ADMINISTRATIVE REPORT **DATE: April 3, 1997**
PUBLIC HEALTH SERVICE/CDC/NIOSH/DSR
FACE 97-02

TO: **Director, National Institute for Occupational Safety and Health**

FROM: **Division of Safety Research, NIOSH**

SUBJECT: **Laborer's Legs Amputated Inside Paper Baler at Resource Recovery Center**

SUMMARY

On September 24, 1996, a 17-year-old male laborer (the victim) suffered amputation of both legs after he fell inside an operating horizontal hydraulic baler at a resource recovery center. The victim and three co-workers had been loading cardboard into the baler via an inclined conveyor belt when the cardboard jammed in the baler's feed chute. The victim shut down the conveyor and climbed the belt to the feed chute opening. He cleared the jam by holding onto the top cover of the baler feed chute and pushing with his feet. When the jam cleared, he fell through the feed chute into the baling chamber. Before he could climb out, the ram automatically activated, cycled into the baling chamber, and amputated his legs. The co-workers heard his cries and shut down the machine by activating an emergency stop switch, then notified 911. The victim's family came to the site and removed him from the machine.

NIOSH investigators determined that to prevent similar occurrences, employers should:

- *ensure that procedures for control of hazardous energy (lockout/tagout) are implemented by workers when it is necessary to perform maintenance, including clearing jammed material from process machinery*
- *comply with child labor laws which prohibit youth less than 18 years of age from operating or assisting to operate paper balers.*
- *ensure that process machines such as paper balers which are prone to jamming are configured to include means of access that protects workers from injury while clearing material jams*
- *develop and implement programs to evaluate the effectiveness of employee training.*

INTRODUCTION:

On September 24, 1996, a 17-year-old male laborer (the victim) suffered amputation of both legs after he fell into an operating horizontal hydraulic baler at a county resource recovery facility. On September 26, 1996, officials of the U.S. Department of Labor, Employment Standards Administration, Wage and Hour Division notified the Division of Safety Research (DSR) of the incident, and requested technical assistance. On November 13, 1996, a DSR safety engineer interviewed the plant manager at the incident site. The incident site was examined and photographs and measurements were taken. The victim was interviewed and the incident was reviewed with the Wage and Hour compliance officer assigned to the case.

The employer was a county resource recovery facility, in operation for about 2½ years prior to the incident. Twenty-five workers were employed at the facility, 20 on a 7:30 a.m. to 4:00 p.m. day shift, and five workers were on the second shift, from 4:00 p.m. to 12:00 a.m. The facility accepts and processes municipal and non-hazardous industrial waste during the day shift and bales recyclable plastic, paper, and cardboard during the second shift.

The victim had been working at the facility for about 3 months prior to the incident. During the summer school vacation he worked on the day shift sorting recyclables from the waste. After summer vacation he had transferred to the second shift so that he could attend classes at the county vocational technical school. The employer's safety program included a first day hazard orientation for new employees and daily safety meetings. Employees were instructed to follow lockout/tagout procedures when working on any of the machines in the facility, including the baler and conveyors. Additionally, the employer's safety policy prohibited any employee with the job classification of laborer from operating or servicing machinery. The employer provided personal protective equipment (PPE) including hard hats, safety glasses, masks, and gloves.

INVESTIGATION

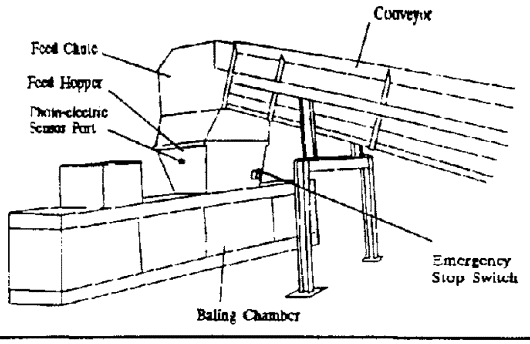
The 200 ton/day-capacity facility had been specifically designed to recover and process recyclable material from municipal waste. Bagged refuse was collected from curbside pickups and deposited on the inside tipping floor. From there the material went through a sorting process which extracted all recyclables including various types of plastic, glass, and metal. Once these were recovered from the waste, the remaining paper and food scraps were pelletized into boiler fuel. This activity was

performed continuously during the day shift. Work activity during the second shift was limited to baling plastic, paper, and cardboard recyclables. The facility also processed paper scrap from area paper mills.

Although power to the baler was controlled by the computer which controlled all the process machinery, it was equipped with its own control panel and operated as a "stand-alone" machine.

