



**Workplace
Safety and Health**

NIOSH ***ALERT***

**Preventing Deaths and Injuries
While Compacting or Baling Refuse
Material**

**DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health**

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Preventing Deaths and Injuries While Compacting or Baling Refuse Material

WARNING!

Workers loading, operating, or working near refuse compacting or baling equipment are at risk of serious injury and death.

WORKERS should take the following steps to protect themselves from injury when operating or working near compacting and baling equipment:

- Never bypass or disable interlocks or control switches.
- Keep all equipment guards in place during operation.
- Before attempting to clear jammed material from a compactor or baler, follow OSHA standards on lockout/tagout procedures [29 CFR 1910.147]:
 1. Disconnect the power from the machine.
 2. Isolate the power by locking the disconnect.
 3. Tag the disconnect to notify others that the power must remain off.
 4. Mechanically block any ram that has the potential to move before accessing the compacting chamber.
 5. Test equipment to ensure power has been de-energized before beginning work.
 6. Locate all coworkers before activating power to the compactor or baler.

EMPLOYERS should take the following steps to reduce the risk of worker injuries and deaths:

- Establish procedures for periodic inspection and maintenance of the equipment:

1. Maintain equipment guards according to the manufacturer's specifications.
 2. Check for proper operation of all interlocks and emergency stop devices.
- Train workers to recognize compactor and baler hazards.
 - Implement standard procedures for dealing safely with material jams.
 - Provide safe access to feed chutes for clearing material jams.
 - Comply with child labor laws that prohibit hazardous work by workers under age 18.

**NO OPERATORS UNDER
18 YEARS OF AGE**



For more information about child labor laws, call your local Wage and Hour office of the U.S. Department of Labor.

For additional information, see ***NIOSH Alert: Preventing Deaths and Injuries While Compacting or Baling Refuse Material*** [DHHS (NIOSH) Publication No. 2003-124]. Single copies of the Alert are available free from the following:

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WARNING!

Workers loading, operating, or working near refuse compacting or baling equipment are at risk of serious injury and death.

The National Institute for Occupational Safety and Health (NIOSH) requests assistance in preventing deaths and injuries among workers who load, operate, or work near refuse compacting or baling equipment. Recent NIOSH investigations suggest that worker injuries and deaths could be prevented by using safe work procedures, appropriate safety devices, and hazardous energy control programs designed to address the hazards of operating, maintaining, and servicing compacting and baling equipment. This Alert describes five cases of fatal injuries that resulted when workers entered, fell, or were caught and pulled into energized compacting or baling equipment.

All managers, supervisors, and workers in companies that use compacting or baling equipment should follow the recommendations in this Alert. NIOSH requests that equipment manufacturers, safety and health officials, industry associations, unions, and editors of trade journals bring the recommendations in this Alert to the attention of all employers and workers who use compacting and baling equipment.

BACKGROUND

Compacting and Baling Equipment

Compacting and baling equipment reduces large amounts of solid waste to smaller, more manageable units by means of powered rams. These machines may be used by manufacturing companies to compact and bale large amounts of scrap and waste materials such as paper, cotton, and metals, and by retail and service industries to compress paper and cardboard boxes. Compactors compress the refuse material into containers for transport. Baling equipment is designed to compress material and produce a bale (bound or unbound) that can be handled and transported as a material unit.

Compacting and baling equipment are available in many sizes and configurations. These machines may have one or more rams for compressing materials or extruding bales. The rams may move vertically or horizontally (Figure 1).

