



Ergonomic and Musculoskeletal Evaluation of Distribution Tasks at a Logistics Agency in California

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Table of Contents

Main Report

Introduction	1
Our Approach	1
Our Key Findings.....	1
Our Recommendations	2

Supporting Technical Information

Section A: Workplace Information.....	A-1
Employee Information	A-1
History of Issue at Workplace	A-1
Process Description	A-1
Section B: Methods, Results, and Discussion	B-1
Methods: Ergonomics Evaluation	B-1
Results: Ergonomics Evaluation	B-1
Methods: Employee Health	B-4
Results: Employee Health	B-4
Discussion	B-6
Limitations.....	B-6
Conclusions	B-6
Section C: Tables	C-1
Section D: Occupational Exposure Limits.....	D-1
Risk factors for Work-related Musculoskeletal Disorders.....	D-1
Section E: References	E-1

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Introduction

Request

Safety management at a national logistics agency requested a health hazard evaluation. They were concerned about ergonomic issues and potential musculoskeletal injuries among employees who performed general warehousing operations.

Workplace

The facility is part of a large distribution platform that delivers materials globally. At the time of our evaluation, the agency employed approximately 1,300 employees at this facility. We evaluated employees with various job tasks in four buildings. Employee job tasks included picking, packing, processing, storing, loading, and unloading materials of various types and sizes.

To learn more about the workplace, go to [Section A in the Supporting Technical Information](#)

Our Approach

We visited the facility in January 2019 to evaluate ergonomic hazards and musculoskeletal health symptoms of employees. During this site visit, we completed the following activities:

- Observed work processes, practices, and workplace conditions.
- Measured workstation heights.
- Interviewed 39 employees about their work and their health. These included distribution process workers and work leaders. Interview topics included job tenure, job tasks, relevant medical history, and musculoskeletal health symptoms and concerns.

To learn more about our methods, go to [Section B in the Supporting Technical Information](#)

Our Key Findings

Most workstations and areas were not designed to reduce work-related musculoskeletal disorders

- Most workstations were static and did not adjust.
- Most workstations lacked antifatigue mats and adjustable chairs and stools.

The most common sites of potential work-related pain were in the back and shoulders

- Employees who reported back pain listed job tasks involving packing and unpacking boxes or loading and offloading boxes from trucks.
- Employees who reported shoulder pain listed job tasks that included packing and unpacking material and sorting material from the chute.

To learn more about our results, go to [Section B in the Supporting Technical Information](#)

Our Recommendations

The Occupational Safety and Health Act requires employers to provide a safe workplace.

Potential Benefits of Improving Workplace Health and Safety:

- | | |
|--|--|
| ↑ Improved worker health and well-being | ↑ Enhanced image and reputation |
| ↑ Better workplace morale | ↑ Superior products, processes, and services |
| ↑ Easier employee recruiting and retention | ↑ May increase overall cost savings |

The recommendations below are based on the findings of our evaluation. For each recommendation, we list a series of actions you can take to address the issue at your workplace. The actions at the beginning of each list are preferable to the ones listed later. The list order is based on a well-accepted approach called the “hierarchy of controls.” The hierarchy of controls groups actions by their likely effectiveness in reducing or removing hazards. In most cases, the preferred approach is to eliminate hazardous materials or processes and install engineering controls to reduce exposure or shield employees. Until such controls are in place, or if they are not effective or practical, administrative measures and personal protective equipment might be needed. Read more about the hierarchy of controls at <https://www.cdc.gov/niosh/hierarchy-of-controls/about/index.html>.

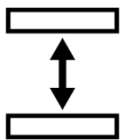


We encourage the company to use a health and safety committee to discuss our recommendations and develop an action plan. Both employee representatives and management representatives should be included on the committee. Helpful guidance can be found in *Recommended Practices for Safety and Health Programs* at <https://www.osha.gov/safety-management>.

Recommendation 1: Reduce risks for musculoskeletal disorders

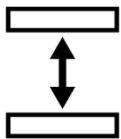
Why? Evidence associates low-back and shoulder disorders with work-related lifting, forceful movements, and awkward postures such as bending, reaching, and twisting. The best way to prevent and control work-related musculoskeletal disorders is through design. Job tasks, workstations, and tools and other equipment should be designed to match the physical capabilities of the employee.

