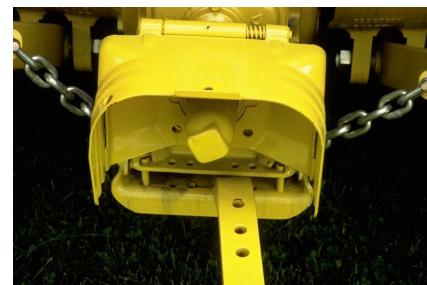


Figure 5.4.h. This PTO stub shaft is protected with a tractor master shield and stub shaft cover. To remove the stub shaft cover, grip the cover firmly and turn counterclockwise. Store the stub shaft cover where it will be available to replace when the job is done.

Safety Activities

1. Using an Internet search engine, type NAGCAT and view the many guidelines presented for the various farm jobs you may be assigned to do. Are you ready to accept these jobs based upon the guidelines presented?
2. Do a survey of the tractors on a farm to determine how many have 540 rpm PTO shafts and how many have 1000 rpm PTO shafts. Record the results.
3. Practice lifting a PTO shaft right handed while squeezing the locking mechanism of the PTO shaft connector. Practice lifting a PTO shaft left handed while squeezing the locking mechanism of the PTO shaft connector. From which side were you able to lift and squeeze best?
4. Check the phasing of three PTO shafts. Make a drawing of the universal joints on each end of the PTO shaft. Did you find any PTO shafts that were out of phase? If so, label this drawing to show what was wrong.

5. Fill in the blanks:
 - A. A PTO shaft with 6 teeth on the shaft is designed for _____ rpms of speed.
 - B. A PTO shaft that has 20 teeth on the shaft is designed for _____ rpms of speed.
 - C. A PTO shaft that has 21 teeth on the shaft is designed for _____ rpms of speed.
 - D. What is the maximum weight that a 14- or 15-year-old worker should be expected to lift without straining the back muscles? _____ % of their body weight.

6. Word scramble. Unscramble the following words. Then fill in the blanks to form a safety message about PTOs.

_____ all PTO _____.

d a u g r = _____

s s t a f h = _____

7. From this phrase “implement input driveline,” write a word list using as many letters as you can. The words must have at least four letters. No two-letter or three-letter words are permitted. Letters may only be used as many times as they appear in the phrase. Example: RIVET can be found in the phrase.

References

1. www.nagcat.org/ Click on Guidelines/Scroll through the list to find a topic. July, 2012.
2. American Society of Agricultural and Biological Engineers, ANSI/ASABE, S203 Power Take Off, St. Joseph, MI.
3. Safety Management for Landscapers, Grounds-Care Businesses and Golf Courses, 2001, 1st Edition, John Deere Publishing, Moline, Illinois.
4. Farm and Ranch Safety Management, John Deere Publishing, 2009. Illustrations reproduced by permission. All rights reserved.

Contact Information

National Safe Tractor and Machinery Operation Program
 The Pennsylvania State University
 Agricultural and Biological Engineering Department
 246 Agricultural Engineering Building
 University Park, PA 16802
 Phone: 814-865-7685
 Fax: 814-863-1031
 Email: NSTMOP@psu.edu

Credits

Developed, written and edited by WC Harshman, AM Yoder, JW Hilton and D J Murphy,
 The Pennsylvania State University. Reviewed by TL Bean and D Jepsen, The Ohio State University and S Steel, National Safety Council.
 Revised 3/2013
 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.



USING POWER TAKE-OFF (PTO) IMPLEMENTS

HOSTA Task Sheet 5.4.1

Core

NATIONAL SAFE TRACTOR AND MACHINERY OPERATOR PROGRAM

Introduction

The power take-off (PTO) shaft, or Implement Input Driveline (IID), is an efficient means of transferring mechanical power between farm tractors and implements. This power transfer system helped to revolutionize North American agriculture during the 1930s. The PTO is also one of the oldest and most persistent hazards associated with farm machinery. This task sheet discusses several aspects of PTO safety.