Some types of equipment allow direct access to the compression chamber. Others

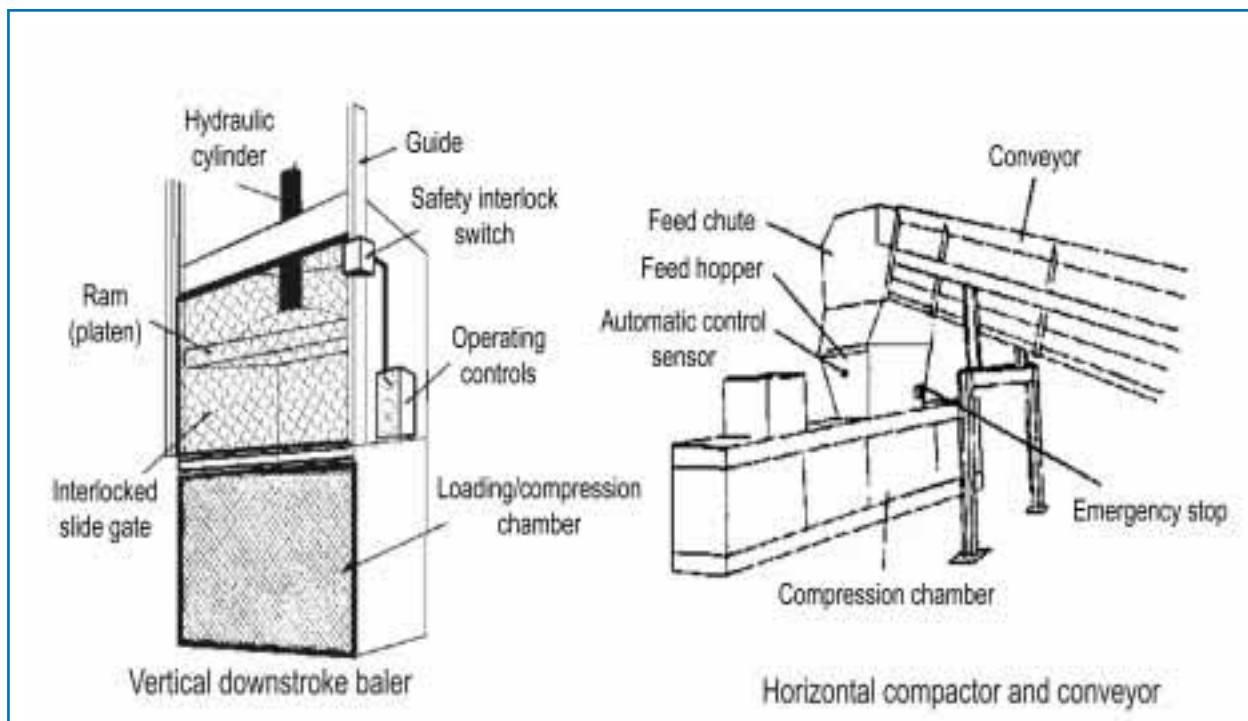


Figure 1. Diagram of a vertical downstroke baler and a horizontal compactor and conveyor.

have a hopper or chute through which material feeds into the machine. In businesses where refuse processing is incidental to the primary operation (such as in retail and service industries), loading and compressing may be done as separate work activities—that is, material may be intermittently loaded until the chamber is full and then compressed. Alternatively, in businesses where compressing scrap and waste materials is the primary operation or where large volumes of refuse materials are processed daily, loading and compressing is a continuous operation.

Machines may operate in a manual, semi-automatic, or automatic mode. In the manual mode, a switch operated by a worker controls ram motion. In the semiautomatic mode, an operator initiates the compression, after which the machine automatically completes the cycle. In the automatic mode, a sensor inside the compression chamber signals when the chamber is full and activates the compression cycle.

Workers at Risk

Because of the widespread use of compactors and balers across varied industries, it is difficult to obtain exact numbers of workers who are exposed to the hazards of this equipment. The workers most likely to be exposed to risk from compacting and baling equipment are those in the wholesale trade and transportation/public utilities industries engaged in recycling and the collection and disposal of refuse. Employees working in manufacturing settings and in retail and service trades may also be at risk because of the large volume of waste generated and processed daily.

Fatality Data

The Census of Fatal Occupational Injuries (CFOI) is a multisource data system maintained by the Bureau of Labor Statistics to identify work-related deaths in the United States. A NIOSH review of the CFOI data identified 34 compactor-related fatalities

during 1992–2000 in which the victim was caught in or crushed by the compacting ram of the machine [NIOSH 2003].

