TO: Director, National Institute for Occupational Safety and Health

FROM: Iowa FACE Program   Case No: 00IA04801   Report Date: Sept. 2002

SUBJECT: Worker Crushed in Rubber Tire Assembly Machine

SUMMARY

During the fall of 2000, a 46-year-old worker at a tire assembly plant was caught and crushed in a tire assembly machine. The machine was making prototype agricultural tires, which differ significantly in assembly procedure from other tires manufactured at this facility. The large computer-controlled machine normally operates in automatic mode while workers build tires on a routine basis during their work shift. On the day of the incident, the machine malfunctioned while working on a prototype tire, and a maintenance crew was called in. The operator cut out the partial tire and removed it from the machine. When they finished the repair, the machine was reset to zero, in manual mode, to a 'start' position, in order to build another tire. However, the machine's computer control system jumped to an "operational mode" and caught the victim off guard from his backside, crushing him in the left pelvic region. Co-workers immediately assisted the man, and he remained alert and conscious during transport to the hospital and during his evaluation prior to surgery. Following surgery he was placed in intensive care where he deteriorated and died 33 days later from multiple system failures and sepsis.

Initial investigation of the tire assembly machine determined that computerized command and control information from the previous tire production run was still stored in the machine's computer system, even though it had been manually reset to zero. Consequently, the tire machines unanticipated operation resulted from this "residual" computerized command and control information. The tire company immediately shut down the machine and later addressed the software problem. Company officials also shut down a similar machine being used at a different tire plant in another state. Multiple safeguards were incorporated into the operation of the machines to eliminate the possibility of recurrence.

RECOMMENDATIONS based on our investigation are as follows:

- *1.) Employers should ensure that machines are safeguarded to protect all employees in the machine area. Computerized machining processes should allow the machine to operate in fail-to-safe mode during and following repairs or general maintenance. Lockout/tagout requirements specified in 29 CFR 1919.147 shall be followed (if employees are not protected by machine guarding).*
- *2.) Job Hazard Analysis should be performed and Safe Operating Procedures should be developed with subsequent training of employees to follow on machines and equipment (including modifications and/or new processes) to which employees are exposed.*

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INTRODUCTION

On September 2, 2000, a 46-year-old male, working on a three-man crew to assemble prototype tires, was crushed in the pelvic region by a tire assembly machine. The Iowa FACE Program was notified two months later by the Medical Examiner's office, and began an investigation. Gaining access to the large tire plant was not possible (denied entry), however, useful information was gathered from local union members and Iowa OSHA.

The employer is a large tire manufacturing company, producing numerous types of tires for agriculture machinery. The tire assembly plant employed 1,600, and had been in operation since 1945. There were four 12-hour shifts of workers, and the plant was normally open 24 hours a day, 354 days each year. The victim and a co-worker had worked together at this tire machine for the previous 2-3 months. Both of them had many years of experience working in other departments at this tire plant.

The union was actively involved in developing proactive safety and health programs at the facility. Training on this machine was done by letting new workers work side-by-side with others, then only after a time of observation, being allowed to work alone.

INVESTIGATION

The tire plant generally produces agricultural tires, and this tire machine was used to build prototype large flotation-type tires for agricultural sprayers. This Japanese machine, being one of two in the country, had been in use at this plant for the past 10 years. All its controls and manuals were written in Japanese and translated into English. Other tire machines in the facility were American made.

The large L-shaped machine normally required a three-person team, two for assembly and one for servicing. If a third person was not available, it could be operated with only two workers. The two assemblers work in separate locations, approximately 20 feet apart. This crew would produce about 15 large flotation tires per work shift.

The tire assembly machine built prototype radial-ply tires, which differed significantly in tire content, thickness, and building procedures from other bias-ply agricultural tires produced at the facility. Software controlling the machine was not specifically programmed for the type of prototype tire being built. Repairs to the machine were common and the computerized machining process allowed the operator to place the machine in manual mode.

