

Rotary Mowers Safety: Lawncare Training Guide

Rotary mower maintenance and safe use

Introduction

Mowing lawns continues to be one of the most popular “summer job” opportunities for youth given the affordable cost and ease in operation of most rotary mowers. However, easy access and widespread use of mowers often creates a false sense of security among the users of these machines. Data from a seven year period (1996-2003) showed the highest rate of hospitalization from lawnmower injuries among youth workers 15-19 years of age (Costilla and Bishai, 2006). The Consumer Product Safety Commission (CPSC) reported that over 37,000 riding mower injuries occurred during 2003-2005 alone. During the same period there were 95 fatalities due to riding mower tip-over. The purpose of this training guide is to reduce the number of mower accidents and injuries by familiarizing young workers with rotary mowers and their safe operation.

Mower Types

A standard lawnmower comes with a single cutting blade that can provide a 12-22 inch wide cut. Larger self-propelled units and riding mowers generally are designed for cutting wider swaths in the range of 36 to 72 inches. Many of these units are designed to serve as garden tractors that can be outfitted with attachments for hauling small loads and to perform operations such as tilling, aeration, snow removal, and spreading fertilizers and chemicals. Front-mounted zero-turn (ZTR) mowers, in particular, come with a variety of other implements that can be attached and detached for landscape related operations.



Regardless of the size of the rotary mower, during mowing, the plant material is cut when the metal blade mounted on a rapidly spinning shaft (typically 2,000-2,500 rpm) comes in contact with the vegetation under the enclosed housing (the mower deck). The mower blade generally comes with a bend opposite to the sharpened edge (3-4 inch long area from the blade tip extending towards the center) known as an “up-sail”. This creates the air flow under the deck to direct the cut material to a deck discharge and/or for hitting the cut plant material multiple times in the case of a mulching mower. While a common term for mowing is “cutting grass,” more precisely, when cutting grass, the mower blade realistically tears the plant foliage as it strikes the stationary plant tissue. The quality of the cut depends on the sharpness of the blade and how well it is balanced. The following are the three basic requirements, recommended by the *TORO University Rotary Mower*



Decks are designed to chop grass clippings several times before discharge

Basics, for best mower performance:

- The blade must be straight with sharp cutting edges.
- The blade must have the proper attitude in relation to the ground surface.
- The blade must rotate at the proper speed with respect to mower ground speed.

The deck and blade designs vary depending on how the plant and other materials under the mower deck are to be discharged. Side or rear discharge decks are more common. The rear discharge decks are generally preferred for mowing areas where people might be around. Mower deck designs for zero discharge are becoming more common. This design chops the vegetation into finer bits and drops them into the canopy as the mower passes over. The advantages of mulching mowers are efficient recycling of clippings and improved safety because bystanders will not be hit by flying debris.

Major Components and Operation

This section of the training guide includes a general description of major components of rotary mowers. For specifications and additional details, readers may depend on an operator's manual.

Power Unit

Rotary push mowers are typically powered by a gasoline engine and some have a self-propelling drive. Most have a four-stroke engine with a 90- to 120-cubic-centimeter displacement, or from about 4 to 8 hp. Some also list torque, or twisting force. Most cut a 21- or 22-inch swath. These mowers can handle long or thick grass and weeds, and can bag, side-discharge, and mulch clippings. Although most of these mowers are powered by 4 cycle engines there are a few brands that are powered by 2 cycle engines and even some powered by electric motors.

Self-propelled models are best for most lawns and blend ease and performance. Self-propelled models will either be front or rear wheel drive. Self-propelled mowers will require engines that have higher horsepower and heavier duty frames to support the heavier engine and drive mechanism.

Commercial walk behind mowers are powered by an electric-start, commercial-duty, 4-cycle engine with a battery starter and power rating from 16 to 25 hp. They have cutting widths that vary from 32 to 60 inches. The drive system for these mowers can either be a gear or a hydrostatic system. The frames of these mowers are made from heavy gauge metal and have heavy duty 4-ply turf tires. Commercial walk behind mowers are designed to offer reliable performance for landscapers and owners of large lots.



