Safety in the *Food Processing Industry*

An observational assessment of hazards from the state of Washington

By Martin Cohen, Catherine Connon and Barbara Silverstein

EXPOSURES AND HEALTH OUTCOMES DUE to hazards in the food processing industry are numerous and varied. In the state of Washington, approximately 2,700 state-fund workers' compensation (WC) claims are accepted each year in the food processing industry, with an annual direct cost of $11 million. Many of these claims involve sprains, cuts and contusions. As part of a larger study of worker health and safety and work organization (sidebar, pg. 21), this group of researchers assessed hazards and controls related to machinery; slips on work surfaces; noise; chemical and biological agents; forklifts; and musculoskeletal disorder risk factors and hazards in 19 food processing facilities.

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Exposures and health outcomes due to hazards during the processing of grain and vegetable, poultry, red meat, seafood, eggs and dairy products are many and varied. Several studies have investigated work-related cancer (Alavanja, et al; Johnson, et al); allergies (Cartier, et al); dermatitis (Bauer, et al; Cohen); musculoskeletal disorders (Bao, et al; Chiang, et al); respiratory diseases (Nieuwenhuijsen, et al; Lenhart and Olenchock; Zuskin, et al; Smith, et al; CDC); infectious diseases (Anderson, et al; Corry and Hinton); and acute trauma injuries [OSHA; NIOSH(b)] in these industry sectors.

However, systematic reviews have been conducted of hazards in the food processing industry. Hazards have been described in meat packing plants (Campbell) and by NIOSH for all industries [NIOSH(b)]. In the Food and Kindred Products industry [Standard Industrial Classification (SIC) codes 2011 to 2099] nationwide, NIOSH found approximately 3,600 people exposed to egg whites, 57,500 to wheat flour, 3,000 to sulfur dioxide and 8,600 to dead shellfish. Also, relevant specific hazards have been studied across industries, such as the consequences of shiftwork (Smith, M.J., et al) and exposure to cold environments (Sinks, et al).

The food processing industry has one of the highest work-related injury and illness rates in the state of Washington. In the years between 1994 and 1999, the state's WC claim rate for state-fund companies in the food processing industry was 18.8 claims per 100 full-time equivalents (FTE) (Bonauto, et al); this is 32-percent higher than the claim rate for all industries combined (12.8 claims/100 FTE) for a similar time period (Silverstein and Kalat). Between 1994 and 1999,

Goals of Healthy Workplaces Initiative

The overall goal of the Healthy Workplaces initiative, of which this assessment was part, was to reduce work-related injuries and illnesses in an industry. Our hypotheses were:

1) Workplaces with high financial and organizational health will have a high level of employee safety and health.

2) The way a workplace is organized determines financial and worker health.

3) Identifying "best practices" in the healthiest workplaces and promoting those practices throughout the industry will improve safety and health.

a total of 16,367 state-fund WC claims came from the state's food processing industry. These claims cost $65.9 million—an average of $11 million each year or $4,000 per claim. Sixty-eight percent of these claims involved sprains (5,593), cuts (3,317) and contusions (2,251). Many of these injuries resulted from overexertion (e.g., lifting), being struck by or against objects (e.g., boxes), and falls (e.g., slipped on floor, fell on stairs). These figures underestimate the true number of injuries because they do not account for those that occurred at self-insured companies (Silverstein and Kalat), nor do they include the likely unreported work-related injuries and illnesses (Biddle, et al).

As part of a larger study, walkthrough hazard assessments were conducted in 19 food processing facilities located within the state. The purpose of these assessments was to better understand the hazards, controls and barriers to controlling hazards within the industry. This article summarizes the haz-

Results of Telephone Survey

A telephone survey of 142 eligible food processing companies found:

- Companies that had higher "organizational health" also had lower workers' compensation claims rates.
- Companies with higher "organizational health," on average, paid higher employee wages.

ards and controls observed in Washington's food processing industry, and offers recommendations for additional controls.

Study Methods

The industry sectors chosen for study were selected by three-digit SIC codes. These included: meat products (SIC 201); dairy products (SIC 202); canned, frozen and preserved foods (SIC 203); grain mill products (SIC 204); bakery products (SIC 205); beverages (SIC 208); and seafood and other products (SIC 209). To gather preliminary company information—such as financial status, organizational health, and employee health and safety—a telephone-based survey of all companies within the chosen sectors was conducted. Results of this survey are reported elsewhere and are summarized in the sidebar at left (Connon, et al).

