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FROM: Minnesota Fatality Assessment and Control Evaluation (MN FACE) Program
Minnesota Department of Health

SUBJECT: MN FACE Investigation 03MN008
Farm Worker Dies After Becoming Entangled In A Power-Take-Off Shaft

SUMMARY

A 50-year-old male farm worker (victim) died after he became entangled in a power-take-off (PTO) shaft. He was using a tractor and a trailer-type mixer wagon to mix feed for dairy cows. The tractor was equipped with a cab that had a hinged rear window that when open, provided an opening along the bottom edge of the window. The window was open at the time of the incident.

The mixer wagon was designed to be hooked to the drawbar of a tractor and operated via the tractor's PTO and hydraulic systems. The design enabled a worker to completely operate and unload the wagon while seated in the tractor seat.

The wagon's PTO shaft was fitted with a tubular safety shield. At the front of the wagon was a short master shield fastened to the wagon. Although the PTO shaft was entirely enclosed in a tubular safety shield and the short master shield covered the end of the shaft, a small gap existed between the two safety shields. The wagon was equipped with a hydraulically controlled discharge chute located at the wagon's left front corner to unload it.

The victim had mixed several loads of feed on the day of the incident. After filling the mixer wagon, the victim engaged the tractor's PTO to begin mixing the feed while he drove the tractor to a dairy barn equipped with several feed conveyors to unload the wagon.

After stopping the tractor and wagon near a conveyor, he got off the tractor and started the barn conveyor. After starting the conveyor, he probably reentered the tractor cab and started the wagon's discharge augers but then exited the cab again.

While the wagon emptied, he entered the area between the rear of the tractor and the front of the wagon. He may have stepped on the tractor drawbar and reached through the cab's open rear window to reach the hydraulic controls and either increase or decrease the flow of feed from the wagon. While doing so, he apparently fell backward and his clothing became entangled in the end of the PTO shaft near the front of the wagon.

Another worker became concerned when the tractor and wagon remained parked longer than normal. He walked to the scene and found the victim entangled in the PTO shaft which had

broken. He ran from the scene and notified other workers who placed a call to emergency personnel. The workers returned to the scene, freed the victim and laid him on the ground. Rescue personnel arrived shortly after being notified and pronounced him dead at the scene.

MN FACE investigators concluded that, in order to reduce the likelihood of similar occurrences, the following guidelines should be followed:

- machinery should only be operated or adjusted when the operator is seated in the operator's seat.,
- manufacturers should design safety shields that totally enclose moving components that may be hazardous, and;
- operators should not wear loose-fitting clothing near operating machines.

INTRODUCTION

On March 13, 2003, MN FACE investigators were notified of a farm work-related fatality that occurred on March 11, 2003. The county sheriff's department was contacted and a copy of their report of the incident was obtained. A site investigation was conducted by a MN FACE investigator on May 28, 2003. During MN FACE investigations, incident information is obtained from a variety of sources such as law enforcement agencies, county coroners and medical examiners, employers, coworkers and family members.

The employer associated with this incident was a dairy farmer who had been operating his dairy farm for the past 22 years. He had grown up on the farm where the incident occurred which was previously owned and operated by his father. His farming operation consisted of a herd of 410 dairy cows of which, at any given time during the year approximately 350 were being milked twice per day. He also farmed 480 acres of land on which he grew 360 acres of corn and 120 acres of hay. The corn and hay was used entirely for feed for the dairy herd.

The dairy farmer employed six full-time employees to perform tasks associated with operating the dairy farm. These tasks included year-round tasks such as twice daily milking of the cows, daily feed mixing and feeding and barn cleaning. During the growing season, employees performed tasks associated with planting and cultivating corn and with harvesting corn and hay. Nearly all of the corn and all of the hay was harvested with a forage chopper and stored in various silos.

The victim was a 50-year-old man who had grown up in the local area and had been employed at the dairy farm for approximately one and one-half years. Prior to being employed by the dairy farmer, he had worked for more than 20 years for a local sawmill company. While employed at the sawmill, he operated a variety of industrial machines such as powered fork lifts, trucks, and bucket loaders. The dairy farmer purchased dried sawdust from the sawmill and his trucks were often loaded by the victim when he was employed at the mill.

