

Tractor Safety: Lawn Care Training Guide

Safe Use of Tractors

Introduction

Tractors are versatile equipment used in variety of applications ranging from hauling goods to lawn care to agriculture. While they are extremely versatile they can be very dangerous unless they are used with care following safe practices. Accidents resulting in fatalities and severe injuries are very common during tractor use. The National Safety Council estimated that approximately 36 percent of all the agricultural fatalities in 1997 involved a tractor. Published data also show that farm accidents cause more than 100 deaths and about 2600 serious injuries among children annually. **Tractors account for about 41% of the accidental deaths among children under fifteen. In spite of these convincing data, a large number of operators continue to follow unsafe practices that can cause serious accidents.**

Tractors used in the green industry are generally smaller than those used in agriculture. They are also unsafe because they are unstable and they overturn more easily. The purpose of this training guide to familiarize the supervisors and managers actively engaged in the green industry with these tractors and how they can be operated safely. Major components of these tractors, built in safety features and safe practices during their use are discussed in greater detail. The hope is that they will utilize this information to train young workers they hire and supervise on the safe use of tractors.

Tractors Used in Green Industry

Tractors are widely used in green industry for variety of jobs. The most common use, however, is mowing grass. Other selected examples of tractor uses include towing, tilling, raking, sweeping, seeding, spreading fertilizer, spraying, aerating soil, thatching, and shredding. Many different sizes of tractors are used in the green industry. The size generally depends on the type of application. They may be grouped into the following three categories:

Riding Lawn Mowers:

These are power units have a 8-25 hp capacity and they are generally equipped with a mower. These do not come with other attachments that could be mounted separately to carry out other jobs.

Lawn and Garden Tractors:

Often this type of tractors is also referred to as compact tractors. They range in size from 12-32 hp and they come with variety of attachments for different jobs. Selected examples of these attachments may include



sweepers, seeder, blades and tillers.

Large Tractors:

Large tractors have power in the range of 18-80 hp. Most tractors in this category are light industrial tractors of 20-45 hp. They are widely used on golf courses, parks, schools, and college campuses and they generally have low center of gravity for added stability when working on slopes. Tractors ranging in capacity up to 80 hp and farm tractors are used infrequently in green industry for heavier jobs. Reference to large tractors in this publication refers to tractors above 18 hp.



Power Unit

For proper use of the tractor and for safety purposes, the user must be familiar with the kind of power unit on the equipment. Operating procedures vary significantly depending on the type of power unit. Three types of power units are used on tractors used in green industry and they are as follows:

- Air cooled engines.
- Liquid cooled engines.
- Electric motors.

Air Cooled Engine

The power units used in lawncare applications generally are air cooled. Since no liquid is used in cooling the engine, they have no radiators. They may be either two or four cycle engines. Tractors used in lawncare applications generally are equipped with 4-cycle engines. One may identify whether the engine is 2-cycle or 4-cycle based on the location of exhaust or muffler, presence of oil sump or information on the name plate.

Liquid Cooled Engines

Lawn and garden tractors and large tractors have larger capacity engines. They are either gasoline or diesel engines with a radiator and a fan. Depending on the size, these engines may have two to six cylinders and they run on gasoline, diesel, or LP-Gas. Gasoline engines are more common than the other two. All the engines may look similar. However, they can be differentiated by observing the presence of fuel injectors for diesel engine, and gas tank for LP-Gas engine.

Electric Motors

Storage batteries are also used to power tractors. Electric tractors are generally small and they range from 5-14 hp. Number of batteries on the tractor may depend on its size. Between uses, the batteries are recharged using a built-in charger connected to a standard 120 volt power source.