The phone survey was used to identify a variety of workplaces for site visits. The target was to conduct 36 site visits, distributed evenly among the different industry sectors and company sizes, although no site visits were made to the grain mill products sector. The site visit team consisted of a manager/worker interviewer, an industrial hygienist, an ergonomist and a safety engineer. The site visit strategy and assessment tools were pilot-tested at one food processing facility. Activities other than the hazard assessment were conducted during the site visits; they are reported elsewhere and are summarized in the sidebar below (Connon, et al).

Exposure Assessment Methods

During the onsite opening conference with the company representative, the team gathered information on the facility's processes. Following this meeting, the team briefly toured the production facility to observe processes, material flow and hazard exposures. After preliminary observations and discussions with management, three to five processes were chosen for observation; these areas were selected based on initial hazard assessments, as well as input from management. Only jobs performed on the day of the site visit were assessed.

Observational tools (checklists and forms) were used to assess potential physical (safety, thermal, radiation, noise and musculoskeletal), chemical and biological hazards in the workplace, as well as potential controls. Full copies of these forms are available elsewhere (Connon, et al). Forms were completed by work process and sometimes by subprocess.

Presence of musculoskeletal risk factors was assessed using the Washington State Ergonomics Rule (WAC 296-62-051) "caution zone" and "hazard zone" checklists for manual handling, postural, repetitive and other hazards (WA State Dept. of Labor & Industries). These criteria were used so that employers could learn whether jobs on their sites may be of concern under the future rule. To identify caution and hazard zone jobs, a checklist was completed for each process/subprocess studied. Each process was also videotaped for later ergonomic assessment. Controls for materials handling, workstation setup/design, repetitive work and tools were also noted.

Where possible, the team assessed the control of acute trauma injury hazards by observing guarding (machine and general area), maintenance, housekeeping, materials handling, PPE, lockout/tagout and confined space procedures. These hazards were rated based on the observers' assessment of control of the potential for the hazard to cause injury. Scales with "poor," "fair," "good," "excellent" or "not applicable" were used.

Chemical and biological exposures were assessed by evaluating 1) various characteristics of the source, such as the exposure process and factors affecting the magnitude of the source; 2) potential for worker exposure; 3) toxicity of the material; and 4) controls used to reduce the exposure (engineering, administrative and PPE). The team also observed how employees worked with the materials. This method was adapted from materials developed by LaMontagne, et al. Some screening air samples were taken for dust (using the ThermoMIE Personal Data Ram 1000, Bedford, MA); carbon monoxide (Metrosonics pm7700, Oconomowoc, WI); and other gases (Metrosonics pm7700, Oconomowoc, WI) where appropriate.

Other physical hazards, including noise, temperature extremes and radiation, were assessed by noting characteristics of the source, controls in place to potentially reduce exposure and how the worker interfaced with the hazard. Where appropriate, the team measured noise (Metrosonics, dB-3100, Oconomowoc, WI) and temperature/humidity (Extech Instruments, Humidity/temperature pen 445580, Waltham, MA).

Data were entered directly into computer-based forms while making observations in a manner similar to that reported previously (Cohen and Cotey). Field staff used handheld computers (HP, iPAQ, Palo Alto, CA) running Windows CE v 2.0 (Microsoft, Redmond, WA). Forms were developed using Visual CE v5.1 (Syware, Cambridge, MA). Each type of hazard had its own forms module. Data collected were downloaded to an MSAccess database, where observations

Other On-Site Activities

Other activities conducted on site included:

- Surveys of workers to determine their job duties, perception of hazards and workplace organizational factors, health symptoms, and job stress.
- A review of safety and health programs and materials.
- A manager interview covering productivity, commitment to safety, policies and practices, perceptions of various hazards and workplace organizational factors, and successful strategies used to reduce or eliminate work-related injuries and illnesses.