How? At your workplace, we recommend these specific actions:



Make sure that hand working heights on conveyors range 38"–49". Also, consider where the employee handles the load, that is the top, middle, or bottom of the item.

- Reach distances should range 11"–22".
- Provide tools, such as hooks, for employees to bring items closer without reaching.



Provide workstations that adjust for sitting and standing based on employees' job demands.

- Standing workstations are recommended if the job includes heavy lifting, long reaches, or frequent walking. Adjust these as follows:
 - Standing hand working heights should have an adjustability range between 38"–47" or fixed at 42". The display viewing height (top of screen) should have an adjustability range between 58"–71" or fixed at 66". Viewing distance should have an adjustability range between 18"–30" or fixed at 23".
 - Parts bins used during standing work should be placed in front of the employee. The reaching distance to the bins should be less than 16". The bins' vertical height should be 24"–70".
- Seated workstations are recommended if the job is visually demanding. Adjust these as follows:
 - Seated hand working heights should have an adjustability range between 27"–36" or fixed at 36". The display viewing height (top of screen) should have an adjustability range between 35"–46" or fixed at 46".
 - Seated workstation clearance should be greater than 18" for knee depth and greater than 30" for knee width.
 - Parts bins used during work should be placed in front of the employee. Reaching distance to the bins should be less than 16". The bins' vertical height should be less than 46".
 - A height adjustable chair with footrest can be provided, if needed



Provide antifatigue mats for employees who routinely stand as part of their job.

- Mats should be at least 0.5" thick. They should have an optimal compressibility (firmness) of 3%–4% and have beveled edges so they are not tripping hazards. They should be at least 8" under a workstation to keep standing surfaces even.
- Mats should cover the entire area that employees move while performing their work task. They should be replaced when they appear worn out or are damaged.



Replace broken chairs. Make sure all chairs can be adjusted to match the seated hand working heights listed above.



Read recommendations for specific tasks in building in Section D in the Supporting Technical Information.

Recommendation 2: Get regular input from employees about workplace safety and health issues, and use this input to improve conditions

Why? Monitoring employee concerns, satisfaction, and well-being is useful for finding areas of focus for intervention and improvement. Engaging employees and asking for their input about work builds trust and morale. Employees will feel their input is valued and useful for improving working conditions.

How? At your workplace, we recommend these specific actions:



Use employee input to help guide efforts in improving employee safety, health, and well-being.

- Form an active ergonomics committee that includes management, employee, and union representatives. Effective committees use employee input and experience to help determine work practice and engineering controls.
- Provide a chance for ergonomics committee members to receive ergonomics training. Training could include instructor-led or online classes, as well as training offered at national ergonomics conferences. The purpose of training is to learn about practical, cost-effective workplace solutions.

Recommendation 3: Encourage employees to report health concerns they think are work-related to their supervisors

Why? Recognizing symptoms early can reduce severity. Management can regularly review this information to look for common processes that might be related with reported musculoskeletal health symptoms and safety concerns. Management can use this information to identify opportunities for improvement.

How? At your workplace, we recommend these specific actions:



If needed, employees should seek care for work-related medical concerns from a healthcare provider knowledgeable in occupational medicine.

- The American College of Occupational and Environmental Medicine (<https://acoem.org/Find-a-Provider>) and the Association of Occupational and Environmental Clinics (<http://www.aoec.org/index/htm>) maintain databases of providers to help locate someone in your geographic area.

Supporting Technical Information

Ergonomic and Musculoskeletal Evaluation of
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Section A: Workplace Information

Employee Information

The agency employed approximately 1,300 people at this facility at the time of our evaluation.

- Employees were members of a union.
- Median employee age was 34 years (range: 19–70 years).
- Median job tenure was 1 year (range: 1 month–30 years).
- Median agency tenure was 8 years (range: 1 month–32 years).

History of Issue at Workplace

- Management submitted the health hazard evaluation (HHE) request after a triannual evaluation by their headquarters.
- After the headquarters evaluation, musculoskeletal disorders (MSDs) were listed as a primary focus area.