When baling cardboard, the workers ripped the material by hand into small pieces which were fed into the horizontal closed chamber baler (see figure 1) by an inclined conveyor measuring 4 by 25 feet. The material was loaded into a hopper at the tail end of the conveyor. From there, the material went up the conveyor and was discharged into a feed chute connected to the feed hopper of the baler. A photo-electric sensor located on the side of the baler feed hopper sensed the presence of a load and automatically activated the ram. The machine operated in this fashion until a bale was completed, at which time the machine ceased automatic operation and sounded an alarm to alert the operator that the bale was completed and ready for tying and unloading. The operator then switched machine control to hand (manual) operation, tied the bale, and opened the baling chamber door. The ram was advanced manually, to eject the completed bale, which was removed by fork lift and transported to a storage area. The ram was retracted, the baling chamber door was closed, and the machine was switched back to automatic operation.

Figure 1: Horizontal Baler and Conveyor



On the day of the incident, the victim, along with five co-workers and a machine operator/foreman, was processing rolled cardboard. Three of the co-workers were located 25 to 30 feet

away from the feed hopper, manually tearing small pieces of cardboard from the rolls, which the victim then loaded into the conveyor hopper. The baler was operating in automatic mode at this time. Shortly before 7:40 p.m., cardboard jammed in the feed chute. The victim attempted to clear the jam by inserting a stick through the photo-electric sensor port located on the side of the feed chute. This was unsuccessful, and the victim shut down the conveyor, climbed up on it, and made his way up to the feed chute opening. There, he used his feet to push the jam free while holding onto the cover above the baler feed chute (figure 2). When the jam cleared, the victim slid down into the baling chamber. He was climbing out when the ram automatically advanced and caught his foot, pulling him back in and amputating both his legs near the knees. The co-workers heard his calls for help, ran to the baler, and activated the emergency stop switch located on the baler feed chute under the conveyor head roller. The foreman called 911 while a co-worker went to the victim's home and notified his family. The family came to the incident site and removed the victim from the machine. He was transported to a nearby emergency room and then transferred to a large metropolitan hospital for further treatment.

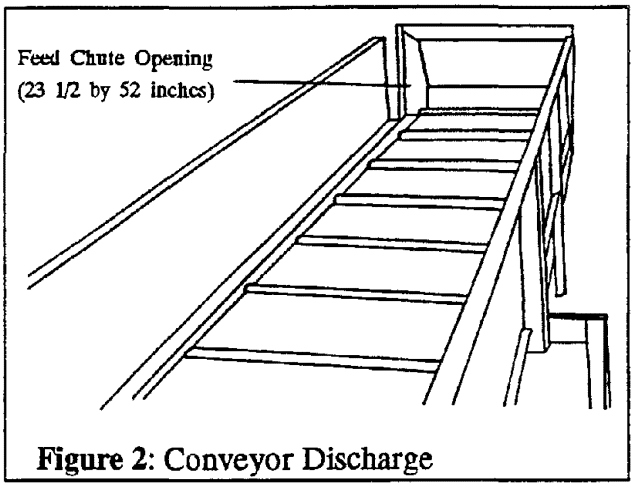


Figure 2: Conveyor Discharge

RECOMMENDATIONS

Recommendation No. 1: Employers should ensure that procedures for control of hazardous energy (lockout/tagout) are implemented by workers when it is necessary to perform maintenance, including clearing jammed material from process machinery.

Discussion: The victim had de-energized the conveyor prior to climbing onto it. However, the baler remained energized with the controls set to automatic, requiring only a signal from the photo-electric sensor to start the ram's compression cycle. When the victim freed the jammed material and fell into the feed hopper the photo-electric sensor was triggered and the ram started its cycle. The machine was equipped with a lockable power disconnect device located next to the drive motor and hydraulic system. At the time of the site visit, this device was operating correctly. Appropriate hazardous energy control procedures include strict prohibitions against workers clearing

jams while machines are energized, and require disconnect devices to be physically locked out to ensure that balers cannot be inadvertently activated.

Recommendation No. 2: Employers should comply with child labor laws which prohibit youth less than 18 years of age from operating or assisting to operate paper balers.

Discussion: The Fair Labor Standards Act provides a minimum age of 18 years for nonagricultural occupations which the Secretary of Labor "shall find and by order declare" to be particularly hazardous for 16 and 17-year-old persons. The Secretary has issued 17 Hazardous Occupations Orders. Hazardous Occupation Order No. 12 (HO 12) prohibits 16-and 17-year-olds from operating or assisting to operate paper balers or compactors. A limited exemption from this prohibition is allowed by the Compactors and Balers Safety Standard Modernization Act of 1996, Public Law 104-174 which provides that 16 and 17-year old workers are allowed to ***load only*** (place materials in), but not operate or unload materials from, scrap paper balers and cardboard box compactors provided that the machines meet certain operation and construction standards. The machine in the incident did not meet all of the standards. The Act requires that:

- *the machine complies with the American National Standards Institute's safety requirements for paper balers or stationary compactors.* -- The machine in the incident did not meet these requirements. For example, the start switch was not recessed or protected from inadvertent operation.

