

REVIEW OF SAFEGUARDING TECHNOLOGY USED ON PAPER BALERS

Executive Summary: NIOSH recommends that the hazardous order prohibiting operation of paper balers by youths under age 18 (HO-12) be maintained. This conclusion is based upon documented deaths and injuries among youths and adults operating paper balers, and upon an engineering assessment of the protective technology in use on the balers we examined. Of the five machines evaluated, we found only one to be safe. Paper balers could be made safer for youth by improving safeguarding design, removing machines with inadequate safety design, ensuring appropriate inspection and maintenance of machines and safeguards, and training and supervising operators.

INTRODUCTION

In a letter dated August 24, 1994, the Wage and Hour Division of the U.S. Department of Labor requested that the National Institute for Occupational Safety and Health "conduct a study regarding the loading, operating, and unloading of paper balers to determine whether minors under 18 years of age can safely perform these tasks." Existing child labor laws prohibit youths under 18 years of age from operating paper baling machinery (Hazardous Occupations Order No. 12). After discussion with the Wage and Hour Division, the scope of this investigation was limited to evaluating the safety technology on a small sample of paper balers in use. This report summarizes the results of the NIOSH investigation, which systematically considered the paper baler loading task and the safeguarding equipment that protects the worker during that task.

BACKGROUND

Paper balers bundle or bale the refuse cardboard boxes used to transport food and consumer items. A typical vertical downstroke baler consists of a hydraulic cylinder mounted to the top of a rectangular, welded steel frame. A ram or platen that closely fits the cross-sectional area of the baler frame is attached to the cylinder rod. A bale chamber is fitted with a door that opens for baler unloading. A typical bale is 3'x5'x3' of compressed cardboard. According to the Waste Equipment Technology Association, hydraulic paper balers are the most prevalent type of paper baler in use today.

EPIDEMIOLOGY

Although the operation of paper balers is prohibited for youth under 18 years of age, case reports do demonstrate that serious injuries and deaths have occurred when youth have worked in violation of the paper baler hazardous order (HO-12). Deaths among adults also demonstrate considerable risk which apply to youth. Additionally, deaths must be considered the tip of the iceberg; serious injuries resulting in hospitalization or significant disability are more likely than death, although a good data source does not exist for identifying many of these serious nonfatal injuries.

Case Reports from Department of Labor/Wage and Hour Division

Wage and Hour has provided case reports for the period June 1988 through April 1992 of eight violations involving injuries specific to HO-12. One of these cases was a fatality of an 11-year-old boy who was loading boxes into a paper baler when his arm got caught in the baler and his body was crushed against the machine. Other cases included two 15-year-olds, three 16-year-olds, and two 17-year-olds. Of these seven, four cases resulted in disability: one of the 15-year-olds suffered a broken arm and wrist with a 20-40% disability in one arm; one of the 16-year-olds suffered a permanent loss of 45% use of one hand; another 16-year-old female tore the muscle and tendons of her right forearm; and one of the 17-year-olds suffered a back injury while attempting to remove a bale of compressed cardboard from a paper baler.

Fatalities from the National Traumatic Occupational Fatalities (NTOF)

NTOF is a death certificate-based census of occupational injury deaths to workers aged 16 years and older which is maintained by NIOSH. The NTOF surveillance system includes data from all 50 States, New York City, and the District of Columbia. There were eight fatalities during the 12-year period, 1980 through 1991, which clearly involved a paper baling machine or compactor. The ages of the workers killed in these events ranged from 16 to 54 years, all but one younger than 35. All of the victims were males. The injury descriptions for these events referenced being caught in paper balers, being crushed in compactors, or having specific body parts (e.g., head, neck) struck by components of paper baling machines. There were a number of other machine-related cases in the NTOF data for which there was not sufficient detail to determine if the machine involved in the fatality was, indeed, a paper baling machine.