The age range of the fatally injured worker was as follows:

| Age | Number of fatalities |
|-----------------|-----------------------------|
| <25 | 8 |
| 25–35 | 10 |
| 36–45 | 8 |
| >46 | 8 |

Industries involved were the following:

| Industry | Number of fatalities |
|---|-----------------------------|
| Wholesale trade | 13 |
| Manufacturing | 7 |
| Transportation/public utilities | 7 |
| Retail trade/services | 7 |

The following materials were being compacted at the time the victim was crushed:

| Material | Number of incidents |
|-------------------------------|----------------------------|
| Cardboard | 7 |
| Paper | 7 |
| Trash/garbage | 6 |
| Other/not specified | 14 |

The NIOSH Fatality Assessment and Control Evaluation (FACE) Program has conducted fatality investigations of selected types of incidents since 1982.* Incident

*FACE conducts fatality investigations of selected categories of cases, including machinery-related incidents, and disseminates injury prevention information. Through a series of cooperative agreements with NIOSH, 15 States maintain multisource surveillance networks to identify all traumatic occupational deaths, conduct site investigations of selected incidents, and disseminate prevention information.

types include electrocutions, falls from elevation, machine-related, and confined-space-related fatalities. The goal of the FACE Program is to prevent occupational fatalities by (1) identifying and investigating work situations that involve high risk for worker injury and (2) formulating and disseminating prevention strategies.

During 1992–2002, FACE received 20 reports of compactor-related fatalities. All of the fatally injured workers were males whose ages ranged from 16 to 72 and were either caught in or crushed by the machine. In-depth investigations were conducted for 13 of these cases in which the victim was crushed in the compacting chamber or suffered amputation from being caught between the ram and the compacting chamber walls. In all cases, the fatally injured worker either reached or fell into the compression chamber. One or more additional risks were also present in each case. In five of the cases, the victim had been in the process of clearing jammed material from the machine just before the injury. In six of the cases, the machine cycled automatically when the victim entered the compacting chamber; and in three of the cases, coworkers activated the machine without knowing that a worker was inside the compacting chamber. In two of the cases, the fatally injured worker was attempting to retrieve material from the machine.

CURRENT STANDARDS

Occupational Safety and Health Administration (OSHA)

No current OSHA standards apply specifically to compacting and baling equipment. However, current OSHA regulations on the control of hazardous energy sources

(lockout/tagout) [29 CFR[†] 1910.147], and machine guarding [29 CFR Part 1910.212] are applicable to these types of equipment. In addition, the confined space standard [29 CFR 1910.146] may apply to entry into compacting and baling equipment. An OSHA publication, *Concepts and Techniques of Machine Guarding*, describes and illustrates methods that can be used for providing safeguards for balers and compactors [OSHA 1992].

Fair Labor Standards Act (FLSA) and Youth Employment

The FLSA is the primary Federal law governing the employment of workers under age 18. Regulations issued under the FLSA (as amended by the Compactors and Balers Safety Standard Modernization Act of 1996, Public Law 104–174) prohibit children under age 18 from servicing, loading, operating, unloading, or assisting in the operation of compacting equipment. These prohibitions are specified under Hazardous Occupations Order No. 12 (*Power-Driven Paper-Products Machine Occupations*) [DOL 2001]. The current prohibitions are specific to machines that are used exclusively to compact and bale paper products. Though no final action has been taken, the Department of Labor has proposed amending Hazardous Occupations Order No. 12 to expand the ban to balers and compactors used to process other materials in addition to paper such as aluminum cans, plastic, foam, and rubber [64 Fed. Reg.[‡] 67130 (1999)]. NIOSH supports this amendment since balers and compactors used to process scrap materials other than paper products pose similar risks of injury and have been associated with fatal injuries [NIOSH 2000a].

[†]Code of Federal Regulations. See CFR in references.

[‡]Federal Register. See Fed. Reg. in references.