Figure 1

First Process Description Form

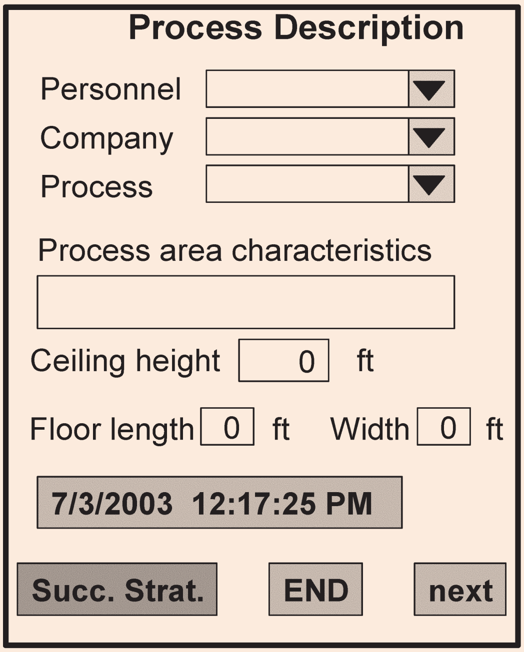
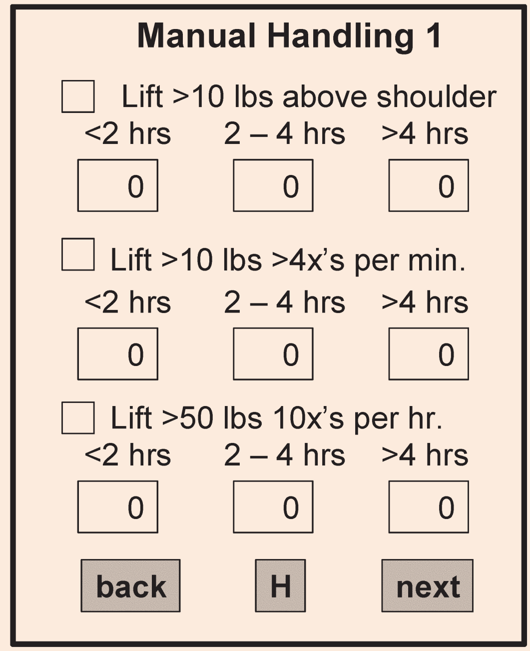


Figure 2

MSD Assessment, First Manual Handling Form



were joined and summarized by work process. Figures 1 and 2 provide examples of these forms. The types of data entry fields used included pull-down lists, check boxes (yes or no), radio buttons (select one of multiple options), boxes for writing text or entering numbers, and time stamps. Navigational buttons were used to efficiently move between screens.

Study Results

A total of 19 sites from various industry sectors were visited (Table 1). For the most part, the sitess visited were relatively small, with only three of the 19 companies having more than 100 employees. Assessment results have been compiled into tables listing the exposure, potential consequences of exposure, current controls, potential controls and the industry in which the observations were made (Tables 2 through 7). The hierarchy of controls was used when making recommendations for controls.

Machinery

Numerous machine guarding hazards were observed during the site visits. They occurred primarily in equipment that transported and processed materials. Typical transport mechanisms included pallet jacks, forklifts, conveyor belts and tote dumps. Typical processing equipment included that used to clean, cut, stir, sort and package materials. Table 2 lists typical machine guarding hazards and controls. Strategies used to reduce machinery hazards ranged from enclosing entire machines or guarding pinch points to training or the use of sacrificial "push sticks" with band saws.

Slips

Most facilities had slip hazards. These hazards are caused by having liquid and/or solid materials on the floor in work areas where the flooring does not provide adequate friction, given the contaminant (e.g., water, grease, animal parts, flour). Materials got onto the floor via mechanisms such as spraying, dripping/flowing and

Table 1

Company Descriptions

Industry (SIC Code)*	Products Manufactured	Number of Production Workers
201	Sausage product	20
201	Egg products	50
201	Sausage	2
201	Meat	>100
202	Milk	20
202	Milk	8
203	Fruit juice	44
203	Frozen vegetables	>100
203	Frozen entrees	19
203	Juice and syrup	30
203	Potato products	60
205	Gourmet cookies	14
208	Wine	23
208	Wine	18
208	Wine	5
208	Beer	1
209	Processed fish	3
209	Fresh/frozen seafood	>100
209	Crab	12

**SIC codes: 201: Meat Products; 202: Dairy Products; 203: Canned, Frozen and Preserved Foods; 205: Bakery Products; 208: Beverages; 209: Seafood and Other Products.*

discarding of material. Table 3 illustrates some slip hazards observed. Potential consequences of slips ranged from twisted or strained ankles and backs to severe head trauma, depending on how a worker might slip and what s/he might strike upon falling.