Compact tractor equipped with mower attachment

Most self-propelled riding mowers used in lawncare may be placed in one of the following two categories:

1. Riding lawn mowers (8-25 hp) fitted with a mower deck. Usually these have no attachments.
2. Lawn and garden or compact tractors (12-60 hp). These come with mower decks and other attachments. Engines on these tractors are either gasoline or diesel and they may be air or liquid cooled.

Cutter Deck Housing

The deck housing supports the blade hubs with their drive mechanism and is shaped to carry the cut grass clippings away from the deck.

Blade Mounting and Drive System

The blade is normally driven directly by the engine crankshaft or a hydraulic motor or through a belt pulley system to each blade hub.

Blade

The blade has a sharpened cutting edge at each end with a curved up sail area to create the air flow under the deck. This air flow will whip the grass blades, exposing them to the blade cutting edge. The air flow also pushes the cut grass

out through the deck discharge.

Power Transmission

The three types of power transmissions associated with mowers include manual shift, variable speed, and hydrostatic. In order to operate different types of mowers effectively, one should be familiar with the different types of transmissions and their operating characteristics.

The manual shift transmissions are usually belt or gear driven. Belt transmissions are the simplest and cheapest and usually found on smaller riding mowers. In most cases, a fixed-speed belt drives a 3-, 4- or 5-speed gear transmission.

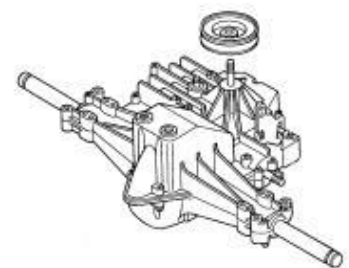
Belt transmissions have the advantage of not needing a separate clutch as the belt can be slackened to provide clutching. Speed is changed by moving the belt on the side of a sheave, in or out, and thus changing the pitch diameter of the sheave. The second sheave is normally spring loaded, so it responds in a direction opposite to the control sheave. Thus, as the operator moves the speed control lever, one sheave in effect is made



Mower blade with up sail for flow of grass



Gear transmission



Mechanical transaxle

smaller while the other is made larger. This causes the transmission ratio to change and to slow down or speed up.

Gear transmission provides three to five forward speeds, plus reverse. A gear transmission may be connected to the engine by a mechanical clutch, which can be slackedened to provide de-clutching. On most small tractors, the gear transmission is integrated with the axle and differential into one unit called a "transaxle."

Mechanical transaxles tend to be durable and trouble-free. While gear transmissions are known for their low cost and high reliability, they lack the flexibility for infinite speed control. Using a mechanical transaxle, a gear transmission in combination with a variable-speed belt drive, provides both cost advantages and flexibility.

The Hydrostatic Transmission, also known as a Continuously Variable Transmission (CVT), offers maximum flexibility in terms of speed control. The major components of such a transmission system include a variable displacement pump, a hydraulic motor, a charge pump to replenish the fluid supply and a set of check valves. In this type of system, power is transmitted through pressurized fluid under confinement. The direction of the motor shaft rotation and its speed are controlled by the direction and quantity of pump output flow, respectively. For a given input speed, infinite output speeds within a range are possible with a hand lever or foot-pedal. Other advantages associated with hydrostatic transmissions include potential for transmitting increased torque, high efficiency, compactness, flexibility in mounting the motor directly on the wheel and easy single hand lever or foot-pedal control for forward and reverse speeds. The primary disadvantages of the system include high initial and maintenance cost and the difficulty in keeping the system contamination free.

Safety Features

Walk-behind mowers are equipped with a clutch on the handle that, when disengaged, quickly shuts off either the blade and/or engine. Riding mowers have a "kill switch" under the seat. This switch cuts off the blade and/or the engine when the operator leaves the seat. Most riding mowers will not start unless the blade is disengaged. NEVER disable these important built-in safety features.