Process Description

- The logistics agency was the second largest of 26 similar facilities at the time of our evaluation.
- The facility consisted of 24 different warehouses. The ergonomic evaluation and employee health evaluation included employees working in four areas of the facility (Building 16, Areas B3 or B5; Building 56, Areas S1 or S3; Building 57, Area S1; and Building 30).
- Distribution process workers and work leaders' job activities included moving material manually and using material handling equipment (MHE) like forklifts or platform lifts; measuring, weighing, and processing materials (verifying content on computers at a workstation); loading and offloading material on delivery trucks; and arranging material on pallets. Employees in Building 30 worked with unitized group rations (UGR), including unpacking food supplies for meals ready to eat (MRE) and assembling MRE boxes on an assembly line.
- The agency operated on three, 8-hour shifts, with second and third shifts operating with a smaller workforce. The same job tasks were performed on all shifts. Employees worked 8 hours per day, 5 days per week. Some employees worked Monday through Friday while others worked Tuesday through Saturday. They had the opportunity to work overtime on additional shifts or over the weekend as needed.
- Job task rotation was mostly informal and depended on daily staffing needs. However, in Building 30, assembly employees rotated every 2 hours and moved two stations at each rotation.

Building 16 Areas B3 and B5

- Small parcel (up to 120 pounds) receiving
- Sorting and packing small items and parcels

Building 56 Areas S1 and S3

- Material receiving, offload, and tally

Building 57 Area S1

- Bulk receiving using MHE

Building 30

- Unloading using MHE, partial pallet pick, de-pack, and MRE assembly line

Section B: Methods, Results, and Discussion

Our objectives were as follows:

- Observe work practices and procedures that may cause MSDs among employees.
- Determine the prevalence of employee symptoms related to work-related ergonomic risk factors.
- Provide recommendations to reduced work-related ergonomic risk factors and MSDs.

Methods: Ergonomics Evaluation

We observed workplace conditions and work practices to identify ergonomic risk factors. We measured workstation heights and reach and viewing distances. Additionally, we noted the availability of antifatigue mats. A description of risk factors for work-related MSDs is provided in Section D.

Results: Ergonomics Evaluation

Building 16 Areas B3 and B5

Area B3 employees rotated between workstations receiving and inspecting small parcels weighing up to 120 pounds. Figure B1 is a photo of one of the workstations. Employees could not adjust the workstation on their own, so maintenance was called to adjust the height. Some stations had antifatigue mats and others had chairs. Employees could not adjust the height or location of monitors or keyboards. Some materials were located at positions (55" or greater) requiring reaching at or above shoulder height.



Figure B1. An example of a workstation in Area B3. Photo by NIOSH.

Area B5 employees rotated on a weekly basis packing outbound material. Employees could not adjust the workstations on their own. Some workstations had arms for monitors and keyboards, however they were not adjustable and keyboard trays were positioned too high and at an awkward angle (see Figure B2). Boxes and other items, including “bogus” paper used for packing, were located at positions requiring reaching at or above shoulder height. We saw one area that had bogus paper on a newer vertical storage. This was preferred because if the vertical bogus paper rolls were removed from the workstations, the upper shelves could be lowered and would reduce employee reach. Employees in this area told us that some stations used to have chairs on the antifatigue mats but the chairs were compressing the mats, so the chairs were removed.



Figure B2. An example of a workstation in Area B5. Photo by NIOSH.

Building 56 Areas S1 and S3

Employees in Area S1 received material that was sent to other facilities on a fast turnover basis. Items were moved via MHE. Employees in Area S3 worked at packing stations. Employees used stock selectors and other MHE to pick items from shelves and bring them back to the workstations. Workstations were not adjustable or had hand-crank tables that employees did not take the time to adjust. Some antifatigue mats were available, but they were too small for the area used and were mostly under chairs. Packing tables had been created using stacks of unused pallets (see Figure B3). This eliminated employees bending at the back to pack items on the floor; however, the use of weight pallet load leveler would help keep the items from being overhead for larger packs.



Figure B3. An example of stacked empty pallets used as packing tables. Photo by NIOSH.

