U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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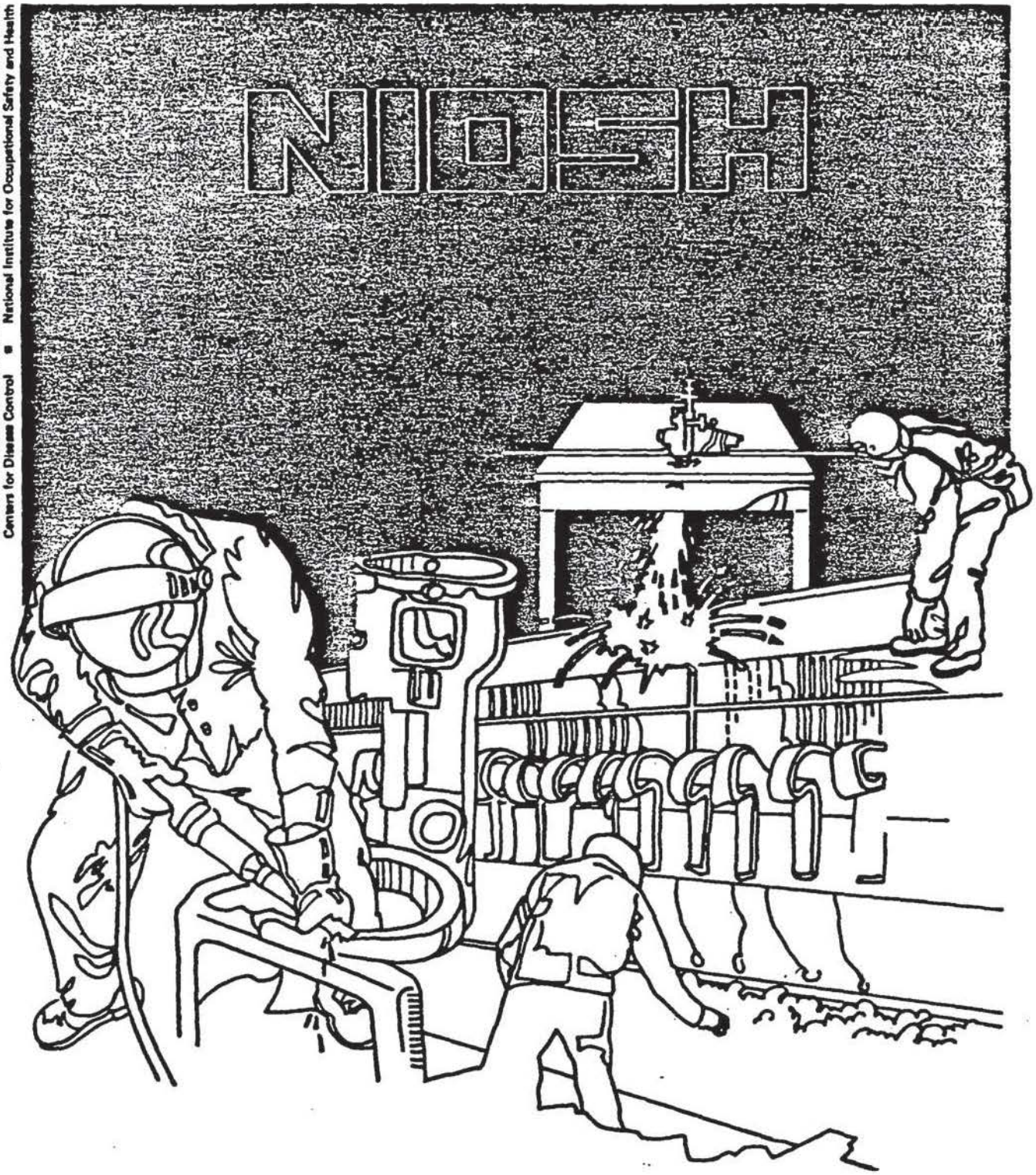

