Each year, there are approximately 130 deaths due to tractor overturns. This is a leading cause of fatalities in the agriculture industry. Accidents occur on private property—construction sites, farms and estates—and on public property, including roadsides and parks.

1. Misuse of the features making the tractor a useful and versatile piece of equipment can cause accidents and result in injuries or death.

2. This data sheet discusses the use of devices known as rollover protective structures (ROPS), when track-type, self-propelled, pneumatic-tired equipment is used in earth moving, landscaping and mowing operations on roadsides, on railroad rights-of-way or in farming.

Hazards

3. Power applied to the rear wheels tends to lift the front end of a tractor. Under the following conditions, for example, the tractor may tip over backward:

   • Driving over soft ground causes the drive wheels to slip or to become lodged. If the wheels are spinning, and the operator blocks or chains the wheels to prevent them from slipping, and then applies full power and engages the clutch too quickly, the tractor may tip over backward.

   • Driving on an incline, such as climbing out of a ditch. If the clutch is engaged too quickly, while applying full power, the tractor may rear upright and tip over backward.

   • Pulling a load attached to the axle or to the drawbar that has been raised too high or has too short a hitch. The moments of force causing a tractor to tip over backward are a product of the load and height of the hitch from the ground. With the hitch at the proper height, if the tractor starts to tip over backward, the hitch will lower rapidly, reducing this force. If the hitch is raised, the force is increased along with the tendency to tip over backwards. If the hitch is shortened on the load attached to the axle, the force may not reduce rapidly enough as the front wheels rise, and cause possible backward tip over.

4. Even when a tractor is operated on level ground, poor soil conditions, holes, ruts, rocks
and other obstacles contribute to instability and possible loss of control of the tractor. On slopes, in ditch sections and on irregular surfaces, tractor control becomes even more critical.

5. The possibility of overturning sideways, especially when operating on slopes, unstable or uneven ground, is increased by:

- Sharp turns
- Sharp turns in an uphill direction
- Traveling too fast for conditions
- Lack of familiarity with area of operation
- Hidden obstacles
- Poor operator judgment
- High hitch points
- Lack of operator training
- Failure to back out of holes or up steep slopes
- Lack of familiarity with a particular type or size of tractor
- Lack of retraining at appropriate intervals
- Operator impairment (such as obscured vision, cold weather or distraction)

6. Properly functioning machinery does exactly what the operator tells it to do through its controls. Therefore, all operators must understand tractor controls and how to direct the tractor. They also must know how environmental factors affect them and their machines.

**Protective devices**

7. Since Sept. 1, 1972, it has been required by OSHA that the following materials handling equipment be equipped with ROPS:

- Rubber-tired, self-propelled scrapers
- Rubber-tired front end loaders
- Wheel-type agricultural and industrial tractors
- Crawler tractors
- Crawler-type loaders
- Motor graders

8. Many utility tractors now in use are equipped with overturn protective frames that may not function as intended, should the tractor overturn. Standards for the performance of rollover protective structures, both the two- and four-post type, have been developed by the American Society of Agricultural Engineers. To ensure safety of tractor operators, frames or protective enclosures should meet these standards. Performance confirmation of shop-fabricated frames will require costly destructive testing. Manufacturers of utility and agricultural tractors offer protective frames designed and tested for a particular model. In many cases they can retrofit several previous models.

9. Protective frames are installed on tractors to minimize the possibility of operator injury from accidental upset. The ROPS are made of tubular steel, formed steel shapes, or I-beams.

10. Safety belts, in addition to protective frames, keep operators in their seats when traveling over rough terrain. They also hold the operator within the protective area of the structure in the event a tractor tips over.

11. Safety belt anchorage should be secured on the movable portion of the seat to permit travel with the operator. For best performance, the belts should be tested according to SAE recommended practice
(J4c), except, a 1,000-pound test load should be applied at 45 degrees to the horizontal, instead of the 5,000-pound load applied at 10 degrees, as specified. (This change is possible because of the lower speeds involved in tractor overturns.)