Companies used a range of solutions to reduce slip hazards, including barriers to keep product and water off of the floor; epoxy flooring with a rough surface; plastic stair treads designed for use on offshore oil platforms; and slip-resistant footwear.

Noise

Many sites had noisy operations in all or part of their facilities. The three primary sources of noise were: 1) objects striking one another; 2) something vibrating; and/or 3) movement of a fluid (liquids or air). Excessive noise came from pumps, motors, compressors, vibrating tables, conveyors and processing equipment. Table 4 summarizes some noise exposure scenarios. Measured noise exposures on the workfloor were routinely greater than 85 dBA.

Most facilities relied on hearing protection to reduce exposure, although not all workers and supervisors used PPE when needed. Given these compliance concerns, it is preferable to reduce the noise level at its source or to isolate the noisy operation. Some facilities attempted to use methods other than PPE; these included purchasing quieter equipment; enclosing noisy equipment in its own room; and using enclosed or semi-enclosed processing booths.

Table 2

Examples of Exposures to Machines Lacking Guarding

Exposure	Potential Consequences	Current Controls	Potential Controls	SIC*
Unguarded tote dump.	Crushing injuries to leg or body.	Kept a watch on the area near the tote dump; used a chain to reduce access.	Develop a physical barrier to prevent access; use a light curtain with an interlock to stop the dump's motion if something crosses it; use a strobe light to indicate the dump's use.	201, 203, 209
No guard on film feeder for packaging machine.	Crushing injury to the hand.	No controls.	Place a guard in front of the feeder.	205
Unguarded dough mixers.	Crushing injuries to the hand and arm.	Safety interlocks.	Place a guard over the opening of the mixing bowl, although this will prevent workers from easily testing the dough.	205
Sanitizing processing equipment in motion.	Crushing, amputation, entrainment.	Guards were removed to allow for cleaning. Reliance on worker awareness.	Use in-place sanitization. Extensively train workers in the operation of each specific piece of equipment.	203
Final set of unguarded rollers on a series of rollers designed to squeeze material.	Crushing or entraining a hand or clothing.	Intermediary rollers spun in opposite directions, which prevented foreign objects from being pulled into those rollers.	A guard could be developed that would limit access to the end rollers and also allow workers to perform their jobs.	201
Unguarded eight-foot diameter spinning product inspection station.	While removing product debris, a worker could be struck by the spinning arms and possibly be entrained for a short distance.	Emergency stop system was present that would shut down the station when a bar was struck.	An enclosure could be developed that would allow workers to inspect the product and minimize the entrainment hazards, similar to another line. This would also reduce the noise levels in this area. A "deadman's switch" could also be used for this application.	201
Band saws used to cut frozen product.	Amputation of a finger or hand.	No controls.	It is difficult to guard this operation, but it may be possible to develop a jig to guide the product into the blade. Newer equipment may have guarding solutions that could be adapted to these saws.	209

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Chemical & Biological Agents

During the site visits, most facilities did not use hazardous chemicals in the processing of the food. However, in some facilities, the plant or animal material being processed could potentially cause illness in exposed workers. All facilities used chemicals for cleaning and sanitizing equipment and surfaces throughout the day and at the end of a shift; some sites also used ammonia in their coolant systems. These processes pose two potential routes of worker exposure: inhalation of the contaminant and skin contact. Table 5 lists some hazards, potential consequences of exposure, current solutions and potential solutions.

Aside from automated mixing/dilution systems and in-place sanitization, exposure to chemical and biological agents was largely controlled by PPE. Some facilities used product substitution to reduce exposures. For example, some had changed the form of a sterilant to a solid rather than a gas or used only electric forklifts inside the facility. Also, at some sites, ventilation was used to remove contaminants generated in the processing of materials. Generally, no exposure controls were used in the processing of food products that have potential or known allergens (e.g., crab, egg, flour).

Forklifts

Forklifts in workplaces pose potential hazards from two different perspectives: 1) as a safety hazard to the operator and others in the area; and 2) as a health hazard due to the fact that combustion engine models may produce carbon monoxide. Table 6 lists some observed hazards, potential consequences of exposure, current controls and potential controls.

