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Iowa City, Iowa 52242

TO: Director, National Institute for Occupational Safety and Health

FROM: Iowa FACE Program

Date of Report 11/15/1999

SUBJECT: Operator of three-wheeled agricultural sprayer was killed when machine overturned in steep ravine.

SUMMARY

During the spring of 1999, a 26-year-old operator of a three-wheeled agricultural boom sprayer was killed when the sprayer drove through a barbed wire fence and careened down a steep ravine, rolling over at the bottom. The victim had just finished spraying a small 5-7 acre field with bean herbicide and was folding in the hydraulically-controlled spraying booms when the machine apparently moved forward too far and rolled through a barbed wire fence.



There were no apparent skid marks from braking. The ravine on the other side of the fence was quite steep and it would have been difficult to stop the machine once the front wheel broke through the fence. While running down the slope, the left rear tire of the sprayer hit a small tree, causing the machine to swing to the left, then crash on its side and top in the gully. The cab was not designed as a Roll Over Protective Structure (ROPS), nor were seat belts installed in this machine. Therefore there was little protection for the driver when the machine overturned. The operator was thrown through the front window and fatally crushed as the cab crumbled under the weight of the sprayer. The machine was 20 years old and appeared to be in good working order. There was some indication that the parking brake was not operational. We requested a test to determine whether the brakes were in working order, however the machine shop where the machine was taken after the crash was not able to have this testing done. The victim was an experienced sprayer operator. The injury occurred about 5:30 p.m. towards the end of the workday and fatigue may be a contributing factor. The death was not discovered until an hour later when the victim failed to show up at another work location. He was found dead at the scene.

RECOMMENDATIONS based on our investigation are as follows:

#1 Self-propelled agricultural boom sprayers should be equipped with Roll Over Protective Structures (ROPS) and seatbelts.

#2 Agricultural chemical applicator training should include specific instructions regarding spraying irregularly-shaped fields.

#3 Owners and operators of agricultural equipment must ensure that the machines are in good mechanical condition and that safe operating procedures are followed.

INTRODUCTION

In April 1999 a 26-year-old operator of an agricultural sprayer was killed when his machine crashed through a field fence and rolled over in a ravine. The Iowa FACE program became aware of the incident that week through a newspaper article and began an investigation. Information was gathered from the County Sheriff, county extension, OSHA, an insurance company, the company that owned the sprayer, the manufacturer, and the wrecking company that removed the machine. An on-site investigation was conducted by two Iowa FACE investigators and two representatives from the national FACE office in Morgantown, WV, who were making a routine visit to Iowa. We interviewed the sources listed above, observed the location where the rollover occurred, and took photographs. The farm owner had also taken personal photographs of the wreckage and shared them with us.

The employer was a grain elevator company, which also provided contract spraying services for area farmers. The spraying services were very seasonal, and this rollover fatality occurred in the middle of the busy spring spraying season. The company had been in business for over 80 years and had 35 employees. They had 13 agricultural sprayers, some of which were identical to the one involved in this rollover. All drivers had received company training on how to operate the sprayers, and each had become certified within the State of Iowa as agricultural chemical applicators. Each operator was required to receive additional annual training to maintain certification. This was conducted through Iowa State Extension, and included instruction in safe handling of pesticides, information on various weeds, pests, nozzles, etc., but did not include instruction related to specific sprayer models.

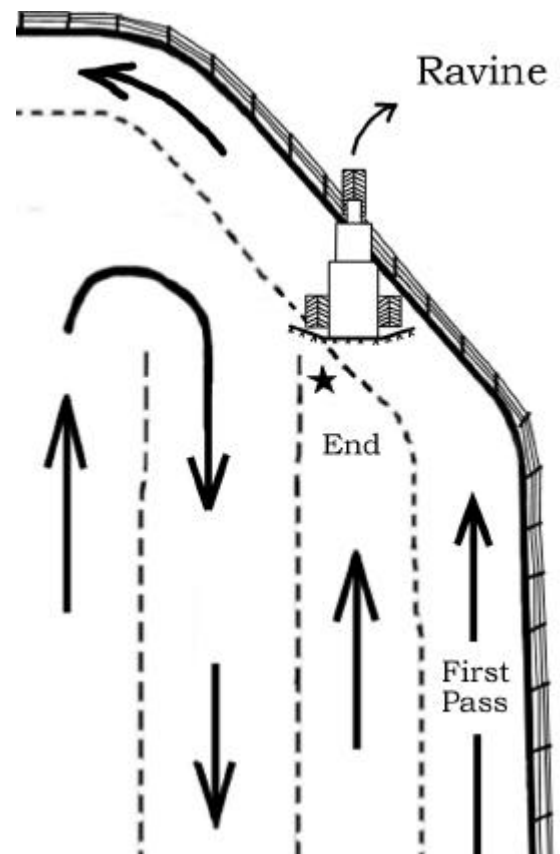
Each sprayer operator had responsibility for monitoring the upkeep and condition of their particular machine, and every operator was required to perform a thorough mechanical pre-season check of his sprayer. The victim had five years of experience as a sprayer operator and was reportedly a conscientious worker, attentive to issues of safety. This fatal injury occurred towards the end of a busy workday, and the sprayer had been used successfully for several hours prior to the overturn. This was the first fatality for this employer.