Health Hazard Evaluation Report

HETA 82-229-1286
AMERICAN STANDARD, INC.
WAUREGAN, CONNECTICUT

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial nygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 82-229-1286
APRIL 1983
AMERICAN STANDARD, INC.
WAUREGAN, CONNECTICUT

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I. SUMMARY

In July 1982, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation at American Standard, Inc., Wauregan, Connecticut. The study was requested by the company and union as part of a settlement agreement of a 1980 citation by the Occupational Safety and Health Administration (OSHA) against the company for alleged hazardous lifting conditions. This facility manufactures chinaware plumbing fixtures (toilets, lavatories, and bidets). Many of the jobs involving heavy lifting (43-73 lbs.) and other manual materials handling tasks.

The study consisted of a review of accident records and an ergonomic assessment of potentially hazardous lifting tasks. Photographs and movies were taken to aid in the ergonomic evaluation.

The overall injury rate (May 1, 1981 - June 30, 1982) for the plant was 13.7/200,000 work hours (equivalent to 100 person-years of work). The most frequent injury was a back muscle strain, sprain, pull or tear. The Refire Department had the highest injury rate, 27.4/200,000. The Casting Department had the second highest rate, 19.9/200,000. The majority of the injuries in the Casting Department occurred in the Mechanized Assist Bench (MAB) and the Bowl Conveyor areas. Every job analyzed exceeded the Action Limit (AL), that weight limit, as described in the NIOSH Work Practices Guide for Manual Lifting[1], above which administrative controls are required. Those in MAB either exceeded or were very near the Maximum Permissible Limit (MPL), the weight limit above which the task is considered unacceptable without mechanical lifting aids.

On the basis of the information collected during this investigation, NIOSH determined that a health hazard existed at the time of this evaluation from tasks which involved the lifting, pushing, or pulling of chinaware plumbing fixtures. Recommendations for decreasing and/or preventing the occurrence of related musculoskeletal conditions are presented in Section VIII of this report.

KEYWORDS: SIC 3261 (Vitreous China Plumbing Fixtures), musculoskeletal disorders, manual lifting, fatigue, chinaware fixtures, plumbing fixtures

II. INTRODUCTION

On July 20 and 21, 1982 the National Institute for Occupational Safety and Health (NIOSH) conducted a Health Hazard Evaluation at American Standard, Inc., Wauregan, Connecticut. The request, which was jointly submitted by management and labor, was part of a settlement agreement of a 1980 citation by the Occupational Safety and Health Administration (OSHA) against the company for allegedly subjecting its employees to hazardous lifting conditions. Accident records at the time of the citation indicated a high prevalence of injuries (such as back strains, hernias, leg trauma) related to manual material handling tasks. NIOSH was asked to evaluate whether lifting hazards existed during the period cited, if they continue to exist and, if so, "whether technologically feasible abatement measures are available and appropriate to correct such hazards".

III. BACKGROUND

At this facility American Standard manufactures chinaware plumbing fixtures, specifically toilets, lavatories and bidets. The production process is organized as follows: first, the molds are assembled and a liquid slip (clay and other materials) is poured into them. This latter phase is referred to as casting. Moisture absorbs into the molds and the slip solidifies to form "greenware". This greenware, which is very fragile, is then loaded onto two- or three-tiered carts and allowed to air dry. (The levels of the shelves on these carts range from 17 1/2 to 65 inches.) Next, the product is placed onto a conveyor line and sprayed with a glaze. The parts are then loaded onto kiln carts for firing in ovens. Once fired these parts are again loaded onto two- or three- tiered carts and moved to inspection. After inspection, the chinaware is moved to the packing department for shipment. Products which fail inspection are taken to the epoxy department for repair, to "refire" (kiln), reinspection, etc.

The manufacturing process is partially mechanized with the use of conveyor belts and mechanical assists for lifting. Between several stages, however, employees must lift parts. The weight of the fixtures to be lifted varies. They are heaviest after they are first cast, i.e., as greenware, and the weight decreases as the product dries. Greenware typically weighs between 43-73 lbs; weight loss from water evaporation is approximately 6% in the finished product.