To reduce acute trauma exposures, companies developed pedestrian and truck corridors within their facilities and provided extensive forklift operator training. As noted, some facilities used only electric

Table 3

Examples of Exposures to Slips on Walking Surfaces

Exposure	Current Controls	Potential Controls	SIC*
Water and plant material on the floor.	Rough concrete floor was used along with slip-resistant boots.	More resources could be put toward preventing materials from getting on the floor in the first place.	203
Flour spilled onto the floor.	Rough concrete floor in use.	Better transfer methods could be developed and slip-resistant shoes used. Spills should be cleaned up immediately.	205
Frozen plant material spilled onto floor while being transported in large totes with forklift trucks.	Rough concrete floor in use.	Alternate transfer methods should be used to prevent materials from spilling onto the floor. Slip-resistant footwear would not help in this situation.	203
Floors greasy from animal fat.	Slip-resistant flooring material used.	The machine dispersing the grease should be shielded to prevent the grease from contacting the floor. The floors should be cleaned with a strong grease-removing cleaner, although this may introduce other hazards. Slip-resistant footwear could be effective in this situation if the shoes were kept clean.	201
Water used to cool product pumps that were on the floor, and allowed to flow freely out of the pumps onto the floor.	Slip-resistant quarry tiles used in this area.	The coolant water should be properly routed via an inline drain or a floor drain without exposing workers to the slip hazard. Slip-resistant footwear would be feasible in this location.	201
Frozen animal parts on the floor from a trimming operation.	Rough concrete floor in use.	A custom-shaped waste receptacle could be developed to prevent waste materials from getting on the floor. Slip-resistant footwear would not be effective for this hazard.	209
Grease from processing animal parts on the floor in the production areas as well as the breakroom and other nonproduction areas.	Rough concrete floor in use in production areas.	Reduce the amount of grease transported through the facility. More aggressive flooring materials should be used in nonproduction areas, in combination with a more effective cleaning procedure. Slip-resistant footwear may be effective in this situation, but would need frequent cleaning.	201

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Table 4

Examples of Exposures to Noise

Exposure	Current Controls	Potential Controls	SIC*
Dumped frozen product into a steel vessel.	The task was performed by one person in an out-of-the-way location while wearing ear muffs.	Consider using a sound-absorbing material on the back of the vessel to dampen the noise.	203
Box processing line created noise as the boxes moved down the line.	Earplugs were used.	Consider dampening the "box pusher's" mechanism to reduce the noise level.	203
Vibrating table used to help break up and convey frozen product to an inspection table.	The table cycled on and off, which would reduce the noise exposure over time. Also, workers stood in noise-absorbing booths and used earplugs.	Place the vibrating table on special floor mounts to decrease the amount of noise generated.	203
A number of noisy pumps, blowers and compressors located in the facility.	Much of the noisy equipment was located in generally unoccupied "soundproof" rooms.	When new equipment is purchased, its noise emissions should be evaluated along with other performance measures.	203
Elevated noise levels caused by the conveying and product washing equipment in a transfer room.	Product washer enclosed, which greatly reduced noise exposures. Earplugs worn by some workers in the area.	Earplug use should be enforced.	201
Loud processing line due to a metal bar striking another metal piece approximately 400 times per minute.	Operator used earplugs.	Nonmetal materials could reduce the noise made by the striking mechanism. Enclosing the processing line could reduce the noise and may also reduce the machine hazards.	201
Band saws used to cut frozen products.	Operators used earplugs.	Enclosing any or part of the saws' motors would help to reduce the amount of noise reaching workers' ears.	209
Workers processed dusty material in an enclosed area with a great deal of noise produced by moving air used for ventilation.	Workers in this area used earplugs.	The ventilation system in this area should be redesigned to be inherently quieter.	201

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forklifts to reduce carbon monoxide exposures; others had preventive maintenance programs and used carbon monoxide detectors and general ventilation.

Musculoskeletal Disorders

Similar musculoskeletal risk factors were found at most facilities, but the potential for jobs to become hazardous varied considerably. Heavy, frequent and/or awkward lifting, particularly during loading and unloading of pallets, was one of the most commonly observed physical risk factors. The team frequently observed highly repetitive motions, often in combination with awkward postures. Many sites had an assembly line layout, where workers performed tasks repeatedly, at a specified pace, with little opportunity to change their postures. Table 7 lists observed hazards, potential consequences of exposure, current solutions and potential solutions.