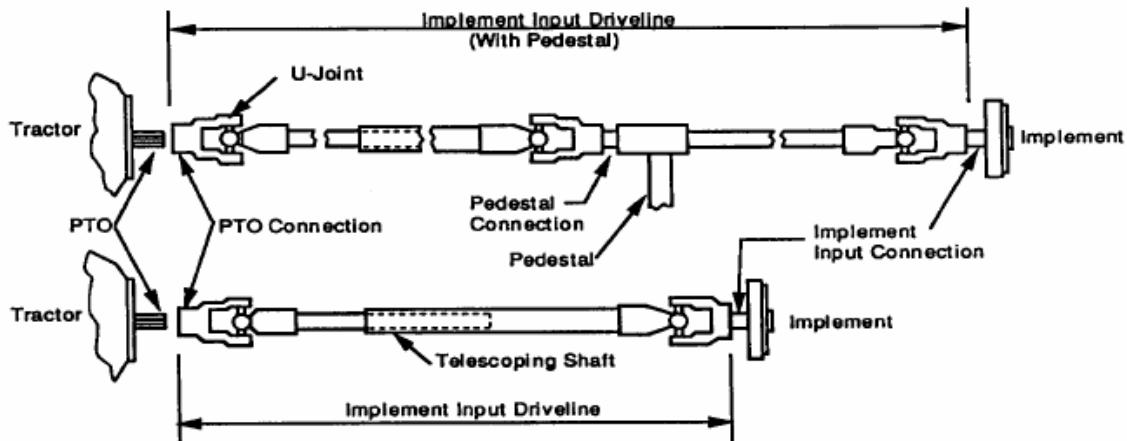


Figure 5.4.1.a. The major components of a PTO system.

PTO Components

Figure 5.4.1.a. is a diagram of the components of an implement PTO system. Two typical PTO system arrangements are shown. The top drawing is of a PTO system involving a pedestal connection, such as one found on many types of towed implements (hay balers, forage choppers, large rotary mowers, etc.). The lower drawing is of a PTO system where the implement's input driveline connects directly to the tractor PTO stub. Examples of this type of connection include three-point hitch-mounted equipment, such as post hole diggers, small rotary

mowers, fertilizer spreaders, and augers.

Connections from the tractor to the implement are made through the flexible universal joints. The "U-joints" are connected by a square rigid shaft which turns inside another shaft. The PTO shaft can telescope in and out for use in turns or over uneven terrain.

The combination of universal joints and turning shafts provides the remote power source to a farm implement. Without proper guarding, a serious threat to the operator's safety is created. Study this task sheet carefully.

Learning Goals

- To identify the components of a PTO system
- To identify the hazards involved with PTO use
- To develop safe habits when using a PTO

Related Task Sheets:

Reaction Time	2.3
Mechanical Hazards	3.1
Making PTO Connections	5.4

PTO Stub

- Transfers power from the tractor to the machine
- Rotates at 540 rpm (9 times/sec.) or at 1,000 rpm (16.6 times/sec.)

Master Shield

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



Figure 5.4.1.b. The major components of a PTO system found on the tractor.

The PTO is one of the oldest and most persistent hazards associated with farm machinery.

PTO Entanglement

This information is taken from the Purdue University source listed at the end of this fact sheet. This reference is the most comprehensive study of power take-off injury incidents to date. The data shown includes fatal and nonfatal injury incidents.

Generally, PTO entanglements:

- involved the tractor or machinery operator 78 percent of the time
- occurred when shielding was absent or damaged in 70 percent of the cases
- were at the PTO coupling, either at the tractor or implement connection nearly 70 percent of the time
- involved a bare shaft, spring-loaded push pin, or through bolt component at the point of contact in nearly 63 percent of

the cases

- occurred with stationary equipment, such as augers, elevators, post-hole diggers, and grain mixers in 50 percent of the cases
- involved semi-stationary equipment, such as self-unloading forage wagons and feed wagons in 28 percent of the cases
- happened mostly with incidents involving non-moving machinery, such as hay balers, manure spreaders, rotary mowers, etc., at the time of the incident (the PTO was left engaged).
- occurred 4% of the time when no equipment was attached to the tractor. This means the tractor PTO stub was the point of contact at the time of the entanglement.

PTO Guards

Implement Input Connection (IIC) Shield

- Protects the operator from the IIC, including the implement input stub and the connection to the IID

Safety Chain

- Keeps the integral journal shield from spinning
- Shows that the shield is not attached to the IID
- Should be replaced immediately if damaged or broken



Figure 5.4.1.c. The major guards of a PTO system.