The FLSA (as amended) provides a limited exemption that allows workers aged 16 and 17 to *load only* (place materials in) but not to operate or unload materials from scrap paper balers and cardboard box compactors that meet certain operation and construction standards. The machines must not be able to operate while being loaded. They must be equipped with a lockable on-off switch that is maintained in the *off* position when the machine is not in operation, such as during loading. The machine must comply with the ANSI Z245.5–1990 standard for baling equipment and ANSI Z245.2–1992 standard for compactors. The employer must provide and post a notice that the machine meets the applicable construction standards. Workers aged 16 and 17 may load the machine, but no worker under age 18 may operate or unload material from the machine. Compliance with these provisions can protect adolescent workers from compactor and baler hazards by eliminating exposure to moving machine parts and ensuring that older, more experienced workers are available to operate and unload materials.

American National Standards Institute (ANSI) Standards

ANSI publishes voluntary standards addressing safety requirements for a variety of equipment, including compactors and balers. These standards were last revised in 1997. Stationary compactor safety requirements are outlined in ANSI Z245.2–1997 [ANSI 1997a], and baling equipment is addressed in ANSI Z245.5–1997 [ANSI 1997b].

The key points of the ANSI standards state the following:

- Employers shall provide workers with instruction and training in safe work methods before assigning them to operate, clean, service, maintain, or repair the equipment.
- The worker shall be responsible for using the safety features on the compactor or baler.
- The worker shall ensure that all persons are clear of the point of operation before starting up the machine or a compaction cycle.
- The employer shall inspect safety interlocks, switches, and other protective devices to ensure that they are not disabled or bypassed. The employer shall not permit operation of the baler unless these devices are fully functional.



Figure 2. Automatic two-stage horizontal baler.

not shut off and locked out before the victim entered it and that the safety interlock[§] on the compression chamber door may have malfunctioned, allowing the machine to operate with the door in the open position [NIOSH 2001].

CASES

The five cases described here are deaths investigated by the FACE Program.

Case 1

On March 7, 2001, a 36-year-old male paper factory worker died from crushing injuries after being caught by the ram inside a two-stage horizontal baling machine (Figure 2). The victim, working alone in the warehouse area of a paper plant, was compacting waste paper when he entered the compression chamber (either through the access door or from the top of the feed chute) to clear a jam and was caught by the machine's hydraulic ram. Investigation revealed that the baler was

Case 2

On July 27, 2000, a 16-year-old male produce market worker died as a result of crushing injuries from a baling machine used to compress waste cardboard boxes for disposal and recycling (Figure 3). The victim, working alone in the basement of a small produce market, was crushing and baling cardboard boxes when he was caught

[§]An interlock is a device or mechanism used to connect individual components so that the action of one part of the equipment is constrained by, or dependent on, another. In general, its purpose is to prevent or interrupt the operation of machine components under specified conditions, usually when a hazard is present. As applied to balers and compactors, the interlock prevents or interrupts movement of the compacting ram if the access doors of the machine are opened while the machine is energized or in motion.

in the hydraulic ram. An investigation of the incident by the police found that the baler was being operated improperly, with the loading chamber door open and the door safety interlocks bypassed with a wad of paper. When the victim was found, it appeared that he had been starting a new bale. The wire had been threaded through the compression chamber and secured to the outside of the compactor, and a flattened box was in place in the base of the compaction chamber. The victim may have leaned over into the compression chamber trying to quickly adjust a tie wire or the base box when he was caught by the ram as it moved downward [NIOSH 2000b].

Case 3

On September 30, 1999, a 24-year-old male machine operator died from crushing injuries after he fell into a baling machine used to compress and bale waste cardboard for recycling (Figure 4). The victim worked alone loading, compressing, and moving completed bales to a storage area. The victim was last seen around 5 p.m.



Figure 3. Vertical downstroke baler.

during a break. Between 5:30 and 7 p.m., the victim may have climbed up the outside walls of the conveyor to dislodge a piece of cardboard that was jamming the conveyor belt—an act he had been observed performing in the past. Workers reported that occasionally cardboard would become lodged in the top part of the hopper just under the conveyor (an area that measures 28 by 8 inches), causing the hopper to jam. During this action, the victim may have lost his balance and fallen into the compression chamber, thereby tripping the automatic sensor that indicated that the chamber was full and caused the baler to cycle [NIOSH 2000c].