INVESTIGATION

The agricultural boom sprayer was manufactured in 1979. It was a three-wheeled flotation type machine with a tank capacity of 5,700 liters (1,500 gallons). The large air-filled tires of the machine were 1.68 meters (66 inches) in diameter with a width of 1.09 meters (43 inches). The machine was self-propelled by a diesel engine with 185 kilowatts (250 horsepower), and had a top road speed of about 57 km/h (35 mph). The typical field speed while spraying was 8 km/h (5 mph). The machine was not operable at the time of our investigation and we were unable to test the controls or functioning of machine components due to the extensive damage to the machine and its cab. The engine had evidently been running without oil pressure for some time after the machine overturned, and therefore was ruined. However, we did test the accelerator pedal and linkage and found them to be free of any restrictions. On our test, the brake pedal went to the floor without resistance.

The victim was working alone and had just finished spraying a small 5-7 acre irregularly-shaped bean field with soybean herbicide. This would have taken him approximately 30 minutes to complete. There was about 1,150 liters (300 gallons) of herbicide remaining in the tank. The field was on top of a hill, with steep slopes at its edges, and surrounded by a three-strand barbed wire fence. The normal spraying procedure for the victim was to circle the field once at the perimeter, then drive back and forth over the center of the field. Some applicators would circle a particular field twice before going back and forth, but according to the company owner, there was no right or wrong way to do this, and both methods were acceptable. The operator chose a method of spraying based on their personal preference and assessment of any particular field.

After spraying around the perimeter once and completing the back and forth spraying in east-west direction, the victim came to the southeast corner of the field, pointing towards the east. The last piece of ground to be sprayed was the pointed area marked with a star on the diagram. He had started to move the sprayer booms to transport position at this point. It is not clear whether he stopped or moved the booms while the machine was still in motion. The booms are at the back of the machine and pivot to the sides for transport. The width of the booms was 15.5 meters (51 feet) according to our measurement. It was apparent that the spray booms were partially folded in when the rollover occurred.



The end of the field was diagonal to the straight south edge of the field (see diagram). As illustrated in the diagram, to spray the entire area, the operator would have to drive forward into the perimeter strip that was sprayed, bringing the front of the machine very close to the fence. While coming to the end of the field and preparing to bring in the sprayer booms, it is possible that the operator could come too close to the edge of the field without noticing it in time.

Any failure in braking at this critical time could also have sent the sprayer through the fence and over the edge of the field. There were no skid marks in the field, nor on the upper part of the slope of the ravine. However, tire marks were evident at the bottom of the slope after the machine turned to the left and overturned. The sprayer had a hand-operated parking/emergency brake but this brake appeared not have been used for some time. The gear selector for the automatic transmission was set in neutral when the wrecker found the machine. The wrecker had little difficulty removing the machine the day after the rollover, and stated that all three wheels were rolling free. We requested a test to determine whether the brakes were in working condition, however, the machine shop where the sprayer was brought after the crash, was not able to perform that test. Therefore we cannot make conclusions about the role of the brakes in this injury.

The sprayer's left rear tire was flat when the machine was found, and tracks on the hillside indicate the machine hit a small 8-inch diameter tree with the left rear wheel. This swung the machine to the left causing it to crash on its right side and top. Had the sprayer not hit the tree, it may have crashed head-on into the opposite bank of the steep gully. The victim was partially thrown out of the front window and was crushed between the top of the cab and the dashboard area as the machine rolled over. The victim was last seen about 5:30 p.m. before he left to spray the field. When he did not appear at the next job, his father began a search for him and found the overturned sprayer after 8:00 p.m.