- *the machines are incapable of operation while being loaded.* -- The victim was classified as a laborer, restricted to loading only. However, the machine in this incident was routinely operated while being loaded (e.g. automatic operation).

- *the machines have a key-locked on-off switch or other system which is controlled by employees 18 years of age or older.* -- The machine in the incident was equipped with a lockable power disconnect device and the operational control of the machine was the responsibility of the operator/foreman. However, the foreman had left the immediate work area while the machine continued to operate automatically and loading was in progress.

Additionally, employers must post a notice that the machine meets the standards; 16- and 17-year-old workers are allowed to

load only; and employees under the age of 18 may not operate or unload the scrap paper baler or compactor.

Compliance with the Act can protect adolescent workers from baler and compactor hazards by eliminating exposure to moving machine parts during loading and ensuring that older more experienced workers are available to detect and correct hazardous work practices. A more detailed discussion of the requirements can be found in the appendix.

Recommendation No. 3: Employers should ensure that process machinery prone to jamming is configured to include means of access that protects workers from injury while clearing material jams.

Discussion: The machine in this incident was loaded by a conveyor which discharged through a chute into the baler feed hopper. The conveyor discharged into the chute through a 23½ by 52-inch opening in the side of the chute, near the top. The top of the chute was covered. A small opening was located on the side of the feed hopper above the baling chamber to allow a photo cell to focus a light beam against a mirrored target mounted inside the hopper on the opposite wall. To clear jams, employees had been inserting a broom stick through this opening. If attempts to clear jams through this opening were unsuccessful, the feed chute was accessed through the inlet at the end of the conveyor. Providing a door on the side of the feed chute large enough to facilitate clearing jams would eliminate the need, perceived or otherwise, to climb up on the conveyor and clear from there. When access doors are provided, they should conform to ANSI Z245.5-1990, Baling Equipment - Safety Requirements which includes comprehensive standards addressing the construction, operation, and maintenance of paper balers. In particular, the standard requires access doors to be interlocked with the baler's control circuitry to interrupt or prevent operation if the door is opened, guarding against worker exposure to ram movement.

Recommendation #4: Employers should develop and implement programs to evaluate the effectiveness of employee training.

Discussion: The victim had been hired during the summer and had worked during the day shift as a picker, picking and sorting recyclables as they moved on a conveyor belt. When the school year started in the fall, he had requested the employer to allow him to remain on the payroll and work the evening shift so he could attend school during the day. He had been working this shift for 3 weeks before the occurrence of the incident. Records maintained by the employer indicate that during the plant tour and orientation on the first day at work the victim had been instructed never to climb in or cross a moving conveyor

and that equipment should be de-energized prior to performing servicing or maintenance. These records consisted of lists of safety topics which the employees sign to indicate that the instruction had taken place. When interviewed 6½ weeks after the incident, and 4½ months after orientation training, the victim did not recall this training having taken place. A training evaluation program which includes frequent testing and supervisory observation reinforces initial safety training for the employee, and can alert management to evolving unsafe work habits.

REFERENCE

American National Standards for Refuse Collection, Processing, and Disposal - Baling Equipment - Safety Requirements. ANSI Z245.5 - 1990; American National Standards Institute, Inc., New York, New York.

American National Standards for Refuse Collection, Processing and Disposal - Stationary Compactors - Safety Requirements, ANSI Z245.2 - 1992; American National Standards Institute, New York, New York.

Child Labor Requirements in Nonagricultural Occupations Under the Fair Labor Standards Act, U.S. Department of Labor, Employment Standards Administration, Wage and Hour Division, WH-1330, August 30, 1990.

Compactors and Balers Safety Standards Modernization Act, Public Law 104-174, August 6, 1996.

Paul H. Moore
Safety Engineer
Trauma Investigations Section
Surveillance and Field
Investigations Branch
Division of Safety Research

Dawn Castillo
Project Officer
Injury Surveillance Section
Surveillance and Field
Investigations Branch
Division of Safety Research

Ted A. Pettit, M.S., R.E.H.S.
Chief
Trauma Investigations Section
Surveillance and Field
Investigations Branch
Division of Safety Research

Timothy J. Pizzatella
Deputy Director
Division of Safety Research

Surveillance of Occupational Injuries Among Children and Adolescents

Approximately 70 youths die from injuries incurred at work each year, hundreds are hospitalized, and tens of thousands require treatment in hospital emergency rooms. Youth less than 18 years of age are a unique segment of the work force with limited work experience and potentially unique risk factors for injury associated with physical and psychosocial development. Investigations of youth work-related injuries may provide information not available from existing surveillance systems about the circumstances and potential contributing factors to injury among this Special Population at Risk. Investigations based on the Fatality Assessment and Control Evaluation Program are being conducted on a pilot-basis to determine the potential of investigations to provide information to guide the development of research and prevention efforts for this Special Population at Risk.

