



Rollover Protection for Farm Tractor Operators

E 42

Dennis J. Murphy, Professor, Agricultural & Biological Engineering
 Dennis R. Buckmaster, Associate Professor, Agricultural & Biological Engineering

Tractor rollovers are the single deadliest type of injury incident on farms in the United States. The latest figures from the National Institute of Occupational Safety and Health (NIOSH) suggest there are approximately 250 tractor rollover fatalities per year. NIOSH estimates that there are approximately 4.7 million tractors in use on U.S. farms; one-half of them are without rollover protection for the operator. This fact sheet will closely examine tractor rollover protection issues.

What are ROPS?

Rollover Protection Structures (ROPS) are roll bars or roll cages designed for wheel- and track-type agricultural tractors. ROPS are designed to create a protective zone around the operator when a rollover occurs. When used with a seat belt, the ROPS will prevent the operator from being thrown from the protective zone and crushed from an overturning tractor or from equipment mounted or hooked to the tractor (see Figure 1).



Figure 1. A buckled seat belt keeps the operator within the zone of protection of the ROPS during an overturn.

Three types of ROPS frames are available: a two-post frame (with solid fold down versions), a four-post frame, and a ROPS with enclosed cab. They all serve the same function: protecting the operator in case of a tractor rollover.

Why Bother?

- ◆ National data suggests that 1 of every 10 tractor operators overturns a tractor in his or her lifetime.
- ◆ Tractors in the Northeast states have the highest rate of overturn deaths and the lowest percentage of tractors with ROPS.
- ◆ The one time effort in installing a ROPS will protect whoever drives the tractor for the life of the tractor.
- ◆ The use of ROPS and a seat belt is estimated to be 99% effective in preventing death or serious injury in the event of a tractor rollover.
- ◆ The Occupational Safety and Health Act (OSHA) requires an approved ROPS for all agricultural tractors over 20 horsepower that were manufactured after October 25, 1976, and which are operated by a hired employee.
- ◆ A ROPS normally limits the degree of rollover thereby reducing damage to the tractor.
- ◆ A ROPS with enclosed cab also prevents tractor operators from being knocked out of their tractor seat from rough ground and low hanging tree limbs, provides protection from the sun and other weather hazards, and reduces risk for the unsafe practice of extra riders on tractors (see Figure 2).



Figure 2. A ROPS with enclosed cab gives the operator the most protection from common hazards of tractor operation.

ROPS History

Between 1967 and 1985 U.S. farm tractor manufacturers provided ROPS as optional equipment on most tractor models. This meant that new tractor purchasers had to add the cost of a ROPS onto the base price of a tractor. Because most farmers are cost conscious, few added ROPS as an option. Even fewer pre-1967 tractors have ROPS, yet many of these tractors are still in use. Beginning in 1986, American tractor manufacturers began voluntarily adding ROPS on all farm tractors sold in the United States over 20 horsepower.

The percentage of tractors in use and manufactured before the voluntary ROPS agreement is high because farm tractors are often in use for 30 to 40 or more years. Many newer tractors originally sold with ROPS have been stripped of the protective roll



Figure 3. A foldable two-post ROPS allows tractor operation in low clearance situations without completely removing the ROPS.

bar or roll cage because some farmers claim the ROPS structure blocks their view during normal tractor operations. Another reason often given for removing a factory-installed ROPS is that the tractor won't fit into smaller spaces with a bulky roll bar. Foldable ROPS are now available to reduce this problem (see Figure 3).

ROPS Construction

ROPS are engineered to mount on specific tractor models and designed to operate with the tractor's mounting brackets and frame. This provides a structure that is flexible, yet rigid enough to withstand the loads produced during a tractor overturn. Prototype ROPS must pass engineered, crush, static, and dynamic tests to assure adequate performance before they are produced for the public. These prototype ROPS must meet the standards set by the Society of Automotive Engineers (SAE) (SAE J167, J2194), and the American Society of Agricultural Engineers (ASAE) (ASAE-S383.1).

The dynamic test involves hitting the tractor ROPS in a prescribed manner with a 4,410 pound pendulum weight from behind and from both sides. In order for a ROPS to pass the dynamic test, the ROPS protective zone must remain intact and maintain the specified distances from the operator. The ROPS can be made of any material as long as the material meets temperature requirements and passes the tests set forth by the standards. Typical ROPS provided by manufacturers are made of steel that will not fracture in cold temperatures and are precision welded. The goal of the ROPS is to absorb the impact energy without excessive deformation to create a zone of protection for the operator.

Overhead Protection

Some ROPS frames and enclosed cabs are equipped with overhead canopies to protect the operator from falling objects. Canopies that protect against falling objects are called FOPS (falling object protective structures) and must be properly designed and certified. Such canopies are recommended when using front-end loaders, working in the woods, or in other circumstances where falling objects may be a hazard. FOPS must be designed according to SAE and ASAE standards. To be sure that a canopy is a FOPS, check with the ROPS supplier or the equipment dealer.