When the sawmill closed, the victim applied for a position at the dairy farm. Based on his familiarity with operating industrial machines at the sawmill, he was hired and began work on the Monday following his last Friday employed at the sawmill. At the time of the incident, he worked primarily as the daily feed mixer and dairy herd feeder and was responsible for mixing and distributing each day twelve loads of feed to the dairy cows and calves.

INVESTIGATION

On the day of the incident, the victim used a farm tractor and a trailer-type feed mixer wagon to mix batches of feed for the dairy cows. The tractor was a Case Model 1170 that was manufactured between 1975 and 1977 and was rated at 130 horsepower. It was equipped with an enclosed cab that had one door for access into and out of the cab via steps located in front of the left rear wheel. The cab had a large rear window that was hinged along the top edge and when open, provided a 12-14 inch opening between the bottom edge of the window and the window frame. At the time of the incident, the rear window was open. The tractor was purchased used by the dairy farm owner and was in good working condition at the time of the incident.

The trailer-type feed mixer wagon was a Knight Model 3300 Reel Auggie that was manufactured in 1996. It was purchased in 1997 by the dairy farm owner, was in good working condition and had a maximum capacity of 330 bushels. It was designed to be hooked to the drawbar of a farm tractor and operated via the tractor's power-take-off (PTO) and hydraulic systems. The design enabled a worker to completely operate and unload the wagon while seated in the tractor seat and using the tractor's PTO and hydraulic controls.

When used, the mixer wagon was hooked to the drawbar of the tractor and the wagon's PTO shaft was connected to the PTO drive shaft at the rear of the tractor. The wagon's PTO shaft was fitted with a two-piece telescopic tubular safety shield to protect workers from the rotating PTO shaft. Although the tubular shield rotated with the PTO shaft, if a worker contacted the tubular shield, it would immediately stop rotating while the enclosed PTO shaft continued to spin.

At the front of the wagon was a short three-sided master shield (open on the bottom side) that was rigidly attached to the wagon. It was about 10 inches in length and covered the very end of the PTO shaft at the front of the wagon. Although the PTO shaft was covered by the telescopic safety tube and the short master shield covered the end of the shaft, the need for the shaft to move left or right as the tractor turned while pulling the wagon resulted in a small gap between the two safety shields.

The tractor's PTO provided the power to operate two augers and a large diameter four-bar reel located inside the feed wagon. The augers extended from the front to the rear along the left side of the wagon box. The two augers were located one above the other and were designed such that the top auger moved the feed toward the rear of the wagon while the lower auger moved it toward the front. The lower auger also moved the feed into a discharge chute when the wagon was emptied.

The feed mixer's large reel turned slowly and gently lifted the feed in the wagon up and into the two side mixing augers. The combined actions of the augers and the reel resulted in a complete

blending of the feeds by gently lifting and tumbling all ingredients in the wagon. These actions resulted in the feed being thoroughly mixed before it was unloaded from the mixer wagon.

The mixer wagon was equipped with a self-unloading discharge chute located at the left front corner of the wagon. The discharge chute contained three small unloading augers that were hydraulically driven. The discharge chute was approximately 3-4 feet long and was positioned in a near vertical position when not in use. The chute could be hydraulically lowered to a nearly horizontal position to unload the wagon. A sliding hydraulically control door was raised when the discharge chute was in the lowered position to allow the feed wagon to be emptied.

The victim had mixed several loads of feed on the day of the incident. Each load was a mixture of chopped corn, chopped or baled hay and commercial dairy feed supplements. The ingredients for each batch were loaded into the mixer wagon with a skid-steer loader equipped with a general purpose bucket. After filling the mixer wagon, the victim engaged the tractor's PTO to begin mixing the feed while he drove the tractor to one of the dairy barns where the wagon was unloaded.

The dairy barns were equipped with conveyors that extended a short distance from the sides of the barns. The conveyors moved the feed inside the barns to where the cows were located. The mixer wagon was pulled into position near one of the conveyors and the discharge chute was lowered to allow the feed to be transferred directly from the wagon into one of the conveyors.