In several facilities, musculoskeletal risk factors were reduced using the hierarchy of controls with the added benefit of increased productivity. To reduce hazards associated with lifting materials, some sites:

1) redesigned conveyor systems to reduce manual handling of the product;

2) used automatic "depalletizers" to unload empty containers onto the conveyor;

3) used vacuum lifts to move product from the conveyor line to the pallet;

4) used scissor lifts that raised and lowered product to eliminate manual lifts from below knee-level;

5) implemented a job rotation policy to reduce the amount of time a worker spent lifting.

Several companies also had safety committees actively working to address these risk factors.

Discussion

By spending one day at food processing facilities, the interdisciplinary team of safety and health specialists identified diverse physical, chemical and biological hazards. Companies used a combination of engineering controls, administrative controls and PPE to eliminate or reduce work-related exposures. Sites visited used a combination of manufactured solutions (e.g., machines with built-in guarding) and facility-developed solutions (e.g., machine guarding fabricated on site). Some of the control strategies reduced multiple hazards simultaneously. These included:

• A product inspection line was covered to prevent workers from putting their hands into the moving mechanism and to reduce noise produced by the line.

• Many facilities had equipment sanitization requirements and used automated mixing and dis-

Table 5

Examples of Exposures to Chemical & Biological Agents

Exposure	Potential Consequences	Current Controls	Potential Controls	SIC*
Exposure to caustic sanitizing agents.	Severe skin rashes and respiratory irritation.	Automated mixers/ dispensers were used along with many automated sanitizing processes.	Longer gloves may be used to protect against excessive splashing.	205
Flour exposure from mixing dough.	To sensitive individuals, exposure may cause an asthmatic reaction.	No controls.	Use a local exhaust ventilation system to remove airborne flour while pouring flour.	205
Sulfur dioxide gas used to sanitize storage vessels.	Acute respiratory irritation and respiratory distress.	Some facilities used a solid form of the product that released sulfur dioxide on contact with water. Respirators used.	The solid form of the product may be a good solution, but requires further study to ensure workers are not ultimately exposed to the gas product.	208
Diatomaceous earth, which contains silica, used as filtering aid to remove sediments from fluids.	Exposure over long periods of time may cause silicosis.	Respirators used.	A synthetic filtration aid or an enclosed transfer system could be used to move the diatomaceous earth from storage to the filtration units.	208
Dust levels from an animal product were very high in the receiving area.	Respiratory disease, including hypersensitivity pneumonitis and asthma.	The area was ventilated and workers used dust masks.	Ventilation system should be redesigned and the respiratory protection program evaluated and upgraded.	201

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pensing equipment. This reduced both chemical exposures and the amount of lifting required for the job. In-place sanitization (automatically pumping in sanitizer and water without a worker contacting the materials) was also used in several locations, which further reduced chemical exposures.

•One company had a slip management program that included providing workers with a large rebate toward the purchase of slip-resistant footwear; this may not only reduce the probability of slips, it may also foster positive employee perceptions of management. The program was successful because slip-resistant shoes were used in combination with a slip-resistant floor.

•By housing much of the loud mechanical equipment (blowers, compressors and motors) in a separate room, one company decreased the noise level on the workfloor, which also may have increased workers' ability to communicate about production issues.

The team's broader goal for site visits was to identify successful strategies that firms used to control or eliminate hazards in order to share those strategies industrywide. The hope is to determine whether any of these controls might reduce work-related injuries, decrease WC claim rates or reduce lost work time reported by companies that use these strategies.

Although companies controlled many hazards, uncontrolled hazards still existed. For example, many obvious machinery hazards were controlled during routine operations. However, during upset conditions or maintenance operations, workers were regularly exposed to various machinery hazards. Also, several more subtle machinery hazards were left unguarded, meaning the sites were relying on worker attentiveness to prevent injury.

In addition, some sites that had safety and health policies did not necessarily operate in a manner consistent with achieving their goals. One study found that companies which were successful at preventing and managing work-related disability had rigorous accident investigations, investigated near-hit incidents, and had a management team that was responsive and timely in implementing corrective solutions to identified problems (Habeck, et al). Another study showed a relationship between "safety diligence" (acting on stated safety goals, responsiveness to addressing safety issues) and workdays lost due to work-related injury, where companies with better safety diligence and better safety training had fewer lost workdays—17 percent and 13 percent fewer, respectively. However, these researchers found no statistically significant differences in WC claim rates between companies that had diligent safety practices and safety training and those that did not (Habeck, Hunt and VanTol 126).