Fatalities from the Fatality Assessment and Control Evaluation (FACE) program

The FACE program is a collaborative effort between NIOSH and state departments of health and labor to identify all occupational injury fatalities and investigate specific types of cases, including machinery-related incidents. The FACE program is currently active in 20 states. From 1993 to 1995, there were 6 fatalities involving paper baling machines reported by states in the FACE program. The ages of the victims ranged from 26 to 62 years and all of the victims were men. In two of these cases, the victims fell into the compacting area of the machine while attempting to clear jams that occurred during the loading of material into the machine. In another two cases, workers were actually inside the machine when it began to operate. One victim was operating a baling press and became entrapped in the machine and was crushed.

SAFETY STANDARDS

There are currently no OSHA standards specific to paper balers. The most comprehensive voluntary U.S. safety standard for paper balers, ANSI Z245.5 (1990), includes standards for

(1) machine safeguarding, (2) equipment and protective device maintenance and (3) worker training. The machine safeguarding portion of the standard describes the various baler configurations, with necessary safeguarding described in performance language within the construction portion of the standard.

The guidelines for protective devices and controls on vertical downstroke balers are:

5.2.2.1 Loading Chamber Closure Operation

The loading chamber closure shall completely cover the loading chamber before the ram can be activated into its compression stroke and must remain in place until the completion of the compression stroke.

5.2.2.2 Movement of Loading Chamber Closure Not Provided with Automatic Opening

The ram shall stop or return to its rest position if the closure of the loading chamber is opened more than one-half inch at any time during the compression stroke. Unless otherwise designed to eliminate the pinchpoint, or equipped with a sustained manual pressure control, balers shall be equipped with a mechanical or electrical interlock to prevent the closure from being opened faster than the baler ram, so as to prevent operator access to the top of the ram during its upward motion.

The intended effect of these standards is to prevent personnel from reaching into areas of high force during the closing motion of the equipment.

The guidelines for equipment and protective device maintenance are:

6.5 Inspection and Maintenance

The employer shall establish and follow a program of periodic and regular inspections of all balers to ensure that all parts, auxiliary equipment, and safeguards are in a safe operating condition. The employer shall maintain records of these inspections and the maintenance work performed.

The guidelines for worker training are:

7.1 Employer Responsibility

7.1 (3) The employer shall be responsible for setting up and following a program of training and instructing employees in safe methods of work before assigning them to operate or maintain a baler. The employer shall maintain records of this training to include the date(s) of the training and the content of training received. The employer shall ensure, by adequate supervision, that correct operating and maintenance procedures are understood and followed. The employer should refer to the manufacturer's and installer's instructions for this purpose.

METHODS

Based on the request from the Wage and Hour Division, NIOSH focused on machine safeguarding issues (protective devices and controls) only. It was agreed that the primary focus of the study should be grocery store applications of paper balers. Site visits were arranged by Wage and Hour staff to the Pittsburgh, Pennsylvania area. The site visits were conducted by both NIOSH and Wage and Hour personnel. From January 31 to February 2, 1995, five paper baling operations were observed at five different grocery stores in southwestern Pennsylvania (Table 1). The condition of the machines observed ranged from well-maintained, newer balers to older, well-worn balers. These sites were chosen by Wage and Hour to reflect a mix of the types of hydraulic paper balers, equipment age, and safeguarding approaches. However, the distribution of the paper balers in this sample cannot be considered representative of the mix or types of paper balers in grocery stores nationwide. A systematic sampling survey of the actual prevalence of paper balers in use in the U.S. was beyond the scope of this review.

Machine Observations

During the site visits, a typical vertical baler platen closing motion speed was measured at 1.5 in/sec (slow). The height of a typical loading chamber door was 59 inches, making it an easy reach to the area where the platen moves in a shearing action past the loading chamber door. Various levels of safeguarding were observed during the site visits. The three primary types of interlock gates for protection of workers from crushing hazards during the operation of paper balers include: powered, manual, and platen-carried. A summary of these safeguards is contained on Table 2.