Note the "clutch-handle" that must be closed to keep engine running.

"No-Mow-in-Reverse" Controls

On average, one child each day in the US is backed over by a riding mower. The biggest danger from "mowing in reverse" comes from the blind spots present on most riding mowers, especially those equipped with a large rear grass catcher. A small child (36 inches tall) playing behind the mower may not be seen by an operator from the operator's seat.



The lawn mower industry had adopted a voluntary safety standard in 2003 (ANSI/OPEI B71.1-2003). This standard requires a “no-mow-in-reverse” (NMIR) mechanism on all new mowers. However, manufacturers are permitted to install equipment that overrides this safety feature temporarily.

The NMIR feature cuts off the mower blades when shifted into reverse. The override device (either a button on the dash or position on the ignition switch) allows overriding the NMIR feature. Some mowers come with a warning on the dash “look for children” before using the overriding option.

Suspension System

Most riding mower chassis suspensions are simple systems that will allow the vehicle to follow the terrain and isolate the operator from shocks and vibrations. The seat suspension systems on most mowers are designed to protect the operator’s backs and for reducing operator fatigue. They are adjustable based on the size of the operator and it is a good practice to adjust the seat to match the operator.

Some commercial units have complex suspension systems for added comfort and reduced fatigue.

Suspension Systems for Mower Decks

Two types of suspended systems are common among mowers. While suspended decks are more common on smaller mowers, ground-carried decks are widely used on larger units. Both types work well. However, it is important the operator recognizes the differences between the two and be familiar with the adjustments to improve the performance.

Suspended Mower Decks

Suspended decks generally hang under the mower on a parallelogram linkage. An adjustable stop link limits the rotation of the parallel linkage and controls the deck height.

The adjustable stop may be controlled by a knob or lever on the tractor. During operation, the deck is lowered until the linkage hits the stop.

With suspended linkages, the anti-scalp wheels and rollers on the mower are not designed to contact the ground during normal operation. They are primarily there to prevent scalping on uneven ground. The height of the wheels and rollers are adjusted to match the mowing height setting chosen, so that the wheels or rollers are carried just above the level ground surface.

If the anti-scalp wheels or rollers are in contact with the ground all the time, they are out of adjustment and this will result in excessive wear. For proper adjustment of these rollers and wheels, follow the recommendations in the operator’s manual.



Suspended mower deck with parallel links

Ground-Carried Decks

The decks on most mowers used for commercial applications are ground carried or ground following. The linkages on these decks are similar to the suspended linkages. However, they are not parallelogram linkages. On these tractors, the linkage lifts the mower deck for transport and pulls the deck along while mowing without carrying the weight of the mower. With ground-carried decks, the deck rides on gage wheels during use. The wheels are generally much larger in diameter than the anti-scalp wheels on suspended decks and usually have pneumatic tires.



Ground carried deck

During transport, the ground-carried decks are lifted off the ground with the linkage. Either the front or rear linkage (or both) will pull the mower deck along while mowing and the mower will follow the contours of the ground, independent of the chassis. Height adjustment is accomplished by adjusting the gage wheels or rollers. Review the operator's manual for instructions on how to set the wheels and rollers.

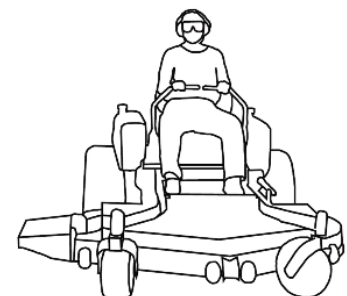
Tires

The tires on mowers should be checked daily. Follow the manufacturer's recommendations in the operator's manual for proper tire pressure. If a manual is not readily available, contact the dealership or visit their website for this information.