Transmission System

Tractors are used as work horses on farms and in lawncare operations. The power generated by the tractor engines need to be transmitted to appropriate locations for doing useful work. Transmission system or power train on tractors transmits power generated by the engine to the wheels or elsewhere. For effective use of tractors, the operator must be familiar with the type of transmission in them. Tractor transmissions operate differently from automobile transmissions. Some transmissions on tractors require that a tractor be stopped before changing gears. Some, on the other hand, have gears that can be shifted on the go without using a clutch. For this reason, tractor operators are advised to review the operator's manual and become familiar with the type of transmission and operation. The following are the most common types of transmissions found on tractors:

- Manual shift transmission
- Power shift transmissions.
- Hydrostatic transmission.

Manual Shift Transmission

With manual shift transmission, the operator engages or disengages the gear to get to the desired speed or to select forward or reverse directions. The manual shift transmission may be either a sliding or planetary gear type. For shifting a sliding gear, one has to disengage the clutch first, shift the gear with shift lever and then reengage the clutch. Most tractors with a sliding gear transmission may have three or more forward gears and one reverse. Sliding gear transmission with synchromesh will allow shifting of the gears on the go.



Manual Transmission

Planetary gear transmissions are more common on large tractors and these may be shifted while moving. Manual shift tractors use a clutch to disengage the engine from transmission when shifting gears. When the clutch is engaged, power is transmitted from the engine shaft through the clutch to the transmission. When the clutch is disengaged, the clutch plates are separated and the engine is disengaged from transmission.

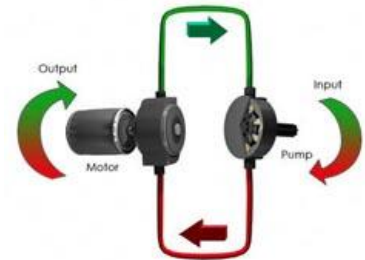
On most tractors with manual transmission used in lawncare operations, use one of the following four ways to transmit the power from the engine to the wheels of the tractor:

- Transaxle with belts.
- Differential with separate transmission and chain and sprocket.
- Disk drive with belt or chain.
- All gear drive.

The transaxle type is the most common on riding mowers and garden tractors with manual transmission. Operators are referred to the operator's manual for the mowers or garden tractors they use to become familiar with the type transmission system and its maintenance requirements.

Hydrostatic Transmissions

Many tractors used in lawncare applications are equipped with hydrostatic transmission for versatility and ease in its operation. The hydrostatic transmission makes it possible to change the direction of the tractor quickly without a clutch. It also provides infinite speed control between 0 to about 7 mph in forward and 0 to about 4 mph in reverse. Often the hydrostatic transmission may be coupled to a differential.



Hydrostatic Transmission

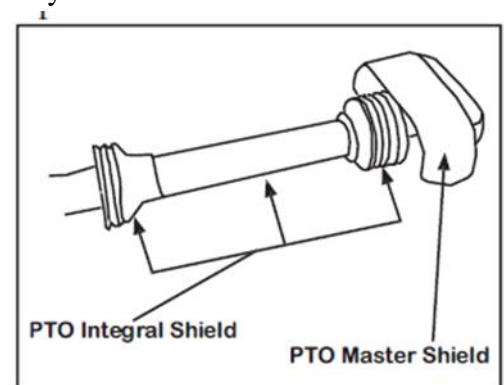
The major components of a hydrostatic transmission may include a variable displacement pump, reservoir, control valves. Tractors with hydrostatic transmission may be equipped with either hand or foot control for adjusting the speed. Hand levers are more common because of ease in controlling speed and direction.

Power Transmission Options

Tractors are used in lawncare for variety of jobs such as mowing, spreading fertilizer and tilling. For carrying out these operations, tractor power must be transmitted to the respective devices. Power may be transmitted to the devices using one of the following five ways: belt, chain, power take – off (PTO), drawbar, and hydraulic. The belt drive is most common on riding mowers and garden tractors. The chain drives are used for heavy applications such as snow removal.