Additional information regarding this report is available from:

Division of Safety Research
National Institute for Occupational
Safety and Health (NIOSH)
1095 Willowdale Road
Morgantown, West Virginia 26505-2888
Phone: (304) 285-5916

APPENDIX

The Fair Labor Standards Act (FLSA) of 1938, intended to protect the educational opportunities, health, and well being of working children, provides a minimum age of 18 years for any nonagricultural occupations which the Secretary of Labor "shall find and by order declare" to be particularly hazardous for 16 and 17-year old persons, or detrimental to their health and well-being. The secretary has published Hazardous Occupation Orders declaring 17 occupations as particularly hazardous. Hazardous Order No.12 (HO 12) prohibits minors from operating or assisting to operate (placing materials in) certain power-driven paper products machines including scrap paper balers and paper box compactors. In 1996, the FLSA was amended by passage of the Compactors and Balers Safety Standards Modernization Act, which provides a limited exemption from HO 12 allowing 16 and 17-year-old workers to load materials into (but not unload or operate) these machines provided that certain standards of construction, operation, and injury reporting are complied with.

For paper balers or cardboard box compactors to be considered safe for adolescent workers to load as stipulated by the amended FLSA, all of the following requirements must be met:

- **Operation during loading** - The baler or compactor cannot be capable of operation while being loaded. Balers or compactors that are capable of continuous operation, such as the machine in this incident, do not comply with this provision.

- **Lockable on-off switch** - Balers or compactors must include a lockable on-off switch or other means of securing the switch against use.

- **Operational Control** - Control of the on-off switch or other means of security is in the custody of an employee 18 years of age or older.

- **On-off switch** - must be maintained in the off position when the baler or compactor is not in operation (such as during loading).

- **ANSI standards** - The baler or compactor must comply with ANSI 245.5 - 1990 or ANSI 245.2 - 1992 -- the American National Standards Institute's Standard ANSI Z245.5 - 1990 Baling Equipment -- Safety Standard or ANSI 245.2 - 1992 Stationary Compactors -- Safety Requirements.

- Employers must **provide and post notice** on the machine that; the scrap paper baler or compactor meets the applicable construction and operating standards; **16- and 17- year-old**

employees may **only load** the scrap paper baler or compactor; and any employee **under** the age of **18 may not operate or unload material** from the scrap paper baler or compactor.

Construction standards addressing the hazards of crushing or amputation from contact with or being caught by moving machine parts or rams of balers include:

- **Operating controls** must be conspicuously labeled according to function.
- **Operating controls** must be designed and located to prevent unintentional activation.
- **Start buttons** must be designed to prevent unintentional activation.
- A readily accessible **emergency stop,** capable of stopping and controlling ram movement at any point must be provided. If the machine has more than one ram (multiple stages) the emergency stop must be capable of stopping all rams. Reverse mechanisms for each ram must be located next to the emergency stop.
- **Stop** buttons and **emergency stop** buttons must be red, distinguishable from all other controls by size and color, and not be recessed.
- **Protective shields** must be installed to protect workers from contact with moving machine parts
- **Access covers** must be interlocked or secured with lockable devices removable by hand tools only.
- **Vertical downstroke baler** rams shall not move unless the bale chamber door is fully closed and latched except when the machine is operated by a sustained manual pressure control (e.g. a push button or lever which must be held in the on position by the operator).
- **Vertical downstroke balers** must be equipped with **loading chamber doors** which completely cover the loading chamber before the compression (down) stroke of the ram can be started. Doors must remain closed until the compression (down) stroke is completed. If the door is opened more than ½ inch during the compression stroke, the ram shall stop or return to its rest (fully up) position.
- **Vertical downstroke balers** must be designed to eliminate pinch points and operator access to the top of the ram during its upward stroke.
- **Vertical upstroke balers** must be provided with interlock systems to keep all doors closed during the ram compression

(up) stroke.

- A ram protective shield shall be provided between the ram and the floor line of the baler pit in a **vertical upstroke baler.**

- Feed hopper access doors on **horizontal balers** shall be equipped with a control circuit interrupt to prevent operation with the door open.

- On **horizontal balers** not equipped with a feed hopper, the loading chamber door shall completely cover the loading chamber before the ram can be started into its compression stroke. The door must remain in place until completion of the compression stroke. If the door is opened during the compression stroke the ram must stop or retract.

- The top of the ram on all **horizontal balers** shall be covered for the full length of the loading-chamber opening.

- **Multiple stage balers** incorporate more than one horizontally or vertically mounted ram and must meet the standards of the appropriate type.

- Charging hopper access doors on **automatic cycling compactors** must have interlock systems that prevent cycling while the door is opened.