Of the approximately 360 hourly employees at the plant, 100-150 are involved in manual materials handling, i.e., lifting of porcelain toilet components and lavatories. New employees receive a preemployment medical examination by a local physician, which includes a standard medical history, occupational history, physical examination

and routine laboratory tests. The same physician evaluates most employee injuries requiring medical attention. While a first aid facility is present at the plant, no nurse is in attendance. Any employee requiring immediate medical attention is taken to a local hospital emergency room.

The Safety Director reviews the Job Safety Analysis (JSA)* with all new employees and with any current employee who bids on a new job. When an accident occurs, it is the responsibility of the foreman to complete the accident report, comment on the reason for the accident, and carry out any recommendations made for preventing future accidents.

The most frequent management recommendation made on the accident reports is to review the JSA with employees for proper lifting and handling procedures. Other frequent comments include: "employee must slow down"; "keep back straight - lift with legs"; "use more caution while lifting"; and "initiate a program of stretching exercises at beginning of shift."

IV. Design and Methods

A. Medical Record Review

A NIOSH Medical Officer reviewed reports of accidents at the plant for the years 1981-82. For the period February 1981- April 1982, accidents were recorded on "Employee Injury/Illness Investigation Reports", which include all OSHA recordable (OSHA 200 log) cases. After April 1982, accidents are recorded on "Supervisor's Report of Accident Investigation" (OSHA 101) forms. Detailed records of man-hours worked in each department were available for May 1, 1981 - June 30, 1982. Consequently, analysis of accident records was restricted to these dates in order to permit calculation of incidence rates of injuries (number of injuries/200,000 work hours**) by department.

*JSA: A type of task assessment wherein a job is broken down into components and analyzed for potential safety hazards. The purpose of such an analysis is to develop solutions such as job redesign or employee training to mininize the identified hazards.

**Equivalent to 100 person-years of work, i.e., 100X2000hrs=200,000

Injuries sustained while lifting, pushing, or pulling chinaware were used to calculate incidence rates. Included were injuries to the back, limbs, shoulders, groin, and wrists. These injuries fall into the following categories on the OSHA 101 form: sprains, strains, hernias, rupture, and inflammation of joints, tendons, and muscles. Excluded were lacerations, bruises, and fractures. Also excluded were injuries such as "twisted ankle while turning", "traumatic synovitis of knee - struck knee", and "foot strain secondary to a fall" not sustained while lifting.

B. Ergonomic Analysis

Ergonomic specialists observed the work processes, selected those with potentially hazardous lifting conditions and measured the lifting heights and frequencies, and load weights. This data was then analyzed according to the procedures outlined in the NIOSH Work Practices Guide (WPG) for Manual Lifting[1] to determine safe load limits. Movies and photographs of various lifting tasks were also taken to aid in the analysis.

Each job analyzed was first broken down into components. A job analysis was then done on each component task with its associated frequency. Next, the task was evaluated using an average vertical height where it was assumed that lifting to this height was done for the entire lifting time (total frequency). For each task condition an Action Limit (AL) and a Maximum Permissible Limit (MPL) according to the NIOSH Work Practices Guide for Manual Lifting (WPG)[1] was determined. Job elements which involved lowering rather than lifting were not calculated individually but were figured in the "average" lifting height (vertical travel).

V. Evaluation Criteria

The NIOSH Work Practices Guide[1] was developed using medical, scientific, and engineering resources to develop quantitative recommendations regarding the safe load weight, size, location, and frequency of a lifting task.[1] The recommendations assume that

1. the lift is smooth
2. the lift is two-handed and symmetric in the sagittal plane (directly in front of the body with no twisting during the lift)
3. the load is of moderate width, i.e., 30 inches or less
4. the lift is unrestricted
5. the load has good couplings (handles, shoes, floor surface)
6. the ambient environment is favorable

It is further assumed that other material handling activities such as holding, carrying, pushing, and pulling are minimal; that the individual performing the lifting activities is at rest when not lifting; and that those involved in lifting are physically fit and accustomed to labor.