Transferring power through PTO is widely used on small and large tractors. One has to be extremely careful when using PTO to utilize tractor power for useful work as they are known cause numerous accidents. Precautionary steps that can be taken to avoid such accidents may include the following:

- Make sure the PTO shield is in place mounted properly.
- Follow the recommended shut down procedure and dismount the tractor only when the rotating parts came to a standstill.
- Never step over a rotating shaft.
- Avoid loose clothing, loose shoe lace and loose hair when operating PTO.



For certain applications, power may not be directly transmitted to the device. Instead, tractor wheels interacting with ground transmits power to the drawbar to utilize for useful work. Hydraulic systems are also widely used for operating mowers.

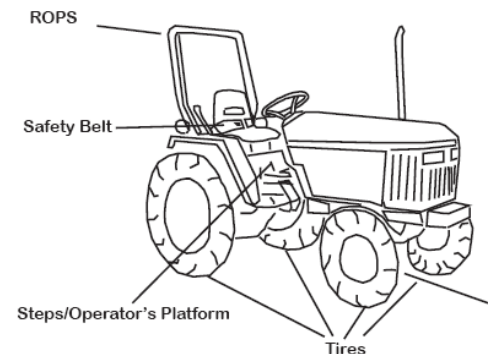
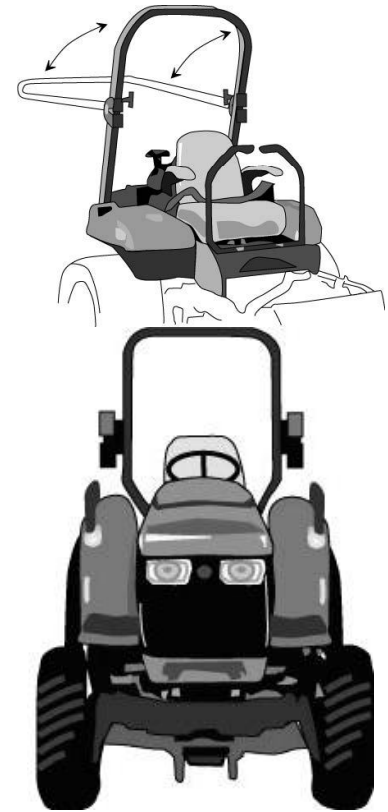
Safety Features and Guards

Tractors of all sizes ranging from lawn and garden tractor to regular farm tractors are equipped with many safety features to protect the operator. An example of such device is automatic cut - off for mower blade when the tractor is not moving or when the operator leaves the tractor seat. Operators must be familiar with all the safety features available on the equipment. Since these features differ from one equipment to the other, it is advised the operator depend on operator's manual for familiarizing with the specifics. Under no circumstances, these safety features be tampered with or disconnected. On the contrary, operators must periodically examine these features to make sure that they are functioning properly.

As stated earlier, tractors are extremely dangerous equipment. Sideways, rearward and frontward overturning of tractors are extremely common. Among these, the sideways are the most common and it accounts for about 75-80 percent of the tractor upsets. The other two types are more dangerous, and each year, these result in large number of fatalities and serious injuries. In recent years, the required use of Rollover Protection Structure (ROPS) has significantly reduced the number of fatalities and injuries. While ROPS is not capable of avoiding tractor upsets, they are very effective in protecting the operators if and when an upset occurs. When using a tractor with ROPS, the operator must always wear the seat belt to avoid being thrown away during a tractor upset.

Large number of old tractors sold prior to the ROPS requirement went in effect is still in use without ROPS. For the wellbeing of operators, it is highly recommended that these tractors be retrofitted with ROPS that meet the established standard.

Tractors and other equipment also come with guards to protect the operators from rotating parts. Under no circumstances, these safety guards should not be removed. Operators, on the other hand, must check to make sure that they are in place properly.