Building 57 Area S1

Employees in this area performed bulk receiving tasks. Some employees used MHE to transport items between areas. The employees used drills to take apart wooden boxes that items were shipped in. The use of inline drills in addition to regular drills could reduce awkward wrist postures. MHE employees rotated between jobs on a weekly basis. Other employees also inspected, counted, and performed warehousing or stocking tasks. We noted workstations that were not adjustable and did not have adjustable chairs. The use of pallet conveyors with powered rollers (not gravity-fed) would help transport material in the area.

Building 30

Employees in this area prepared UGR, which included MREs. This is the only logistics location where this job was performed at the time of our evaluation. Job tasks included unloading, de-packing (unpacking) deliveries, and assembly. We were not able to observe the assembly jobs during our visit because of problems with the box machine. However, it was noted that employees rotated down two workstations every 2 hours. We did observe employees in the de-pack area. We noted that one of the pallet lifts did not compress completely as it was loaded (see Figure B4). This resulted in the material being higher than preferred when stacked on the lift.



Figure B4. Pallet lift holding about 400 pounds, but lifts are not completely compressed. Photo by NIOSH.

Methods: Employee Health

Confidential Medical Interviews

We held voluntary confidential medical interviews with employees who worked in Building 16, Areas B3 or B5; Building 56, Areas S1 or S3; Building 57, Area S1; and Building 30. We interviewed a convenience sample of the 39 total employees in these buildings. Our team was on site to conduct interviews primarily during first shift, but we also interviewed second-shift employees when our time on site overlapped with that shift.

During these interviews, we discussed job tenure and job tasks, musculoskeletal health symptoms and concerns, and relevant medical history. Employees were asked open-ended questions about musculoskeletal pain experienced during the past 3 months. Employees were also asked an open-ended question about what they thought caused their pain. Musculoskeletal pain was classified as potentially work-related if employees reported that the pain was caused by or made worse by an activity they do at work (e.g., lifting).

Record Review

We reviewed Occupational Safety and Health Administration (OSHA) Form 300 Logs of Work-Related Injuries and Illnesses for the years 2013 through 2018. We summarized the entries by year, building, type of injury and activity, and body part affected.

Results: Employee Health

Confidential Medical Interview

In total, 39 employees participated in voluntary confidential medical interviews. Of the 39 employees, 12 reported working in Building 16, Areas B3 or B5; 8 reported working in Building 56, Areas S1 or S3;

8 reported working in Building 57 Area S1; and 14 reported working in Building 30. Three employees reported working in another building or area, including Building 16 Area B2; Building 58; and Building 3. Three employees reported working in more than one building.

Of the 39 interviewed employees, 29 (74%) were male, and the median age was 34 years (range 19–70 years). Most interviewed employees worked first shift (n = 25); 14 employees worked second shift. Interviewed employees reported working in their current positions a median of 1 year, 2 months (range: 1 month–30 years) and reported working for the agency a median of 8 years (range: 1 month–32 years).

Most interviewed employees were distribution process workers and a few work leaders. Management and employees reported that distribution process workers were qualified to perform most warehouse-related job tasks throughout the agency’s warehouses. They performed a variety of tasks, including packing and unpacking boxes, loading and offloading boxes and pallets from trucks, selecting material from the warehouse, stowing material in the warehouse, opening boxes or crates, rearranging pallets, and inspecting and verifying the contents of packages. These tasks were performed while operating a forklift or other MHE or while standing/sitting on the warehouse floor, in an assembly line, or at a workstation.

Of the 39 interviewed employees, 16 (41%) reported potentially work-related pain during the past 3 months (Table C1). The most common sites of potentially work-related pain were the back (n = 11) and shoulders (n = 4). Of the 11 employees who reported work-related back pain, 4 reported working in Building 56, Area S1 or S3; 3 reported working in Building 57, Area S1; 3 reported working in Building 16, Areas B3 or B5; and 3 reported working in Building 30. Common work activities among these employees included packing and unpacking boxes, loading and offloading boxes from trucks, using forklifts and other MHE, selecting and stowing material in the warehouse, and working at workstations and the MRE assembly line.

Of the 11 employees who reported work-related back pain, 9 responded to an open-ended question about how often they used a two-person lift. Answers varied whether two-person lifts were always utilized, but lifting was a common theme among employees with work-related back pain. Of the four employees who reported work-related shoulder pain, three reported working in Building 16, Areas B3 or B5. Work activities among these employees included examining material, selecting and stowing material, packing and unpacking material, and working at workstations, the material sorting chute, or the MRE assembly line.