Visual checks of the tires are important. With over-inflated tires a smaller portion of the tire will be in contact with the ground. An over-inflated tire may cause excessive drive wheels slippage, causing faster and uneven tire wear. An under-inflated tire on the other hand, could cause rim slippage and loss of air pressure. It could also cause sidewall buckling while loaded and excessive wear on the sidewalls. Correct pressure provides better contact between the tire and the ground, good traction and the best wear patterns.

Zero-Turn Mowers

Zero-turn (ZTR) mowers use a dual hydraulic system to take 180 degree turns quickly and easily. These mowers are capable of covering large areas in less time and mow in the close proximity to objects in and around the landscape. Front-mount ZTR mowers have the cutting deck in front of the operator. On the other hand, mid-mount ZTR mowers have the deck directly below the operator. Rear-mount mowers offer advantages because of their shorter body lengths which provide space saving during transport and storage. Front-mount mowers are generally more stable and offer advantages in mowing around obstacles. They, however, require extra care when going up and down the hills as discussed in the safe use section below.



Zero-turn mower with front deck.

Safe Use of Mowers

Safety in mower use can be improved significantly by purchasing the right kind of mower for the job to be carried out. When shopping for a new push mower or a riding mower, make sure that they meet the established safety standards. The current standards guarantee certain safety features such as automatic disengagement of blade when the mower is stopped or when the operator leaves the seat or when the mower is in reverse. This automatic cut off will be helpful in reducing the number of accidents and associated injuries. These standards also give guidelines for better safety systems to protect the operators and provisions for vehicle stability.



Mower with ROPS

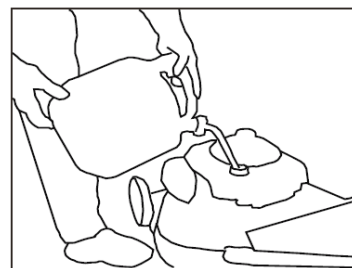
Mowing safety also depends on how experienced the operator is and how familiar he/she is with the equipment. The operator's manual is extremely helpful in getting familiar with the equipment. The manual also provides maintenance and safety tips. Therefore, repeated review of the manual by the operator is highly recommended to make the mowing operation safer.

In addition to these, there are a number of other precautionary measures the operator can take to improve the mower safety and they are as follows:

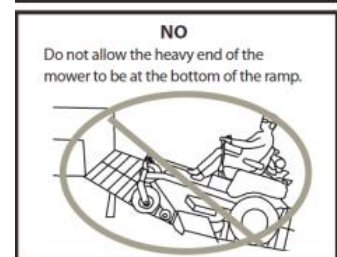
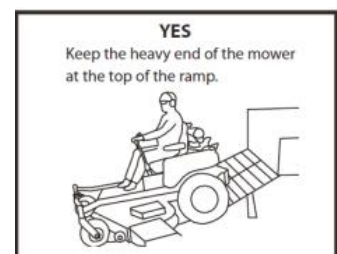
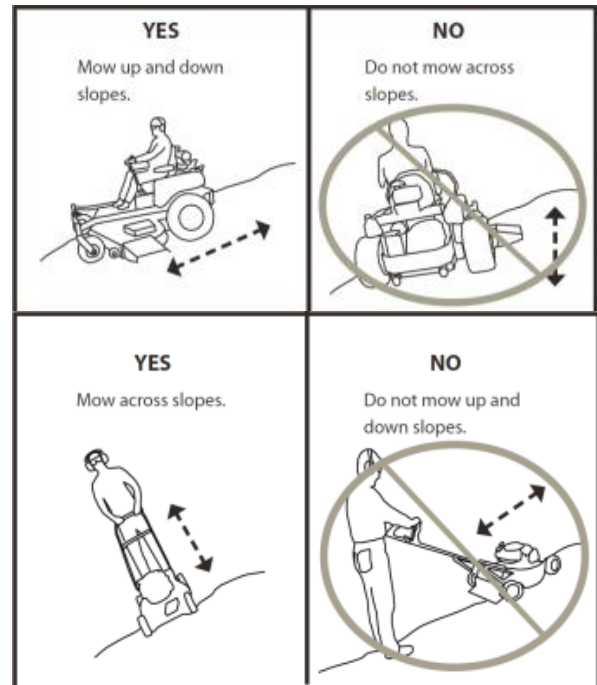
- During mowing, wear all the required personal protective equipment (PPE) recommended in the owner's manual. In particular, pay attention to utilizing equipment that has protective devices to protect eyes, ears, and all extremities.
- Ensure all shields and guards are in place and functioning. Never remove shields for increasing clipping discharge.
- Before operating a riding mower or a ZTR mower, make multiple practice runs without engaging the blade to ensure that the operator can handle the equipment safely.
- Make sure that the riding or ZTR mower is equipped with seat belts and Roll over Protection Systems (ROPs).
- Follow guidelines in the operator's manual strictly.
- Disconnect the spark plugs before any mower maintenance activities such as blade sharpening, balancing, and adjusting.
- To avoid binding of the mower blades and to improve grass health, do not remove more than 1/3rd of the leaf blade during any single mowing.
- Prior to mowing, check the area for toys, trash, landscape debris, exposed rock, wires, or irrigation heads, and remove and/or mark them to avoid damage.
- Operate the mower at the recommended engine speed.
- Discharge clippings away from bystanders or doorways.
- Keep hands and feet away from the spinning blades at all times.