Operating Manual

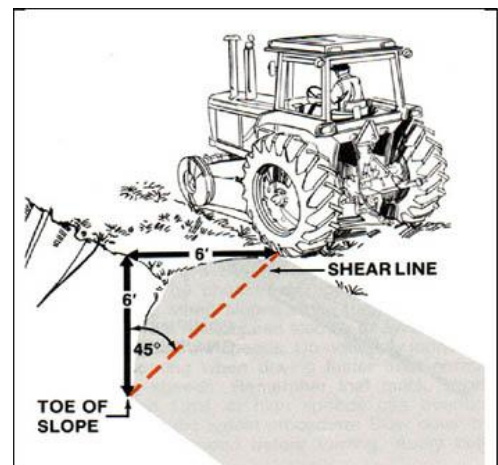
Operator manual supplied with any equipment is an important document because it contains valuable information on safety features, servicing information, maintenance schedule and tips for safe operation. Prior to operating tractors, all operators must become familiar with the content of the manual first for quick reference when needed and to operate the tractor effectively and safely.

General Tractor Safety Tips

- Read and understand the operator's manual before using the equipment. Become familiar with the safety features, items to check before operating the tractor, starting and stopping the tractor, and maintenance schedule.
- Before operating the tractor, check crank case, air cleaner, battery, cooling system, fuel tank, transmission system, hydraulic system, and tires. Readers may refer to the operator's manual for checking and servicing details.
- Make sure the safety features are working properly and the guards and shields are in place.
- Do not drive riding mowers and garden tractors on public roadways. When larger tractors are taken on the road, use flashing lights and slow moving vehicle emblem. **No extra riders. No children – ever!**
- When tractors are used, make sure that they are equipped with ROPS and always use seat belts particularly when the tractors are equipped with ROPS.
- Under no circumstances, take an extra rider in the tractor
- Never leave the tractor running unattended.
- Never turn the tractor engine on inside an enclosed area. If it must be done, make sure that building is properly ventilated.
- Refuel the tractor when it is cold. Also make sure that the fuel is stored properly.

Tips for Safe Operation of Tractors

- Before mowing, survey and remove all debris such as rocks, cans, wire, toys, etc. from the area to be mowed to avoid personal injuries and other damages.
- While operating a tractor, be alert and watch for moving vehicles, people or animals in the work area. Be prepared to change course or stop quickly.
- Avoid mowing too close to trees to prevent damages to trees, and personal injuries from low lying branches.
- Maintain proper speed during operation. A hole, bump, or a quick turn at high speed can cause tractor upset. Use the widest possible wheel spacing and proper ballasting to improve the stability.
- When operating on a slope move up and down at slow speed. Use the same gear setting for going up or down the hill and allow the engine will act as a brake. On steep slopes, it is a good practice to go up in reverse to reduce the chances for backward overturning.
- Stop mower blades before crossing gravel patches.
- Do not dismount from the operator's seat while an attachment on the tractor is running.
- When reversing a tractor, make sure the path is clear. Some lawn and garden tractors have a forward/reverse



Stay clear of embankments.

lever that will reverse the tractor with a short pause.

- Stay clear of ditches, embankments and ponds. Transfer power slowly to the wheels when driving out of a ditch to avoid a tractor upset.
- Never leave a tractor unattended with the engine running.
- Do not refuel the tractor when the engine is hot.
- Do not turn the tractor on in an enclosed area to avoid poisoning from exhaust fumes.
- Use appropriate PPEs (safety shoes, ear protection, respirator, safety glasses, proper clothing etc.) when operating a tractor.

Resources

Ayers, P.D., 2005. General tractor safety. Publication No. 5.016. Colorado State University. Fort Collins, CO. <http://www.ext.colostate.edu/pubs/farmmgmt/05016.html> (Accessed July 25, 2011)

Childhood Agricultural Safety Network. 2011. Child tractor safety. National Children's Center for Rural and Agricultural Health, Marshfield Clinic Research Foundation, Marshfield, WI. <http://www.childagsafety.org/> (Accessed July 29, 2011).

Gasch, G. J. 2001. *Safety Management for Landscapers, Grounds-Care Businesses and Golf Courses*. Moline, IL: Deere & Co.