Of the 16 interviewed employees with work-related pain, eight (50%) had ever been diagnosed with a related musculoskeletal disorder. Of the 11 employees who reported work-related back pain, 4 had ever been diagnosed with a related musculoskeletal disorder.

Of the 15 interviewed employees who had ever been diagnosed with a musculoskeletal disorder, 8 (53%) were diagnosed after they started working at the agency. These diagnoses included muscle strains; tendinitis of the elbow, shoulder, and wrist; torn meniscus and medial collateral ligament (MCL); torn rotator cuff; and torn shoulder tendon. However, some employees noted that their symptoms began before working at the agency, and they waited to see a doctor, or that the injury occurred outside of work.

Record Review

During 2013–2018, there were 265 OSHA Log entries recorded for the site. The number of entries was greatest in 2013 (n = 61) and ranged between 31 and 47 entries per year during 2014–2018 (Table C2). Among the buildings included in this evaluation, OSHA Log entries (2013–2018) most commonly occurred in Building 30 (n = 50) and Building 16, Areas B3 and B5 (n = 31). Musculoskeletal strains, sprains, pain, and disorders were the most common type of injury reported (n = 173), followed by contusions, lacerations, or impalements (n = 56). Injuries were frequently acquired while manually handling material (n = 102) or during a slip, trip, or fall (n = 44). Thirty injuries involved MHE, such as forklifts or platform lifts, and 30 injuries involved equipment other than MHE. Injuries were also acquired while moving around the facility by foot (n = 16) and when struck by an object (n = 14). Overall, Log entries were injuries involving the upper and lower back (n = 58), shoulder (n = 37), hands or wrists (n = 35), or fingers (n = 32). Injuries to the knees, feet or ankles, arms, elbows, neck, leg, head and face, and eyes were also reported.

Discussion

Work activities, such as extended reaching, bending at the back, lifting items from various levels, and prolonged standing, whether observed by us or reported by employees, could explain the musculoskeletal symptoms, injuries, and disorders that affected employees throughout the facility. Similar activities were listed in descriptions of the incident on the OSHA Logs. Redesigning job tasks and workstations as well as decreasing the duration of continuous repetitive movements (e.g., rotation to jobs that use different muscle groups) are well accepted measures that should reduce employees' risk for MSDs. Additionally, some studies have shown that small increases in break times have decreased symptoms with no significant effect on productivity [Dababneh et al. 2001; Faucett et al. 2007; Galinsky et al. 2007].

A review of participatory ergonomic processes found that training can be tailored to specific workplace risks and hazards or targeted solutions [van Eerd et al. 2010]. However, reaching goals depends on multiple considerations such as creating teams with appropriate members (employees, union, and employers); defining team members' responsibilities; making decisions using group consultations; providing ergonomic training; and addressing key factors that could help or hinder the process [van Eerd et al. 2010].

Limitations

This evaluation was subject to limitations. The observations of job tasks were limited to the days when the evaluation occurred. Additionally, we were only able to document concerns and symptoms that were reported to us during our evaluation by current employees who chose to participate.

Conclusions

Most employees with work-related back and shoulder pain reported job tasks including packing, unpacking, and working at workstations. Our ergonomic evaluation identified potential hazards related to these job tasks, including improper workstation design, prolonged standing without antifatigue mats, and overreaching. Ensuring the appropriate ergonomic design of workstations might reduce work-related musculoskeletal pain among employees.

Section C: Tables

Table C1. Number and percentage* of interviewed employees (n = 39) who reported musculoskeletal pain lasting a whole day or more during the last 3 months

Pain location	No. (%) employees reporting pain	No. (%) employees reporting work-related pain
Any pain	17 (44)	16 (41)
Back	11 (28)	11 (28)
Shoulder	6 (15)	4 (10)
Knee	4 (10)	3 (8)
Hand/wrist	3 (8)	3 (8)
Elbow	2 (5)	2 (5)
Neck	2 (5)	2 (5)
Other	4 (10)	3 (8)

* Percentages do not sum to 100% because employees could report pain in more than one location.