While making the first tire on the day shift, the machine experienced a mechanical malfunction and was shut down. A maintenance crew was brought in and asked the victim to cut the partially built tire off the drum so the problem could be repaired. After the tire assembly machine was repaired, it was put in manual mode, backed up to zero, and put back into production. The machine began to operate starting at the previous tire operating cycle. The workers had taken their positions to begin the next tire, assuming that the machine was starting at the beginning of a tire production cycle, when the accident occurred. In mid-cycle the machine moved according to residual computerized command and control information that had remained in its active computer memory from the previous tire, and caught the victim in a movement that was never expected. The man was severely crushed in the left abdominal and pelvic region. Co-workers called for assistance and removed the man from the machine. The injured worker remained conscious and alert before transport to the hospital, and during his evaluation prior to exploratory surgery. He suffered a massive crush injury to his left abdominal and pelvic region, and continued to deteriorate, dying one month later.

The tire company had another similar Japanese tire assembly machine located at a facility in another state. Company officials notified the remote facility, and that machine was immediately shut down. Japanese company officials, who were at the remote plant, arrived at the tire plant within a few days and were able to duplicate the circumstances, which caused the malfunction. The operating software for the machine was subsequently updated with five safety features, and multiple mechanical safeguards were incorporated into the tire-building process to prevent recurrence. These software improvements included built-in redundancy to check for proper positioning of materials and personnel, before initiating machine movements. Hardware improvements included installation of light curtains, pressure-sensitive mats, and movable platforms, all designed to ensure that employees are prepared for the next machine movement. Certain procedures requiring optional manual mode were changed to automatic only.

CAUSE OF DEATH

The immediate cause of death, as taken from the Medical Examiner's report was sepsis 34 days following massive crush injuries. No autopsy was performed.

RECOMMENDATIONS / DISCUSSION

Recommendation #1----- *Employers should ensure that machines are safeguarded to protect all employees in the machine area. Computerized machining processes should allow the machine to operate in fail-to-safe mode during and following repairs or general maintenance. Lockout/tagout requirements specified in 29 CFR 1919.147 shall be followed (if employees are not protected by machine guarding).*

Discussion: The requirements of the Machine Guarding Standard *29 CFR 1910.212* require that machines be designed and constructed as to prevent employees from having any part of their body in a danger zone. Operators and other employees in the machine area shall be protected with one or more methods of guarding from such hazards as those created by; points-of-operation, ingoing nip points and rotating parts. Moreover, the machining process should be maintained such that if one component fails, it shuts down the process to a fail-to-safe mode. When properly installed, the system will shut down to a fail-to-safe mode when safe operating conditions are not met. The system should also contain hardware integration so it cannot be bypassed by other control circuitry or hardware. One example of an engineering control is a presence-sensing device (light curtain) that may be installed to ensure conditions are met before the machine begins operation. Additionally, in this situation the prototype tire differed significantly, and the computerized software was not re-programmed for the specific process for the prototype tire. Nor were prevention guards installed or devices installed to control the machine. When the above is not accomplished for normal production operations, then the Lockout/tagout Standard is applicable. All servicing and maintenance operations where potential hazards are related to the unexpected energization or unexpected movement, the machinery or equipment shall be rendered to a safe position. Therefore, Lockout/tagout programs, machine specific procedures, training (including retraining) and periodic inspections shall be utilized.

Recommendation #2-----*Job Hazard Analysis should be performed and Safe Operating Procedures should be developed with subsequent training of the employees to follow on the machines and equipment (including modifications and/or new processes) to which employees are exposed.*

Discussion: Safety training is a critical element in an integrated safety and health program and should include the communication of task-specific safety procedures and training on safe operating procedures specific to machining processes after hazards have been addressed by a hierarchy of controls. Employees should have the knowledge, training, and experience to perform the job that he/she is designated. In this case, there may not have been a clear understanding of safe work procedures following a machine malfunction, shutdown, or repair.

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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, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, Oklahoma, Oregon, Washington, West Virginia, and Wisconsin.

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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