Case 4

On May 9, 1997, a 34-year-old laborer at a paper products plant died after falling into an operating paper compactor (Figure 5). The victim and a coworker were loading scrap paper into the automatically operated compactor via a belt conveyor when the material jammed in the feed chute. The coworker shut down the conveyor, but the compactor's



Figure 4. Automatic conveyor-fed baler.

controls remained in automatic mode. The victim climbed up to a platform between the conveyor discharge and the feed chute to clear the jam. When the victim leaned over the platform rail to clear the jam, he fell into the compression chamber. His presence tripped the automatic control system, and the compactor's ram was automatically activated [NIOSH 1997].

Case 5

On April 17, 1996, a 72-year-old recycling center laborer was crushed to death after falling into the loading chamber of an industrial baling machine (Figure 6). The incident occurred as the victim and his coworkers were baling discarded newspapers in a vertical upstroke baler. This machine used a 12-foot-deep pit in the floor as a loading chamber. The victim, a "broom-man" who usually swept loose material into the baler, was working near the machine when he apparently fell into the loading chamber pit. His coworkers, not knowing that he was in the baler, filled the loading chamber with newspapers and started the machine [NJ FACE 1996].



Figure 5. Automatic conveyor-fed horizontal baler.



Figure 6. Vertical upstroke pit baler.

CONCLUSIONS

Compacting and baling equipment has widespread use across varied industries. The incidents discussed in this Alert involve hazardous work practices, the lack or failure of safety devices, and failure to develop and implement standard lockout/tagout procedures. Information from the FACE investigations indicates that workers suffered fatal injuries when they entered the compactor to clear a jam, fell into the travel path of the ram, or reached into the machine while performing operational procedures. Employers who recognize the need to implement lockout/tagout procedures during maintenance may not fully appreciate that clearing jammed material poses a similar risk of injury to workers and should be conducted using standard procedures that include appropriate hazardous energy control methods.

Failure to de-energize the equipment and ensure that the device could not be inadvertently reactivated contributed to some

of these fatalities. In addition, compacting and baling equipment and any attached conveyors could have been interconnected so that a single lockable device could de-energize and isolate the power to both machines during lockout/tagout procedures. Failure of safety devices and lack of instruction and training in the operation of the equipment may have contributed to some of these deaths. The circumstances involved in these cases indicate that workers may not fully appreciate the hazards of entering or working near feed hoppers of energized compacting and baling equipment.

RECOMMENDATIONS

NIOSH recommends that employers take the following measures to protect workers from injury when operating or working near refuse compacting and baling equipment.

Lockout/tagout

Because ram motion ceases during a jam, workers may not recognize that the machine remains operational and the ram could activate inadvertently unless the power supply for the machine is disconnected. Whenever unjamming, performing maintenance, or repairing a compactor or baler, the machine should be de-energized and OSHA's lockout/tagout procedures [29 CFR 1910.147] should be followed. At a minimum, lockout/tagout procedures should include the following elements:

- A statement of how the procedure will be used
- Training for workers in the specific hazards of each machine
- Identification and marking of power disconnects

- The steps required to shut down, isolate, block, and secure power to the machines
- The steps designating the safe placement, removal, and transfer of lockout/tagout devices and the person who has the responsibility for them
- The specific requirements for testing machines or equipment to determine and verify the effectiveness of locks, tags, and other energy control measures
- Notification of workers by the employer or an authorized worker before lockout or tagout devices are applied and before they are removed from the machine

Additional recommendations for developing and implementing a hazardous energy control program are included in *NIOSH Alert: Preventing Worker Deaths from Uncontrolled Release of Electrical, Mechanical, and Other Types of Hazardous Energy* [NIOSH 1999].