Many sites relied on worker behavior to prevent work-related injury and illness, often via use of PPE. For such practices to be effective, the worker must use the assigned PPE—and use it correctly. One study found that management considered worker

Table 6

Examples of Exposures to Hazards from Forklift Trucks

Exposure	Potential Consequences	Current Controls	Potential Controls	SIC*
Poorly tuned forklift driven around facility.	Carbon monoxide poisoning, loss of consciousness, possibly death.	Minimal ventilation.	Use electric trucks, increase ventilation and keep forklift trucks well-tuned.	201, 208
Forklift delivered a large bin of raw material to a worker's station, and came within two feet of the worker while his back was turned.	Crushing between large bin and workstation, amputation of limb, internal injuries or death.	No controls.	Bin could be delivered with a conveyor or to a slightly different location using the truck. Receiving worker needs to have eye contact with the forklift driver.	209
Considerable forklift traffic in the facility.	Being struck by or run over by a forklift could lead to fractures, crushing injuries or death.	Well-lit area with forklift truck honking horn as it approached high traffic areas. All trucks used backup alarms.	Use another method to transfer materials, such as conveyors. Designate and enforce the use of forklift and pedestrian pathways.	201

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attitudes, use of PPE and worker participation most important in ensuring workplace safety and health.

It also showed that housekeeping and machine hazards were the most common hazards investigated by the Joint Health and Safety Committee (Shannon, et al 262). In this study, even though companies tended to rely on workers' use of PPE, worker involvement in safety and health processes seemed to be lacking. In addition, inconsistent manager compliance with stated safety policies and goals was observed. For example, in some facilities, the management representative did not wear hearing protection in high-noise areas or did not follow designated walking pathways.

Other Observations

Slips. Sites were aware of slip hazards and various controls were used to reduce these hazards; however, it appeared that there was an acceptance within the industry to have materials on the floor—along with the implicit residual hazard. Keep in mind that between 1994 and 1999, nearly nine percent of the state's state-fund WC claims from the food processing industry (1,447 of 16,367 claims) were due to falls on the same level (although not all of these claims were from slips on surfaces).

Noise. Frequently, companies relied on use of hearing protection to control noise exposure instead of attempting to control noise at its source or to install absorptive materials in the work environment. Short of purchasing quieter equipment, many facilities had potential opportunities to reduce noise levels by enclosing or shielding equipment, or by using noise-absorbent surfaces near workstations. Because of sanitization requirements, employers may not wish to add more surfaces to the workplace, especially ones that may be porous. Job rotation is another way to potentially reduce exposure to noise; this strategy may also reduce exposure to musculoskeletal disorder risk factors.

Chemical/biological contaminants. Several facilities were processing allergenic materials without exposure controls. Only a few managers reported knowing about health problems among their workers due to exposure to these materials. It may be that a "healthy worker effect" is operating, where workers with allergies find other jobs in the company or leave all together (Choi).

Forklifts. Forklift use was ubiquitous in the industry. The control of acute trauma injuries was addressed via operator training, rather than by isolating trucks from pedestrian traffic or using other means to move material. Most larger companies were aware of carbon monoxide hazards and either used electric forklifts or had preventive maintenance programs and fixed-station carbon monoxide monitors. The smaller companies visited generally used propane-powered trucks and had no preventive maintenance program.

Although not strictly defined as food processing, many associated industry sectors have had a large number of carbon monoxide poisoning incidents (Lofgren 290). Between the wholesale trade of fresh fruit and vegetables, the production of deciduous tree fruits and crop preparation services for market, approximately 47 carbon monoxide poisoning incidents were reported in Washington for the years 1994 and 1995. Many of these incidents involved multiple workers, with one involving nearly 100 workers.

Musculoskeletal disorders. Management seemed to be relatively well aware of risk factors for the development of musculoskeletal disorders, but follow through on controls was not as good. Often, hazards were abated when the process was redesigned for processing efficiency; in many cases, however, the new layout or process introduced new hazards.