Table C2. Number and percentage of OSHA Form 300 Logs of Work-Related Injuries and Illnesses, 2013–2018 (n = 265)

	2013	2014	2015	2016	2017	2018	Total
Building							
16 Areas B3, B5	8 (13)	5 (11)	3 (10)	2 (5)	8 (17)	5 (14)	31 (12)
56 Areas S1, S3	2 (3)	0 (0)	0 (0)	2 (5)	1 (2)	2 (5)	7 (3)
57 Area S1	1 (2)	2 (4)	0 (0)	3 (7)	3 (6)	3 (8)	12 (5)
30 (UGR)	8 (13)	17 (36)	6 (19)	8 (19)	7 (15)	4 (11)	50 (19)
Other	42 (69)	22 (47)	22 (71)	25 (60)	28 (60)	21 (57)	160 (60)
Missing	0 (0)	1 (2)	0 (0)	2 (5)	0 (0)	2 (5)	5 (2)
Type of injury*							
Musculoskeletal strain, sprain, or pain	46 (75)	35 (74)	19 (61)	24 (57)	30 (64)	19 (51)	173 (65)
Contusion, laceration, impalement	13 (21)	8 (17)	10 (32)	8 (19)	10 (21)	7 (19)	56 (21)
Fracture	1 (2)	1 (2)	1 (3)	3 (7)	3 (6)	2 (5)	11 (4)
Other	1 (2)	2 (4)	2 (6)	8 (19)	3 (6)	2 (5)	18 (7)
Missing	0 (0)	1 (2)	1 (3)	1 (2)	2 (4)	7 (19)	12 (5)
Type of activity*							
Manually handling material	26 (43)	25 (53)	6 (19)	14 (33)	21 (45)	10 (27)	102 (38)
Slip, trip, or fall	11 (18)	7 (15)	7 (23)	7 (17)	5 (11)	7 (19)	44 (17)
Involved MHE	5 (8)	6 (13)	4 (13)	6 (14)	6 (13)	3 (8)	30 (11)
Involved other equipment (non-MHE)	8 (13)	7 (15)	4 (13)	8 (19)	3 (6)	3 (8)	33 (12)
Moving around the facility by foot†	4 (7)	1 (2)	3 (10)	2 (5)	4 (9)	2 (5)	16 (6)
Struck by an object	1 (2)	3 (6)	3 (10)	1 (2)	3 (6)	3 (8)	14 (5)
Other	7 (11)	2 (4)	4 (13)	4 (10)	6 (13)	2 (5)	25 (9)
Missing	1 (2)	1 (2)	0 (0)	2 (5)	0 (0)	8 (22)	12 (5)
Body part affected*							
Upper and lower back	11 (18)	16 (34)	9 (29)	13 (31)	4 (9)	5 (14)	58 (22)
Shoulder	11 (18)	8 (17)	3 (10)	2 (5)	6 (13)	7 (19)	37 (14)
Hand and wrist	8 (13)	3 (6)	3 (10)	7 (17)	9 (19)	5 (14)	35 (13)
Finger	6 (10)	6 (13)	5 (16)	3 (7)	8 (17)	4 (11)	32 (12)
Knee	11 (18)	2 (4)	3 (10)	3 (7)	4 (9)	2 (5)	25 (9)
Foot or ankle	2 (3)	2 (4)	3 (10)	2 (5)	7 (15)	3 (8)	19 (7)
Arm	5 (8)	3 (6)	0 (0)	0 (0)	4 (9)	1 (3)	13 (5)
Elbow	1 (2)	0 (0)	4 (13)	3 (7)	1 (2)	1 (3)	10 (4)
Neck	1 (2)	1 (2)	3 (10)	1 (2)	4 (9)	3 (8)	13 (5)
Leg	1 (2)	3 (6)	1 (3)	2 (5)	2 (4)	0 (0)	9 (3)
Head and face	2 (3)	0 (0)	2 (6)	2 (5)	0 (0)	2 (5)	8 (3)
Eye	0 (0)	0 (0)	0 (0)	4 (10)	2 (4)	1 (3)	7 (3)
Other	5 (8)	6 (13)	2 (6)	5 (12)	2 (4)	3 (8)	23 (9)
Missing	0 (0)	0 (0)	0 (0)	1 (2)	1 (2)	3 (8)	5 (2)
Total	61 (23)	47 (18)	31 (12)	42 (16)	47 (18)	37 (14)	265 (100)

* Numbers and percentages for type of injury or illness, activity, and body part affected may vary because OSHA 300 Log entries allow for listing more than one type of injury or illness, activity, and body part.