12. The design of the protective frame should:

- Be of sufficient strength to prevent a tractor from crushing an operator in the event of a rollover or (backward) tip over
- Tend to limit side roll or rear tip over to 90 degrees
- Extend sufficiently to the rear to prevent operators from coming in contact with towed or mounted attachments, in the event of a rear tip over
- Permit optimum visibility
- Not interfere with an operator’s movements in controlling the equipment
- Permit easy attachment and removal when maintenance repairs are to be performed
- Permit an operator’s easy escape after a tractor overturns
- Not limit usefulness of equipment

13. Because there are many different models, types and sizes of tractors, and types of towed, or mounted, equipment, the protective frame design should be worked out by the manufacturer. ROPS are available from manufacturers of industrial and construction equipment; therefore, the use of devices contrived by “ball-peen machinists” or “backyard mechanics” should be discontinued. (Only ROPS that withstand both side and backward rollovers, matching or exceeding SAE-ASAE standards, should be permitted on equipment.)

Operating safety precautions

14. Safety belts, when used, prevent operators from falling under a tractor in an upset or during rough operations, when operating a tractor with ROPS. If tractors are not equipped with ROPS the use of safety belts is strongly discouraged, because operators would be unable to escape in the event of tractor overturn.

15. The ROPS and safety belts are devices used to protect operators when an accident occurs. Failure to use safety belts has resulted in critical or fatal injuries. Safety belts will not prevent accidents; therefore, it is helpful to observe the following “Rules for Tractor Safety”:

- Slow down when making sharp turns. Most tractors can overturn sideways whenever a short turn is made at a transport speed.
- Front-end weights should be added when operating on hilly ground. Lower gears should be used when going downhill. If tractors are equipped with multirange or automatic shifts, make certain the range used is direct drive, not freewheeling.
- When pulling a load, only the draw bar should be hitched. Draw bars should be kept hitched at least 13 inches but less than 17 inches off the ground. The higher a load is hitched, the easier it is for the tractor to overturn backward.
- Front-end loaders or fork-lifts raised high will make a tractor top heavy; therefore, when moving a front load, the load should be kept low and the rear wheels should be kept as level as possible.
- Holes and obstacles such as stones or stumps should be avoided.
- Operators should move slowly when vision is limited or when operating on rough ground.
• When stuck, operators should try to back out. Racing an engine or fastening a post to the rear wheels greatly increases the chances of tipping over backward. Help should be sought when operators are unable to back out.

• When traveling on highways, operators should abide by the accepted rules for auto drivers: use proper hand signals; avoid traveling during heavy traffic periods; check brakes for equal application when locked together for highway use.

• Lighting and markings required by state vehicle codes should be used when driving on highways. Slow-moving vehicle emblems mounted on the back of vehicles are now required by OSHA when employees are operating vehicles traveling 25 mph or less on highways.

• Grass should not be mowed with a tractor on slopes greater than four to one.

• Tractors should be left on inclines only after the engine has been turned off, the gearshift placed in the park position, and wheels braked and blocked.

• Operators should not wrap their thumbs around steering wheels, as steering wheel kick can cause serious injury to hands and wrists.

• Tractors should be mounted or dismounted only when they are stopped.

• Operators should shut off their engines before refueling or making adjustments to either the tractor or towed equipment.

• Operators should shut off their engines before dismounting a tractor.

• Riders should not be allowed on tractors, draw bars or on towed equipment unless a seat is provided for them.

• Fenders are guards, and they should be kept in place at all times.

• Jobs should be planned ahead of time and hazards should be watched for, including those overhead.

Sources of information


U.S. Department of Labor Occupational Safety & Health Administration 200 Constitution Avenue NW, Washington, D.C. 20210

Tractor Safety Guidelines, Iowa State University of Science and Technology, Ames, IA 50011 Tractor Safety Is No Accident, Cooperative Extension Service, University of Illinois, Urbana, IL 61803.

SAE - Society of Automotive Engineers International Warrendale, PA, USA - Headquarters 400 Commonwealth Drive, Warrendale, PA 15096 http://www.sae.org/about/contact/directns.htm

Department of Labor Occupational Safety & Health Administration Agricultural Safety Fact Sheet https://www.osha.gov/Publications/OSHA3835.pdf Agriculture Safety: Protecting Workers from Tractor Hazards Fact Sheet OSHA 3835.2015