Ebert, K., M. Richetts, S. Lind, and P. Riemenschneider. 2006. **Tractor safety** for the **landscaping and horticultural** services industry. Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Kansas State University, Manhattan, KS. <http://www.ksre.ksu.edu/library/ageng2/mf2708.pdf> (Accessed July 28, 2011)

Grisso, R.D., B. Stone, G. Hetzel. 2009. Safe operation of compact tractors. Virginia Cooperative Extension, Publication Number 442-093. Virginia Tech, Blacksburg, VA. http://pubs.ext.vt.edu/442/442-093/442-093_pdf.pdf (Accessed July 25, 2011)

Lehtola, C.J., and C.M. Brown. Safer tractor operations for landscape maintenance and horticultural industries. Florida Cooperative Extension Service, Publication Number CIR1252. University of Florida, Gainesville, FL. <http://edis.ifas.ufl.edu/pdffiles/AE/AE19800.pdf> (Accessed July 28, 2011)

Lind, S. and M. Ricketts. 2009. Mowing and trimming safety for the landscaping and horticultural services industry. KSU Publication Number MF-2714 rev. K-State Research and Extension, Manhattan, KS, <http://www.ksre.ksu.edu/library/ageng2/mf2714.pdf> (Accessed on October 24, 2011)

NSC (National Safety Council). 2011. <http://www.nsc.org/> (Accessed on October 24, 2011)

NIOSH (National Institute of Occupational Safety and Health). 2004. Worker Health Chartbook 2004. Publication No. 2004-146. <http://www.cdc.gov/niosh/docs/2004-146/detail/imagdetail.asp@imgid264.htm> (Accessed July 28, 2011)

OSU. 2011. Tailgate Safety Training for Landscaping and Horticultural Services. Factsheet numbers: AEX.192.1.40 (PTO shielding), AEX.192.1.56 (ROPS), AEX.192.1.64 (PTO), AEX.192.1.65 (tractors), AEX.192.1.66 (tractor starting and stopping), AEX.192.1.80 (loader), AEX.192.1.81 (towed equipment), AEX.192.2.32 (no riders), AEX.192.2.80 (loader; for trainers). Ohio State University, Columbus, OH. <http://ohioline.osu.edu/aex-fact/192/> (Accessed August 5, 2011)

HOSTA (Hazardous Occupations Order in Agriculture). 2011. National Safe Tractor and Machinery Operation Program. Task sheets series. Pennsylvania State University, University Park, PA. <http://www.nstmop.psu.edu/> or <http://www.abe.psu.edu/ash/safetractorprog.htm> (Accessed August 4, 2011)

PSU. 2007. Pennsylvania farm safety and health quiz bowl sample questions. Pennsylvania State University, University Park, PA. <http://www.agsafety.psu.edu/QuizBowl/SampleQuestions.pdf> (Accessed August 4, 2011)

USU. The ten commandments of tractor safety. Fact sheet FM-27. Utah Cooperative Extension Service, Utah State University, Logan, UT. <http://extension.usu.edu/files/publications/factsheet/FM-27.pdf> (Accessed July 25, 2011)

Resources – Videos

How to drive a tractor. Ryan, J. eHow Presenter, Demand Media, Inc. http://www.ehow.com/video_4941615_drive-tractor.html (Accessed August 5, 2011)

Farm Tractor Safety - No Extra Riders. BickelProductions. <http://www.youtube.com/watch?v=0xYZoQrSmCA&feature=related> (Accessed August 5, 2011)

Tractor Safety Training Video. Tractor ByNet, IMC Digital Universe, Inc <http://videos.tractorbynet.com/video/618/Tractor-Safety-Training-Video-from-SafetyInstructioncom> (Accessed: August 5, 2011)

Childhood Agricultural Safety Network. 2011. Tractor Videos. National Children's Center for Rural and Agricultural Health, Marshfield Clinic Research Foundation, Marshfield, WI. <http://www.childagsafety.org/TractorCampaign.htm> (Accessed November 3, 2011).

Credits

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