Factory Installed ROPS

Farm tractors (including some lawn and garden models) should have a factory installed ROPS with a seat belt. These ROPS are certified to meet maximum rollover impact and dynamic forces. Modification of the factory installed ROPS (cutting, grinding, drilling or welding) is unauthorized and unwise. Modification of the ROPS design can impair the ROPS ability to carry out its function (i.e. providing a protective zone to save a human life) in the event of a tractor overturn. Factory installed ROPS will have a certification label attached to the roll bar stating that the roll bar meets SAE/ASAE/OSHA standards. See Figure 4 for a typical example. It is important to check for this label on imported tractors.



Figure 4. This certification tag indicates the ROPS meet nationally approved standards for operator protection during a rollover.

ROPS Maintenance and Misuse

It is necessary to inspect and service a ROPS and seat belt periodically to check for extreme rust, cracks, or other sign of wear. Any of these could cause a failure of the ROPS during a rollover. If there are signs of wear, the manufacturer or dealer should be consulted to determine the suitable course of action.

ROPS can also be abused or misused. Holes should never be drilled into the ROPS frame, nor should a piece of steel be welded onto the frame. If lighting or other light attachments are needed, they should be clamped onto the ROPS. A ROPS should not be used as a point of attachment for a chain, hook or cable. Pulling with the ROPS could damage it and result in a rear overturn. If a tractor with ROPS does overturn, the ROPS should be replaced because it is specifically designed to bend to absorb the energy

generated by the tractor contacting the ground. ROPS are only designed and certified to withstand a single overturn.

Retrofit ROPS

Many farm tractors manufactured since 1967 can be retrofitted with a ROPS. Tractor companies and aftermarket manufacturers have designed and developed ROPS for most tractor models. Manufacturers such as AGCO, Case-IH, Kubota, New Holland and Deere and Company offer low cost retrofit ROPS kits for tractors manufactured from the mid 1960s to 1985. ROPS for many older and smaller tractors can be purchased for \$600 or less. Agricultural equipment dealers are approved to install a retrofit ROPS and seat belt. Installation charges are normally in addition to the cost of the ROPS.

A listing of ROPS retrofits for farm tractors manufactured since 1967 has been compiled by the National Farm Medicine Center, Marshfield, Wisconsin, in a publication called, "A Guide to Agricultural Tractor Rollover Protection". This guidebook is available on the web at <http://research.marshfieldclinic.org/nfmc/resources/rops/>. Local equipment dealers should also have information on ROPS retrofitting for their brands of tractor.

ROPS for some older models of tractors may not be available even though one is listed by a ROPS manufacturer. This is because a ROPS manufacturer often will not produce a specific ROPS for an older tractor until an order has been placed. An order for just one ROPS may mean the cost will be prohibitive to the tractor owner.

Homemade ROPS

Because of the severe impact and dynamic forces present during a rollover, it is important that a ROPS be properly designed, manufactured, and installed. If the ROPS is too rigid or too flexible, injury could occur to the operator during a rollover. Homemade ROPS are not recommended because they may not be properly designed, built, or installed. Poor welds and undersized bolts could fail under the impact and stress of a tractor overturn. Farmers, local hardware stores and welding shops do not have the special steels, bolts or welding supplies required for an approved ROPS. Nor do they have the testing equipment that is needed to certify that a ROPS meets design standards. A homemade ROPS also exposes the owner and builder of the ROPS to liability damages should a tractor overturn and the homemade ROPS fail.

ROPS and Seat Belts

A seat belt is an integral part of the tractor rollover protective system as it keeps the operator within the protective zone created by the roll bar or roll cage. The seat belt assembly must also conform to engineering standards.

A ROPS alone will not provide full protection to the operator when there is a tractor overturn. A seat belt must be used in combination with the ROPS to provide the highest degree of safety. Without a seat belt, the operator will not be confined to the protective zone, and may be crushed by the tractor or even the ROPS itself.

Many farmers give the excuse that because they won't wear the seat belt, they won't bother to install a ROPS. While a ROPS alone won't completely protect the operator, it will provide considerable protection. Precise statistics are not available but what is known is that:

- ◆ Few tractor operators buckle their seat belts while operating a tractor;
- ◆ There are an estimated 2,000 ROPS equipped tractor overturns each year;
- ◆ There is no data at the national, state, or local level to suggest these ROPS equipped tractor overturns are fatal to the tractor operators.

While roll bars and seat belts together are the most effective system for operator protection from a tractor that is overturned, the ROPS portion of the system provides the bulk of the protection. Installation of a ROPS on all tractors is an important step toward agricultural injury prevention.

PSU

1st Edition 7/03

www.abe.psu.edu/factsheets

The Pennsylvania State University is committed to the policy that all persons shall have equal access to programs, facilities, admission, and employment without regard to personal characteristics not related to ability, performance, or qualifications as determined by University policy or by state or federal authorities. It is the policy of the University to maintain an academic and work environment free of discrimination, including harassment. The Pennsylvania State University prohibits discrimination and harassment against any person because of age, ancestry color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status. Discrimination or harassment against faculty, staff, or students will not be tolerated at The Pennsylvania State University. Direct all inquiries regarding the nondiscrimination policy to the Affirmative Action Director, The Pennsylvania State University, 201 Willard Building, University Park, PA 16802-2801, Tel 814-865-4700/V, 814-863-1150/TTY.