Master Shield

- Protects the operator from the PTO stub and the connection of the IID to the PTO stub

Integral Journal Shield

- Completely encloses the IID
- May be made of plastic or metal
- Mounted on bearings to allow it to spin freely from the IID
- Always check before operation for free movement

PTO Safety Practices

There are several ways to reduce the risk of PTO injuries and fatalities. These safety practices offer protection from the most common types of PTO entanglements.

- Keep all components of PTO systems shielded and guarded.
- Regularly test driveline guards by spinning or rotating them to ensure they have not become stuck to the shaft.
- Disengage the PTO and shut off the tractor before dismounting to clean, repair, service, or adjust machinery.
- Walk around tractors and machinery rather than stepping over a rotating shaft.
- Always use the driveline

recommended for your machine. Never switch drivelines among different machines.

- Position the tractor's drawbar properly for each implement used. This will help prevent driveline stress and separation on uneven terrain and in tight turns. See Task Sheet 5.1.
- Reduce PTO shaft abuse by observing the following: avoid tight turns that pinch rotating shafts between the tractor and machine; keep excessive telescoping to a minimum; engage power to the shaft gradually; and avoid over tightening of slip clutches on PTO-driven machines.

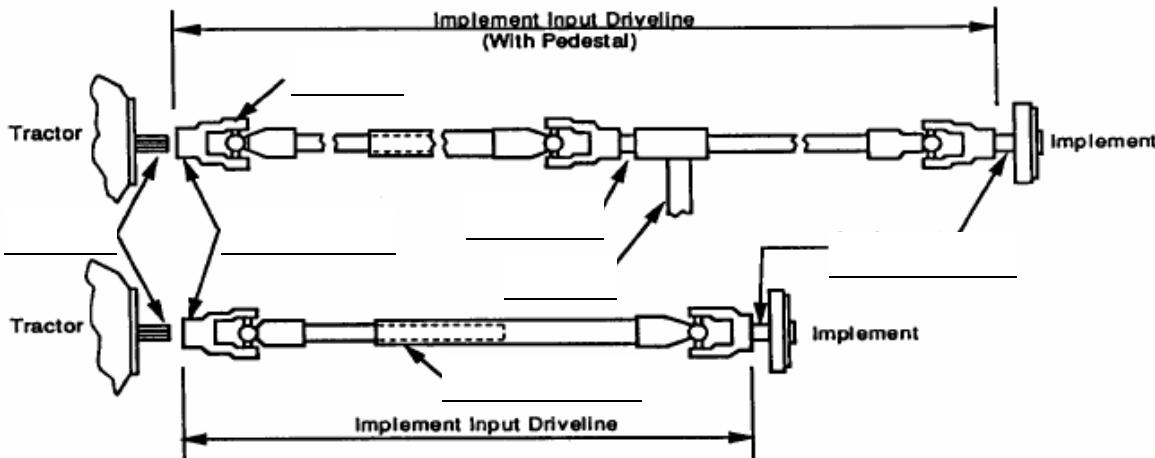
If PTO guards are removed or damaged, they should be replaced immediately.



Figure 5.4.1.d. A bent shaft guard offers no protection from a spinning PTO shaft. Also notice the missing master shield and the inadequate guarding of the universal joint near the PTO pedestal.

PTO Safety Activities

1. Fill in the blanks in the following figure of the major components of a PTO system based on the information in this sheet.



2. You are working with another tractor operator. He/she is sitting on the tractor seat and is able to reach the PTO control. If your shoelace is caught in the PTO shaft, how long does the shoelace need to be in order for the tractor operator to have enough time to shut off the PTO before your foot is pulled into the PTO shaft? The PTO shaft is spinning at 540 rpm, the shaft diameter is 3 inches (d), and the operator can react by shutting off the PTO in 3 seconds.