Table 1 - Safety Information on the Paper Baling Equipment Observed at Five Grocery Stores During the NIOSH Site Visits

Baler	Type	Gate Type	ANSI Safe Device	Safety Concerns	Age of Machine ¹
1	Vertical down-stroke	Manual	No	Gap too large (>1/2")	New
2	Vertical down-stroke	Manual	No	Gate open during upstroke	Old
3	Vertical down-stroke	Powered	No	Gap too large (>1/2")	Old
4	Vertical down-stroke	Manual	Yes	N/A	New
5	Vertical down-stroke	Platen carried	No	Gap too large (>1/2"); Interlock located on platen/ easy to bypass	Old

¹Machine considered "new" if age was less than 10 years.

Table 2. Safeguarding on Five Observed Paper Balers

<u>Safeguarding Type</u>	<u>Safeguarding Description</u>
Interlocked Gate:	
-Powered 1 of 5 machines	Gate automatically closes before platen will descend and gate closure is verified by electromechanical interlock.
-Manual 3 of 5 machines	Gate must be closed by hand before platen will descend and gate closure is verified by electromechanical interlock.
-Platen-Carried 1 of 5 machines	Gate is carried down by descending platen. Leading edge of gate is ahead of platen, and is verified by electromechanical interlock.

NOTE: In some stores, supervisors lock the safety gate closed when the paper baler is not in use to prevent minors from operating the machine.

Compliance with the ANSI standard was only one of the factors NIOSH looked at in determining whether the paper balers were safe. In addition to the ANSI guidelines, NIOSH believes that two additional criteria need to be considered. These include the accessibility of mechanical or electrical interlocks and the ease of bypassing such interlocks. An interlock that is in a readily accessible location and can be easily defeated (bypassed) can limit the effectiveness of safeguarding devices on paper balers.

Comparisons Between the ANSI Standard and the Observed Balers

The portion of the ANSI Standard that specifically applies to baler safeguarding technology is paragraph 5.2.2.2 (see page 3). Of the five vertical-downstroke balers that were observed, four had safeguarding that would not satisfy the current ANSI standard (paragraph 5.2.2.2) because their interlocked safety gates could open more than ½" inch during a downstroke, or the baler upstroke motion would not stop if the gate were opened during the upstroke. One baler's safeguarding did meet the ANSI criteria.

Task Description

Tasks involved in baler operation include: loading or throwing cardboard boxes into the loading chamber, closing safety gates and operating the controls for manual or automatically compressing the cardboard, ensuring that the baler controls are in a safe condition and then manually freeing cardboard around platen edges, watching for and refeeding cardboard that protrudes from loading area during bale forming, notifying supervisor about baler mis-operation, opening the loading chamber, inserting and tying baling wires, setting the ejection

chains, operating controls to raise the platen, and using a hand truck or dolly to move the bale to a holding area.

ENGINEERING ANALYSIS

A composite "what-if" review was conducted to identify scenarios that could result in an injury on a paper baler. This review involved: defining "what-if" events or actions that are potentially hazardous; describing the consequences; identifying how to protect against these consequences; and explaining the work-task in which such events or actions occur. The appropriate worker protection for most of the "what-if" scenarios was a properly functioning interlock on the safety gate.

The areas of paper baler safety that are of particular concern for 16- and 17-year-olds relate to lack of experience or training on machine operation and safeguarding failures. Interlock locations where cardboard can interfere with effective switch operation are also a safety concern. Sixteen- and seventeen-year-olds might not recognize the danger of such conditions. The "what if" scenarios that particularly relate to protection for 16- and 17-year-olds are:

Frequent Need to Access Baler During Normal Cycle - The observed current technology for compressing cardboard boxes permits cardboard in the loading chamber to slide out of safety gate openings and to slide over the platen and clutter the top of the platen, necessitating clearing that area with the safety gate raised.