Machine Guarding

Compactors and balers should be equipped with machine guards and safety interlocks to prevent worker injury, and interlocks should be designed so they are not easily bypassed. All machines should be equipped with safety interlock devices that will immediately stop the machine should a worker attempt to gain access to a ram or the travel zone of the ram while the machine is operating. Currently manufactured compactors and balers conform to ANSI standards that specify point-of-operation guards to prevent workers from reaching into an operating machine and interlocked control systems that interrupt or reverse the ram's motion if the compression chamber doors are opened. However, guards and interlocks

may be deliberately bypassed or may not be present on some older machines.

Where conveyors are used to feed materials into compactors or balers, workers may mistakenly believe that turning off the conveyor also prevents the compactor or baler from operating. To protect against this, compacting and baling equipment and any attached conveyors should be interconnected so that a single lockable device can be used to de-energize and isolate the power to both machines. In addition, all emergency stop devices should be interconnected so that the activation of any emergency stop will shut down both the conveyor and the compactor or baler.

ANSI Z245.2, and Z245.5, and 29 CFR 1910.212 provide information about machine guarding. These standards also provide information about modification of older equipment to improve safety. Any modifications made to equipment should be done only by qualified persons. In addition, descriptions and illustrations of methods that can be used for providing safeguards for balers and compactors can be found in the OSHA Publication entitled *Concepts and Techniques of Machine Guarding* [OSHA 1992]. Machine guards and safety interlocks should be frequently checked by safety personnel, supervisors, and workers to assure that they are in proper working order.

Work Practices and Procedures

Jams are common occurrences in compacting and baling machines. Employers should implement standard procedures for dealing safely with common events such as material jams. Employers should train their workers in these safe work procedures and strictly enforce adherence.

Fatalities have occurred when machines were activated while the operator was

unaware that a coworker was inside the compacting chamber. Employers should establish procedures requiring machine operators to account for the location of coworkers before activating compactor or baler rams.

Safe Access and Fall Protection

Because jams often occur at the openings to feed chutes of conveyor-fed machines, workers may use the conveyor as a means of access to the jam. Platforms incorporating stairs and standard railings should be provided near the openings of feed chutes to allow safe access for clearing jams. In addition, employers should consider providing workers with fall protection devices, harnesses, and lanyards to prevent them from falling into the feed chute if they inadvertently lean over the platform railing while clearing jammed material. Although neither of these measures eliminates the need to follow appropriate lockout/tagout procedures, their use could provide extra protection for workers.

Training

Employers should train workers to recognize the hazards of operating or working near compactors and balers. Procedures and safe work practices addressing problems that may develop during machine operation should be developed and implemented. At a minimum, training should include the following elements:

- A description and identification of the hazards associated with particular machines
- The safeguards themselves, a description of how they provide protection, and a list of the hazards for which they are intended
- Instructions for using the safeguards

- Instructions for removing the safeguards (these should include the circumstances under which they can be removed and the persons who can remove them—in most cases, repair and maintenance personnel only)
- What to do (e.g., contact the supervisor) if a safeguard is damaged, missing, or unable to provide adequate protection

Protecting Adolescent Workers

Employers should not assign workers under age 18 to service, load, operate, or assist in the operation of compacting or baling equipment. For cases in which the Compactors and Balers Safety Standard Modernization Act applies, employers should comply with all provisions of the Act—including ensuring that the compacting or baling equipment meets specified safety standards and that young workers are limited to loading materials into de-energized equipment. When training young workers on their job and work procedures,

employers and supervisors should explicitly note restrictions on having young workers load and operate compacting or baling equipment. All workers in the work setting should be aware of any workers under age 18 and be similarly trained so that they do not assign them to work with compactors or balers and can notify the employer or supervisor should violations of the policy occur. For stickers that employers can post on the machine to alert workers of the age requirement, see <http://youthrules.dol.gov/posters.htm>

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Please direct any comments, questions, or requests for additional information to the following:

Dr. Nancy Stout, Director
 Division of Safety Research
 National Institute for Occupational Safety and Health
 1095 Willowdale Road
 Morgantown, WV 26505–2888

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John Howard, M.D.
Director
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