The cab on this machine was not designed to be a Roll Over Protective Structure (ROPS), as cabs are in newer field tractors. OSHA initially did a brief investigation of this fatality, but issued no citations since there were no regulations concerning rollover protection for agricultural sprayers. Although new machines do not provide rollover protection, they do include seatbelts for operators. The victim in this case was killed as the cab crushed down on him, after he had been thrown through the front window. Had the machine had ROPS protection, or had the victim been wearing a seatbelt, he may have survived this crash.

CAUSE OF DEATH

RECOMMENDATIONS / DISCUSSION

Recommendation #1 *Self-propelled agricultural boom sprayers should be equipped with Roll Over Protective Structures (ROPS) and seatbelts.*

Discussion: Agricultural tractors have been equipped with ROPS since mid 1980's. Agricultural sprayers are used in the same environment as farm tractors, and operators are exposed to the same risks from overturn as are tractor operators. While sprayers are normally used on farm fields, they also must traverse rough terrain, crude farm roads and ditches to get in

and out of farm fields. Furthermore, sprayers are driven on public roads from field to field, often on narrow roads and facing traffic. This sprayer was a tricycle type, and the 5700 liter (1500 gallon) tank was positioned 1.67 meters (5 1/2 feet) off the ground. These factors make it somewhat unstable on steeply sloping ground. A ROPS and seatbelt would likely have prevented this fatality, and similar equipment should have ROPS to protect the operator in case of an overturn.

Recommendation #2 *Agricultural chemical applicator training should include specific instructions regarding spraying irregularly-shaped fields.*

Discussion: The field in this case was irregularly-shaped and the operator came to the corner of the field where the field edge turned about 45 degrees to the left. The operator had circled the field once at the perimeter and then had completed driving back and forth the rest of the field. As presented in diagram 1, to cover the area near the end of the diagonally edged field, the operator must drive very close to the edge of the field. If the operator makes two passes around the field before back and forth spraying, there would be more room at the end of the field to make turns and the stop at the end. This method may be safer in most cases when the field is irregular. Pesticide applicator certification training, as well as a company specific training should address this method.

Recommendation #3 *Owners and operators of agricultural equipment must ensure that the machines are in good mechanical condition and that safe operating procedures are followed.*

Discussion: This sprayer was 20 years old, yet was evidently in relatively good condition prior to the overturn. From the rusted appearance of the parking brake, it appeared as this brake was rarely used. This machine had an automatic transmission and the park position may have been adequate in most situations to keep the machine stationary. However, the parking brake should be operational and used when needed. It is unclear whether the operator had stopped completely for folding the booms. The gearshift appeared to be in neutral and the parking brake was not engaged. The edge of the field slopes towards the ravine, likely enough to cause the machine to move if left in neutral without a brake. There were no visible skid marks at the end of the field or down the slope. This appears somewhat unusual since the operator may have had at least a few seconds to apply brakes. We were not able to obtain testing results to determine whether the brakes functioned properly. Regardless, a safe operating procedure would be to come to a complete stop before folding the booms and using the parking brake when stopping on sloping ground.

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Fatality Assessment and Control Evaluation

FACE

FACE is an occupational fatality investigation and surveillance program of the *National Institute for Occupational Safety and Health* (NIOSH). In the state of Iowa, *The University of Iowa*, in conjunction with the *Iowa Department of Public Health* carries out the FACE program. The NIOSH head office in Morgantown, West Virginia, carries out an intramural FACE program and funds state based programs in Alaska, California, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, Nebraska, New Jersey, Ohio, Oklahoma, Texas, Wisconsin, Washington, and Wyoming.

The purpose of FACE is to identify all occupational fatalities in the participating states, conduct in-depth investigations on specific types of fatalities, and make recommendations regarding prevention. NIOSH collects this information nationally and publishes reports and Alerts, which are disseminated widely to the involved industries. NIOSH FACE publications are available from the NIOSH Distribution Center (1-800-35NIOSH).

Iowa FACE publishes case reports, one page Warnings, and articles in trade journals. Most of this information is posted on our web site listed below. Copies of the reports and Warnings are available by contacting our offices in Iowa City, IA.

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