- a. Find the circumference of the PTO shaft.

$$\text{Circumference} = \pi d = 3.14 \times 3 \text{ inches} = \underline{\hspace{2cm}} \text{ inches}$$

- b. How many times does the PTO shaft rotating 540 revolutions per minute rotate in one second?

$$\frac{540 \text{ revolutions}}{1 \text{ Min}} \times \frac{1 \text{ Min}}{60 \text{ sec}} = \frac{540 \text{ revolutions}}{60 \text{ sec}} = \underline{\hspace{2cm}} \text{ revolutions/sec}$$

- c. How many times does the PTO shaft rotate in 3 seconds?

$$\text{Answer b} \times 3 \text{ sec} = \underline{\hspace{2cm}} \text{ revolutions}$$

- d. How much shoelace will become wrapped up in the PTO in 3 seconds?

$$\text{Answer a (in inches)} \times \text{Answer c (in revolutions)} = \underline{\hspace{2cm}} \text{ inches of shoelace.}$$

References

- Campbell,W.P.1987. *The Condition of Agricultural Driveline System Shielding and Its Impact in Injuries and Fatalities*.M.S.Thesis. Department of Agricultural Engineering,Purdue University,WestLafayette,IN.
- Farm and Ranch Safety Management, John Deere Publishing, 2009.
- Murphy, D.J. 1992 *Power Take-Off (PTO) Safety*. Fact Sheet E-33. The Pennsylvania State University. University Park, PA.

Contact Information

National Safe Tractor and Machinery Operation Program
The Pennsylvania State University
Agricultural and Biological Engineering Department
246 Agricultural Engineering Building
University Park, PA 16802
Phone: 814-865-7685
Fax: 814-863-1031
Email: NSTMOP@psu.edu

Credits

Developed by WC Harshman, AM Yoder, JW Hilton and D J Murphy, The Pennsylvania State University. Reviewed by TL Bean and D Jepsen, The Ohio State University and S Steel, National Safety Council.
Revised 3/2013

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 20101-41521-20839. 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.



IMPLEMENTS WITH HYDRAULIC COMPONENTS

HOSTA Task Sheet 5.5

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

Hitching a machine to a tractor using a drawbar or 3-point hitch is the beginning skill in using the attached machinery. Many implements are powered by a PTO shaft (Task Sheets 5.4 and 5.4.1), while others are powered by hydraulics (or fluids), electrical connections, or some combination of these.

This task sheet will help you to understand and properly care for and use the hydraulic systems located on the tractor and used with the implement.

Hydraulic Power

The term “hydraulic” refers to fluids under pressure. Any liquid can be placed under pressure, but not all liquids are used for hydraulic work. An undrained garden hose left lying in the sun serves as an example. When we turn the nozzle on, solar-heated water erupts from the hose with great force. Water, however, becomes steam at 212 degrees Fahrenheit and could not be used as a working hydraulic fluid.

Oil is the common hydraulic fluid used with farm equipment. Hydraulic oil system components are briefly shown on page 2, Figure 5.5.b. Turn to Figure 5.5.b. before reading further.

Hydraulic fluids work through systems with very small openings and are under great pressure. There are several precautions which users must observe.

Wear safety glasses or a face shield and gloves when checking hydraulic systems.



Figure 5.5.a. Missing hydraulic connection covers signify a problem with this tractor. What will happen to the hydraulic system if the dust covers are not kept in place?

Precautions When Using Hydraulics

To safely and correctly operate hydraulic systems, understand these three points:

- Clean oil needs
- Heat generated by use
- Oil leaks under pressure

Be sure you understand each point. If necessary, discuss these points with a knowledgeable farmer or mechanic.

Clean Oil Needs:

Hydraulic pumps and control valves operate with minute clearances (tolerances). Grit, grime, and dirt pushed through these openings can eventually wear the surfaces and damage the system. Clean hydraulic oil must be used. The fill area and connections must be kept clean as well. Dirt is the greatest source of hydraulic system damage.

Hydraulic connector covers should be in place to keep out dust, dirt, grease, and moisture. Clean connections keep systems working longer.