After stopping the tractor and wagon at one of the conveyor locations, the victim got off the tractor and started the barn conveyor. During the entire time from when he left the site where the wagon was filled to the spot where he stopped the tractor to unload the wagon, the PTO was engaged to continuously mix the feed. After starting the barn conveyor, he probably reentered the tractor cab and used the hydraulic controls to start the wagon's discharge augers and open the slide door to begin emptying the wagon. While the wagon was unloading, the victim was not in the tractor cab but was along the side of the mixer wagon, probably just monitoring the unloading process.

After beginning to unload the wagon, the victim entered the area between the rear of the tractor and the front of the wagon. He may have stepped on the tractor drawbar and reached through the open rear window of the tractor cab to reach the hydraulic controls to either increase or decrease the flow of feed from the wagon. While doing so, he apparently lost his footing, fell backward and his hooded sweatshirt became entangled in the end of the PTO shaft near the front of the wagon where the telescopic safety tube met the rigid master shield on the front of the wagon.

Another farm worker became concerned when the tractor and mixing wagon remained parked longer than normal at the unloading site. He walked to the scene and found the victim entangled in the PTO shaft which had broken and was not rotating. He ran and notified other farm workers who immediately placed a call to emergency medical personnel. The workers returned to the scene and freed the victim by cutting his entangled cloths and laid him on the ground. Rescue personnel arrived shortly after being notified and pronounced the victim dead at the scene.

CAUSE OF DEATH

The cause of death on the death certificate was multiple traumatic injuries due to farm accident.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Machinery should only be operated or adjusted when the operator is seated in the operator's seat.

Discussion: The operator's seat of farm tractors and machines provides a work station from which the operator can safely operate and maintain control of the tractor and any machine that is hooked to the tractor. Proper control can be safely maintained not only while a tractor or machine is being driven but also during operation of the tractor or machine while in a stationary position. While seated in the operator's seat, an operator can safely check and/or adjust all controls such as the engine throttle position, control levers for engaging and disengaging PTO shafts, and hydraulic control levers that operate many components of modern farm machines. In addition, while seated in the seat, an operator is in position to stop the tractor or machine as quickly as possible if an emergency situation should suddenly occur. In this incident, the victim may have attempted to adjust the tractors hydraulic control levers from a location other than the tractor seat. In doing so, he positioned himself in the hazardous zone that existed between the rear of the tractor and the front of the mixer wagon. If he had not entered this hazardous zone while the PTO was engaged, this fatality probably would have been prevented.

Recommendation #2: Manufacturers should design safety shields that totally enclose moving components that may be hazardous.

Discussion: The PTO shaft on the mixer wagon associated with this incident was fitted with a tubular safety shield and a short fixed three-sided shield that was fastened to the front of the wagon. This combination of shielding is commonly found on nearly all modern PTO driven equipment. Although this design provides significant protection from the PTO shaft when it is rotating, it is possible for small items such as drawstrings on hooded sweatshirts and jackets to become caught under certain conditions such as what apparently happened in this incident. Additional protection could be provided by extending the length of the fixed shield fastened to the PTO driven machine to make it more difficult for drawstrings or frayed clothing to become entangled at the ends of a PTO shaft. The fixed shield fastened to machines could also be fitted with a flexible material such as rubber to close any gaps between the PTO safety tube and the fixed shield. A flexible material would allow the PTO shaft to move from side to side during turns yet would prevent items such as drawstrings from becoming entangled at the ends of the PTO shaft.

Recommendation #3: Operators should not wear loose-fitting clothing near operating machines.

Discussion: The risk of entanglement in rotating shafts and machine components can be reduced if operators do not wear loose fitting clothing. Work clothing should be well-fitting and zippered or buttoned, not open. Frayed or loose fitting clothes, jackets and sweatshirts with drawstrings, and boots or shoes with long shoe laces should be avoided. This recommendation is

a general safe work practice that should always be followed by operators of machines whenever the risk of entanglement exists.

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