Table 7

Examples of Exposures to Lifting & Repetitive Motion

Exposure	Potential Consequences	Current Controls	Potential Engineering Controls	SIC*
Awkward postures while repetitively performing a forceful activity.	Shoulder, wrist and back disorders.	No controls.	Alter the workstation design and/or alter the method in which the product is processed so that it requires less force to complete the task.	201
Lifting heavy bags of waste product.	Shoulder and back disorders.	Job rotation and infrequent lifts.	Install a conveyor system.	203
Lifting large, heavy handfuls of dough to an overhead bucket.	Shoulder, wrist and forearm disorders.	No controls.	A hoist is commercially available to lift and dump a mixing bowl.	205
Lifting heavy boxes from conveyor belt, stacking them on a pallet from ankle level to above shoulder level.	Shoulder and back disorders.	No controls.	Box weight could be lowered, job rotation could be used, or a lift assist could be implemented.	201
Pallet jacks used to move large, heavy bins of product.	Shoulder and back disorders.	None present.	An electric pallet jack would reduce the force required to push and pull the bins.	201
Unloading palletized product onto conveyor.	Shoulder disorders.	A scissor-lift was used to keep the top of the pallet between waist and shoulder level.	An assist device should be investigated to reduce the amount of reaching required by the worker when unloading the pallet.	201
Product fed onto tubes for storage and shipping. The thumb used rapidly and repeatedly to feed product onto the tube.	Thumb, hand, wrist and forearm disorders.	A tube extender was developed that reduced the amount of motion required by the worker, although some exposure still existed.	A new method could be found to mount the product onto the tubes.	201
Workers were sorting product while wearing loose-fitting gloves.	Hand, wrist and forearm disorders.	No controls.	Provide a variety of glove sizes so a close, but not too tight fit is achieved. This will also reduce the likelihood of a glove catching on a piece of moving machinery.	201
Workers were lifting cases of product from one location to another.	Shoulder and back disorders.	A vacuum lift was installed to assist the workers in lifting the boxes.	None.	208
Workers were required to hang product on overhead hooks at a fast pace.	Shoulder and elbow disorders.	The line was redesigned to allow workers to hang product at elbow-height.	Much of the repetition in this job could be reduced by using more workers on the line, rotating workers or slowing production.	201

**SIC codes: 201: Meat Products; 202: Dairy Products; 203: Canned, Frozen and Preserved Foods; 205: Bakery Products; 208: Beverages; 209: Seafood and Other Products.*

Study Limitations

The site visits were limited in scope and comprised only one visit per facility. Also, the team generally was not able to observe seasonal workers (e.g., those processing fresh fruit and vegetables) at some sites because the visits were conducted between January and March.

The typical site visit occurred between 9 am and 4 pm. This generally precluded the team from observing most of the sanitization process; doing so may have provided more insight into the chemical and physical hazards associated with that process. By having such few and short visits, the team saw few upset conditions; such situations could greatly increase worker exposure to agents of interest. In addition, maintenance activities were not assessed; this may have allowed the team to observe more fall, confined space and machinery-related hazards.

The generalizability of this study's findings is limited as well. The study used a convenience sample of companies that volunteered to have a site visit after completing the telephone interview. This may introduce bias in the findings in that those sites willing to participate may have been those with better safety and health practices and attitudes. Also, because the study approach was industrywide, companies visited were from six of the industry's sectors. This creates difficulties in making generalizations because of differences in processes, equipment, job tasks, hazards and control measures across the different sectors.

Conclusion

The site visits revealed that some hazards have been adequately addressed in this industry sector, but a large number still require solutions other than PPE and training. Often, these strategies were used as the first—and last—line of defense against exposure with no further investigation into ways to reduce exposures (Raterman 532). This may be a shortsighted approach that is partially responsible for the common sentiment that most work-related injuries are caused by "unsafe acts" (Heinrich, et al 58). Reliance on fallible human beings to enact a control only leads to the conclusion that these injuries are due to unsafe acts.

From a broader perspective, the problem is not one of the person or the machine, but of the system. A company must look upstream and resolve SH&E issues at the highest levels. It must also use a "top-down" approach to communicate and manifest its commitment and responsiveness to addressing SH&E issues. Until a company is proactive in assessing and controlling hazards at their source, it cannot adequately address worker safety and health before an injury or illness occurs. ■

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Acknowledgements

The authors thank the following individuals for many hours of field work and planning in this study: Arelene Stebbins, Tom Sjostrom, Ninica Howard, Rom Rwamamara, Michael Foley, Christy Curwick, Steve Whittaker, Stephen Bao, Peregrine Spielholz and David Bonauto.