To Properly Fill Fuel Containers:

1. Set the container on the ground.
2. Touch the nozzle to the container before removing the container lid.
3. Keep the nozzle in contact with the container while filling.
4. Don't fill to the brim. Leave room for expansion. Portable containers and gas tanks should be filled ¾ full.
5. To reduce the chance of static sparks, do not fill containers in the bed of a pickup or in a car.



- When operating push mowers, wear shoes that optimize traction.
- For better shoe and wheel traction, avoid mowing wet grass, particularly on slopes.
- Turn off the mower engine before unclogging the discharge chute.
- Never leave a running mower unattended.
- To prevent possible injury from flying debris, wear heavy steel-toed shoes and long pants when operating a push mower.
- When the mowing is done with a riding mower to avoid sideways overturning, mow up and down the slopes and not across. Mow across the slopes with a push mower to avoid a runaway situation. For ZTR mowers, follow the recommendations in the operator's manual.
- Do not allow any additional riders on riding mowers.
- Use a funnel when refueling a warm engine. (Add fuel on a flat surface, preferably off the lawn).
- Maintain proper speed and avoid sharp turns to prevent tip over.
- When operating a riding mower on a rough terrain, slow down and maintain control.
- Stay clear of ditches and embankments. If a ditch is six feet deep, the rule of thumb is that the riding mower should not be any closer than six feet from the edge of the embankment to avoid embankment failure.
- When backing up riding mowers, do so carefully. Watch especially for young children when backing up.
- Do not operate a riding mower under the influence of drugs or alcohol.
- Follow the manufacturer's recommendations for wheel weights or counterweights on riding mowers.
- Follow general safety tips for outdoor work; protect yourself from heat stress, solar radiation, dehydration, and insect bites.



Safe Transport of Riding Mowers

In addition to following the recommendations in operator's manuals, the following steps may help safe transportation of riding mowers:

- Keep bystanders at a safe distance.
- Block the rear wheels of the transport vehicle.
- Attach appropriate ramps to the transport vehicle before loading.

- Back the mower up the ramp. To unload drive forward down the ramp.
- Chain and block the riding mower to avoid movement during transport.

Resources:

Anonymous. Rotary Mower Basics. TORO University Technical Training. PART NO. 09167SL. <http://www.toro.com/customercare/commercial/education/pdf/09167sl.pdf> (Accessed on October 24, 2011)

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Credits

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