Learning Goals

- To safely and correctly connect hydraulic components

Related Task Sheets:

Tractor Controls	4.5
Using 3-Point Hitch Implements	5.3
Using Power Take-Off (PTO) Implements	5.41

A Simple Hydraulic System

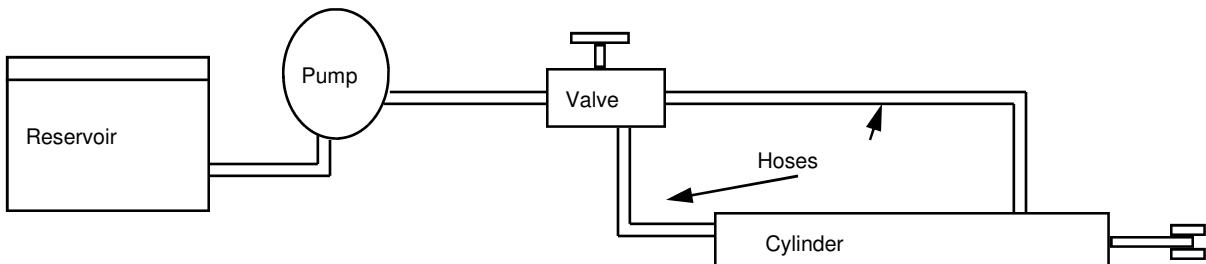


Figure 5.5.b. Hydraulic systems are closed systems which move and control fluid (hydraulic oil) for the purpose of operating cylinders and/or motors. This drawing gives a general look at hydraulic components. Much more detail is involved in these systems than this drawing shows. Filters, pressure relief valves, accumulators, etc. are included as well. Consult a machinery owner's manual to see drawings of more complex hydraulic systems.

Hydraulic Use Precautions (Continued)

Heat Generated by Use Hazards:

As hydraulic fluid moves through the closed system, the fluid meets resistance from the load to be lifted or moved. Pressure increases and heat from friction builds. Under extreme load conditions, the reinforced hoses can become hot, however, metal connections, fittings, and piping can become super-heated. *Place your hand near the connection to sense for heat before touching the connection.* If hot, allow the hydraulic system to cool down before touching the heated connections.

**Hydraulic
system
pressure may
exceed 2000
psi. Pin hole
leaks can
develop.**



Figure 5.5.c. Hydraulic hoses may be reinforced, but damage to the outer covering—plus pin holes from high pressure—can cause serious injury (e.g. amputation) and machinery down time.



Figure 5.5.d. Hydraulic hoses and fittings can become hot during use. Place your hand near them to check for heating. Do not just grab them!

High Pressure Oil Leaks:

Pressure within the hydraulic system can exceed 2000 pounds per square inch (psi). Reinforced hoses develop pin hole leaks and hydraulic connections can vibrate loose.

Hydraulic leaks may be hard to see. Never check for these leaks with your hand. The high pressure can inject oil droplets under your skin. Oil injected under your skin is a medical emergency and will require immediate medical care. Gangrene can occur, and limb amputation may be necessary.



Figure 5.5.e. Use a mirror or piece of cardboard to check for high pressure hydraulic leaks. Do not use your skin! Pin hole leaks are often invisible.

Fittings and Connections



Figure 5.5.f. The female half of the hydraulic coupler is considered to be part of the tractor. Dust covers protect the quick release fitting which includes the lock ring.



Figure 5.5.g. The male half of the coupler is part of the cylinder or hydraulic device system. Be sure to wipe dirt and grime from the hose end fitting.

Connecting Hydraulic Hoses to Couplers

Hydraulic couplers make the connections quick and simple to use. Follow these steps.

1. Use gloves or a wipe cloth to remove dirt and grit from the couplers.
2. Remove the dust covers from the couplers.
3. Push the couplers together until the lock ring snaps the two parts securely. See figure 5.5.h and 5.5.i. Older style lock levers and manual pull lock rings may be found also. Ask for a demonstration of these.

If you cannot easily make the connection, try the following:

- a. While seated on the tractor where no hydraulic lift arms or other moving parts can crush you, move the hydraulic control levers back and forth to release the static pressure. The previous operator may have failed to do this.
- b. Move the locking ring of the female coupler back and forth to be sure that dirt has not blocked its movement.



Figure 5.5.h. The lock ring of the female end of the coupling will secure the two fittings together.

In some circumstances, the hoses leading to the hydraulic cylinders may have become reversed. The system will still operate. However, using the system with hoses reversed will result in the control valves/levers causing the opposite action of what is expected. This can lead to hazardous situations where operators must react quickly and adjust their knowledge and skills to the new condition.

To correct the reversal problem, disconnect the hydraulic hoses and switch them to the opposite female coupler.

