

Power Take Off Boot and Shoelace Demonstration

Background

Power-Take-Off (PTO) shaft entanglement is a great hazard for farm workers. Tractors spin PTO shafts at either 540 revolutions per minute (rpm) or 1000 rpm. At 540 rpm the shaft makes 9 revolutions per second and will travel about 7 feet per second. This demonstration will illustrate how far and fast a 540 rpm shaft travels. The shaft spins much faster than human reaction time. PTO safety shields may wear out, get broken from misuse or be removed to service the universal joint. If they are not repaired or replaced the spinning shaft and hardware is exposed to catch anything that comes near such as a person's clothing.



Scan for a video on this learning lab.

PTO entanglements usually inflict extremely gruesome injuries. The PTO shaft is located about a foot above the draw bar of the machine it is powering, and there are often wire-reinforced hydraulic hoses hanging nearby as they are connected between the tractor and the drawn implement. Typically, in only a few seconds during an entanglement, the victim either has limbs torn off or their body is battered against the drawbar, pulling them repeatedly through the small space between the PTO shaft and drawbar, and wrapping the hydraulic hoses around the victim. Few survive, and those who do are often severely disabled.

Materials Needed

- One work boot with laces
- A 21 foot long string tied to one of the boot's shoelaces
 - The 21 foot long string is a simulated shoelace
 - The string must be neatly coiled and lowered into the boot so that it will come out with getting knotted or tangled during the demonstration.

Procedures

1. This demonstration is a visual activity that can be used as part of a PTO safety educational event. The Instructor will want to first discuss the hazards of 540 rpm PTO shafts that are in our NEC lesson plan on PTO safety and the background information in this handout. This could be performed in a classroom, or on a farm or other outdoor

setting. This would be a very good activity for a youth farm safety day. This activity also works well with adult audiences.

2. In the PTO Boot demonstration you will use two volunteers. One volunteer will pretend to be a tractor operator and the other volunteer will be the victim. The tractor operator will be holding the work boot which has a 21 foot long piece of string tied to the shoe lace. The string is tucked neatly into the boot. It is not visible to the audience that the shoelace is going to be 21 feet long.
3. As the instructor, you will explain the scenario to the two volunteers and the audience. You will say that the tractor operator is pretending to be in the operator's seat and operating the tractor in a stationary manner, for example, maybe they are using a 540 rpm PTO powered post hole digger to dig post holes. The volunteer that is the victim, was working on the ground in close proximity to the PTO shaft while it was spinning at 540 rpm's. In the scenario, the victim gets their shoelace caught in the PTO shaft because they were working too close to it while it was running and the PTO shield was not in place, or it was damaged and not repaired.
4. The Instructor will then ask, "If the victim gets their shoe lace caught in this spinning shaft, how long would the shoelace have to be in order for the tractor operator to react, shut off the PTO control, and save the victim from being pulled into the shaft and entangled?"
5. The Instructor will then ask the victim to take the string and walk out away from the tractor operator holding the boot. The instructor can then ask the tractor operator, or maybe the audience to tell the victim to stop walking out when they think the shoelace would be long enough to provide enough reaction time to shut off the PTO. In most cases, audiences will tell the victim to stop before they get to the end of the 21 foot long string (Simulated shoelace). They may stop them two or three times too early.
6. When that part of the demonstration is over, the Instructor will then tell the victim to stretch the string out completely, so that all the string and shoelace has come out of the work boot. At this point the Instructor will then say, "That shoelace is 21 feet long. That is approximately how far a 540 rpm shaft will have traveled in three seconds." The Instructor can then ask the victim, "Do you have shoelaces 21 feet long?". They always say no, that they don't.
7. The Instructor can then explain, that in most pieces of equipment, it doesn't shut off instantly. Even though the PTO has been stopped the machinery may still spin for a period of time until it comes to a complete, thus further entangling a victim.
8. At this point the Instructor can then review the main points of PTO safety which would include:
 - a. Make sure that all shields are in place and working properly
 - b. Never get close to a spinning PTO shaft
 - c. Never step over a PTO shaft

- d. Always wear tight fitting clothes, remove jewelry, keep long hair tied up when working around PTO powered equipment
 - e. Before performing any service, adjustments, or repairs, shut off the PTO, shut off the tractor's engine and wait for all machinery to come to a complete stop.
 - f. Always keep children and other non-working people out of the area where PTO powered equipment is being used
9. The last part of the demonstration is to ask the victim to walk back to the tractor operator with the string. If the Instructor is doing another one of these demonstrations, it is important to slowly coil and lower the string back into the boot to have it ready for the next demonstration. If the string is quickly jammed back into the boot it can become tangled and knotted and will not come out correctly in the next demonstration.