Safety Gate Interlocks Located Where They Are Easily Accessible to the Operator - Some interlocks can be defeated by manually depressing or taping the interlock switch closed, allowing the machine to cycle when the safety gate is not in the closed (safe) position. Failure by 16- and 17-year-olds to understand the dangerous consequence of defeating (bypassing) a safety interlock can be controlled by strong safety supervision and training programs. The one platen-carried safety gate observed during these site visits depended on an interlock switch attached to the top of the platen. With the platen in a lowered position, the interlock switch could be easily reached and bypassed, allowing the machine to operate without proper worker protection. On the other two types of interlocked gates observed, this was not an apparent problem.

Interlock Device Is Easy to Bypass - Coupled with being easily accessible, an interlock can be a safety concern if it can easily be bypassed or tied to always indicate a "safe" condition. When this condition exists, the hydraulic power controller can permit platen motion even though a safety gate is raised. Electromechanical switches are commonly used, but proximity detection and direct links to hydraulic valve position are also possible.

In one of the balers observed, safety interlocks on the platen-carried safety gate appeared to be of a type that could be easily adjusted to a condition that permitted access to the loading chamber with the gate raised and the platen moving under hydraulic power. Table 1 provides a summary of the safety information collected during the NIOSH site

visits.

DISCUSSION

While safeguarding technology does exist for protecting workers (including adolescents) using paper balers, the prevalence of safe and unsafe machines is currently not known. Additionally, in protecting workers from injury during the operation of paper balers, NIOSH believes there are three criteria which must be satisfied:

- (1) the point-of-operation guarding, such as a powered interlock gate, must prevent workers from placing any part(s) of their body into the hazardous areas of the paper baler during operation;
- (2) periodic inspection and maintenance of the equipment and safeguarding devices must be conducted to ensure proper operation and safe performance; and
- (3) workers must be trained in safe operation of the equipment, understand the hazards relating to bypassing safety devices, and recognize the limitations and effective operating ranges of safety devices.

A safety gate was the primary method for protecting personnel when the baler platen was moving down or up. The three types of safety gates observed each rely on an interlock or a combination of interlocks. The purpose of these interlocks is to stop platen motion if someone raises the gate during normal operating motion, or to prevent the platen from moving if the gate was up and a manual (constant pressure) or automatic (momentary contact) control button was pushed.

RECOMMENDATIONS

Based on our review of surveillance data and this study of paper baler safeguarding technology, NIOSH believes that minors under the age of 18 cannot safely operate paper balers for the following reasons:

First, there are paper balers in the field (both newer and older models) that we did not consider safe because of either the type and location of the interlock or because of a gap allowing manual entry into the baling compartment. NIOSH believes that additional criteria related to interlock location (which go beyond the ANSI Z245.5 standard) need to be considered for assessing adequate safeguarding related to paper baler operation. In addition, it is unclear how compliance with the existing voluntary ANSI standard for guarding could be assessed and enforced by the Wage and Hour Division.

Second, there are other important factors needed to ensure worker safety -- namely, periodic equipment inspection and maintenance to ensure that the safeguarding continues to function as intended and adequate worker training and supervision. Of particular concern are older machines. It is not known how many old paper balers are currently in use and how they could be retrofitted with appropriate safety equipment.

Based on this NIOSH review, which demonstrated the potential for serious injury and death, NIOSH recommends that those parts of the current Hazardous Occupations Order (HO-12) from the Fair Labor Standards Act that relate to minors working at paper balers be maintained.

REFERENCES

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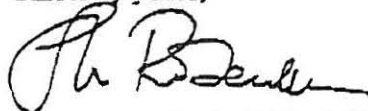
Maria Echeveste
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Dear Ms. Echeveste:

At your request, we have reviewed whether minors under 18 years of age can safely operate paper balers. In particular, we evaluated the safety technology on a sample of paper balers identified by your Division. Enclosed is the report of our study, which indicates that paper balers currently in use have the potential for serious injury and death. Therefore, we recommend that Hazardous Occupations Order 12 (HO-12) prohibiting operation of paper balers by youths under the age of 18 should be maintained.

Please let me know if we can provide you with further assistance in this matter.

Sincerely yours,



Linda Rosenstock, M.D., M.P.H.
Director

Enclosure