If hydraulic repairs have changed the standard coupling set-up, you may find that you must ask for help in determining which hose goes with which coupler.

Hydraulic systems in operation can produce pressure in excess of 2000 psi. Oil trapped in a hydraulic component may still be under enough pressure to cause mechanical problems or hazardous situations to develop. Someone's faulty repairs may have created several problems that the beginning operator cannot solve.

Disconnecting Hydraulic Hoses

To disconnect hydraulic hoses:

- relieve the static pressure
- push back on the lock ring
- remove the hydraulic hose
- replace the dust caps on each connector
- hang the hoses on the implement
- keep hoses off the ground

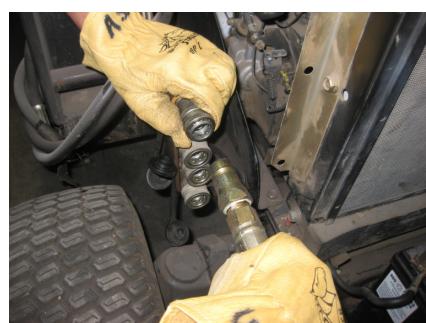


Figure 5.5.i. A firm grip will be needed to insert the hydraulic hoses from the implement (male end) into the coupling on the tractor (female end).

Safety Activities

1. On several different tractors, identify all the hydraulic system components that are external to the tractor. You may wish to name the parts and their purpose to a friend or mentor.
2. To supplement your knowledge of the hydraulic systems components, examine a log splitter and identify all the hydraulic components. You may wish to demonstrate the location, the name, and the function of each part to a friend or mentor.
3. Check the hydraulic fluid level of several tractors.
4. Practice connecting the hydraulic hoses to the tractor coupler.
5. Use the tractor hydraulic system for practice:
 - a. raising and lowering the 3-point hitch arms
 - b. raising and lowering a high-lift bucket
 - c. tilting a high-lift bucket.

Note: NAGCAT recommends that 14- and 15-year-old youth operate front-end loaders on tractors of less than 20 horsepower only.

6. Answer these questions:

A. What is the greatest source of damage to a hydraulic system?

1. Water
2. Dirt
3. Air
4. None of these

B. The term hydraulic refers to:

1. Fluid under pressure
2. Air under pressure
3. Gas under pressure

C. Hydraulic pressures on farm equipment may exceed _____ psi

1. 2000 psi
2. 4000 psi
3. 10,000 psi

D. The safe way to check for pin hole leaks in the hydraulic system is to:

1. Rub your hand over the hose.
2. Hold a match near where you suspect the leak.
3. Hold a piece of metal or cardboard near where you suspect the leak.

References

1. American Society of Agricultural and Biological Engineers, ANSI/ASABE, S366 Hydraulic Couplers, St. Joseph, MI.
2. Safety Management for Landscapers, Grounds-Care Businesses and Golf Courses, 2001, 1st Edition, John Deere Publishing, Moline, Illinois.
3. [### Contact Information](http://www.nagcat.org>Select Guidelines topic, July, 2012.

</div>
<div data-bbox=)

National Safe Tractor and Machinery Operation Program
 The Pennsylvania State University
 Agricultural and Biological Engineering Department
 246 Agricultural Engineering Building
 University Park, PA 16802
 Phone: 814-865-7685
 Fax: 814-863-1031
 Email: NSTMOP@psu.edu

Credits

Developed by WC Harshman, AM Yoder, JW Hilton and D J Murphy, The Pennsylvania State University. Reviewed by TL Bean and D Jepsen, The Ohio State University and S Steel, National Safety Council.
 Revised 3/2013

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.



IMPLEMENTS WITH ELECTRICAL CONNECTIONS

HOSTA Task Sheet 5.6

NATIONAL SAFE TRACTOR AND MACHINERY OPERATION PROGRAM

Core

Introduction

Hitching an implement to a tractor using a drawbar or 3-point hitch is the beginning skill in using the attached machinery. Many implements are powered by a PTO shaft (Task Sheets 5.4 and 5.4.1), while others are powered by hydraulics (or fluids), electrical connections, or some combination of these.

This task sheet will help you to understand and properly care for and use the electrical systems located on the tractor and used with the implement.