† Does not include slips, trips, and falls.

Section D: Occupational Exposure Limits

Risk factors for Work-related Musculoskeletal Disorders

MSDs are conditions that involve the nerves, tendons, muscles, and supporting structures of the body. They can be characterized by chronic pain and limited mobility. Work-related musculoskeletal disorder refers to (1) MSDs to which the work environment and the performance of work contribute significantly, or (2) MSDs that are made worse or longer lasting by work conditions. A substantial body of data provides strong evidence of an association between MSDs and certain work-related factors (physical, work organizational, psychosocial, individual, and sociocultural). The multifactorial nature of MSDs requires a discussion of individual factors and how they are associated with work-related MSDs.

Strong evidence shows that employees whose work tasks involve high levels of static contraction, prolonged static loads, or extreme working postures involving the neck/shoulder muscles are at increased risk for neck/shoulder MSDs [NIOSH 1997]. Furthermore, strong evidence shows job tasks that require a combination of risk factors (highly repetitive, forceful hand/wrist exertions) increased the risk for hand/wrist tendonitis [NIOSH 1997]. Finally, evidence shows that low-back disorders are associated with work-related lifting and forceful movements, awkward postures such as bending and twisting, and whole-body vibration [NIOSH 1997].

A number of personal factors can also influence the response to risk factors for MSDs: age, sex, smoking, physical activity, strength, and body measurements. Although personal factors may affect an individual's susceptibility to overexertion injuries/disorders, studies conducted in high-risk industries show that the risk associated with personal factors is small compared to that associated with occupational exposures [NIOSH 1997].

In all cases, the preferred method for preventing and controlling work-related MSDs is to design jobs, workstations, tools, and other equipment to match the physiological, anatomical, and psychological characteristics and capabilities of the employee. Most of the recommendations provided in this report were adapted from principles outlined in *The Handbook of Ergonomic Design Guidelines* [Humantech 2009]. Under these conditions, exposures to risk factors considered potentially hazardous are reduced or eliminated.

Recommendations for specific buildings include the following:

- Building 16 Area B3
 - Refer to recommendations for workstations, mats, and chairs in the Main Report. Pay particular attention to the non-adjustable workstations.
- Building 16 Area B5
 - Refer to previous recommendations for workstations, mats, and chairs in the Main Report.
 - Provide new vertical bogus paper holders for each workstation. Remove old bogus paper bars from behind workstations.

- Once paper bars are removed, lower workstation shelves to reduce shelf reach distances.
- Remove keyboard trays and place on workstation counter.
- Consider cutting the counter for each sorter station to reduce reach distances.
- Building 56 Areas 1–3
 - Refer to recommendations for workstations, mats, and chairs in the Main Report. Pay particular attention to the crank-adjustable tables that employees do not adjust.
 - Replace one cube at each packing station with a load leveler for the larger, heavier pallets.
- Building 57 Area 1
 - Refer to recommendations for workstations, mats, and chairs in the Main Report. Pay particular attention to the small office desks with broken chairs.
 - Provide pallet conveyors with powered rollers for packing stations.
 - Provide inline drills for use on wooden crates.
 - Rotate MHE operators on a more frequent basis, possibly daily or every 2 hours.
- Building 30
 - Adjust the springs on pallet lifts in the de-pack area to accommodate the weight of different materials and assign areas for different weight items (e.g., light, medium, heavy).
 - A full pallet should almost touch the floor; this would place the product to be removed at approximately waist height.
 - Conversely, an empty pallet should start at waist height and lower as product is added.
 - Ensure that the employee rotation at the assembly lines does not require the employee to use the same muscle group back-to-back.
 - Although we did not see the assembly lines in action, it was explained that employees rotate two stations down the line so they were not performing the same task continuously. However, we noticed that employees may still be using the same muscle groups when they rotate between stations.

Section E: References

Discussion

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