Electrical Needs

Modern farm implements come equipped with many features which need electrical power.

Lights are added to implements to allow nighttime field operation, provide lighting for nighttime repair work, and to serve as warning signals during public roadway transport.

Electrical *sensors* are used to measure equipment operation functions and can stop the implement if problems exist.

Monitors signal the operator when a machine function is disrupted. For example, corn planter monitors can signal the tractor operator to discontinue the planting operation. The planter may not be dropping seeds due to

a plugged seed drop tube.

Warning devices can be activated by using the reverse gear which sounds an alarm while backing the tractor and implement. Horns and flashing lights also serve to warn bystanders of your actions.

Convenience outlets, using a wiring harness, permit connection to a trailer or wagon for proper lighting for public road use.

Modern tractors and equipment rely not only on PTO and hydraulic systems, but on electrical accessories to complete the work package.



What do you think this electrical connection is used for?

Figure 5.6.a. Connected implements need electrical power. Connectors may have prongs with screw in couplings to keep them from vibrating loose. Other connectors may be plug types that are simply pushed together. Recognize the difference to avoid damage when connecting or disconnecting them.



Figure 5.6.b. Electrical connectors are protected from dust, dirt, grease, and grime with dust caps. Keep these covers repaired and in place to insure that electrical connections can be made without delay.

Electric connector covers should be in place to keep out dust, dirt, grease, and moisture. Clean connections keep systems working without delays.

Learning Goals

- To safely and correctly connect electrical components

Related Task Sheets:

Tractor Controls	4.5
Using Drawbar Implements	5.2
Using 3-Point Hitch Implements	5.3

Using Electrical Connections

To properly care for and use electrical connections, follow these instructions:

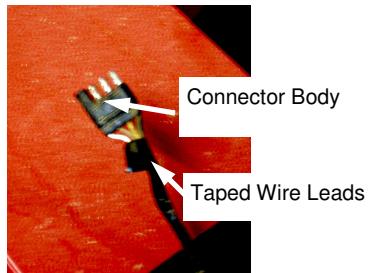
- Turn the powered device to the “off” position before connecting or disconnecting the electrical apparatus. Power surges can damage electronic components.
- Wipe away moisture and dirt before making the connections.
- Carefully lift the protective cover to make the connections. Protective caps can be broken and the electrical contacts exposed to moisture, dust, and dirt.
- Slowly and carefully align the prongs or plugs of the

connectors. Do not force connections together as you may damage them.

- Grip the connector body when disconnecting the circuit. *Do not pull on the wires.* Grasp the connectors firmly, and separate them using a straight line pull. Expect some connections to be tighter than others. A threaded connector must be unscrewed first! Others require a half-turn before disconnecting them.
- Consult the Operator’s Manual for other precautions in using electrical components.



Figure 5.6.d. Align the pins of the electrical connection before attaching. Do not force the connector if the pins are not aligned. Threaded connectors do not pull loose; unscrew them first.



Be sure the electrical cables cannot be caught or pinched by hydraulic lift arms or moving parts of the equipment.

Figure 5.6.c. Grip the connector body to disconnect the wiring harness. Do not pull on the wires themselves. Become familiar with other connector styles before disconnecting them.

Safety Activities

1. Practice connecting electrical wiring harnesses together to get the feel of how easily the connection can be made.
2. Examine several tractor and implements to learn the positions of electrical connections and control switches or knobs that activate the circuits they connect.
3. Locate Operators’ Manuals to learn more about machinery monitors, crop sensors, and remote lighting features of a machine.
4. Ask a qualified tractor operator to demonstrate a tractor’s electrical components for you.

References

1. Electronic and Electrical Systems, Fundamentals of Service, John Deere Publishing, 2005.

Contact Information

National Safe Tractor and Machinery Operation Program
The Pennsylvania State University
Agricultural and Biological Engineering Department
246 Agricultural Engineering Building
University Park, PA 16802
Phone: 814-865-7685
Fax: 814-863-1031
Email: NSTMOP@psu.edu

Credits

Developed by WC Harshman, AM Yoder, JW Hilton and D J Murphy, The Pennsylvania State University. Reviewed by TL Bean and D Jepsen, The Ohio State University and S Steel, National Safety Council.
Revised 3/2013

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.