The formula used to analyze the various tasks is as follows:

Action Limit (AL) (lbs) = 90 (6/H) (1-.01 V-30) (.7+ 3/D) (1-F/Fmax); (MPL = 3 AL); where

H = horizontal location forward of midpoint between ankles at origin of lift

V = vertical location at origin of lift

D = vertical travel distance between origin and destination of lift

F = average frequency of lift (lifts/minute)

Fmax = maximum frequency which can be sustained (table of values provided in Work Practices Guide)

Tasks analyzed in this manner are divided into three categories:

1. those above the Maximum Permissible Limit (MPL) which are considered unacceptable and which require engineering controls
2. those between the AL and MPL which are unacceptable without administrative or engineering controls
3. those below the AL which are believed to represent nominal risk to most industrial workforces.

As indicated in the Work Practices Guide, corrective action is needed for jobs which exceed the Action Limit for several reasons including the finding that the incidence and severity rates of musculoskeletal injury have been found to increase in populations "exposed to lifting conditions" described by the Action Limit. It has been determined that over 75% of women and over 99% of men could (safely) lift loads described by the Action Limit. [1]

VI. RESULTS

A. Medical Records

The types of injury by department for the period May 1, 1981- June 30, 1982 are listed in Table 1. The overall injury rate was 13.7/200,000 work-hours. The most frequent injury incurred (30 of 67 cases) was a back muscle strain, sprain, pull or tear. Injury rates by department for the same time period are listed in Table 2. The Refire Department had the highest injury rate, 27.4/200,000. The Casting Department

had the next highest rate, 19.9/200,000. The Casting Department is divided into two main areas: (1) Miscellaneous and Shop, which includes MAB (Mechanical Assist Bench), BCU (Battery Cast Unit), and Bench and (2) the Automatic Conveyors, which includes Bowl, Tank, and Lava conveyors. The majority of the injuries in this department (22 out of 32) occurred in Miscellaneous and Shop (injury rate 22.1/200,000), specifically MAB and BCU, and most involved the back. The injury rate in Glost Inspection was 7.3/200,000 and in GIS (Green Inspection), 18.1/200,000.

B. Ergonomic Analysis

The results of the physical stress job analyses are presented in Table 3. In columns 5, 6, and 7 the Action Limit (AL), the Maximum Permissible Limit (MPL), and the actual weight of the load lifted are listed. Comparision of the actual weight and the Action Limit (columns 6 and 7) shows that all the jobs analyzed exceed the Action Limit. Jobs in the Automatic Conveyor Department (except for H-Station) were closest to the Action Limit; jobs in BCU were also close to the AL. Only one job exceeded the MPL (MPL=69.4 lb, actual weight, 73 lb). This involved lifting a #3065 (toilet, weight 71-73 lbs) which was in the MAB Casting Department . The two remaining jobs in this department which were analyzed did not exceed the MPL but were very close to it (MPL 66.4; actual weight, 61 lb).

VII. DISCUSSION

The approach used to calculate rates of lifting-related injuries at American Standard yields a conservative estimate of the magnitude of the health problem for two reasons. First, less severe injuries are excluded, either because they are not OSHA-reportable, or because they are not brought to the attention of a foreman. Secondly, individuals with chronic low back pain, possibly resulting from or exacerbated by manual lifting, may be excluded, since only acute injuries are considered in this analysis.

It is difficult to compare the calculated injury rates with data in the literature. Injury incidence rates are rarely reported. More commonly, the proportion of workers at a particular time (prevalence) complaining of lower back pain is determined. Comparison is also difficult because of varying definitions as to what constitutes an injury. In some cases only low back pain is considered, while other studies include a variety of injuries possibly related to lifting. Consequently, in this study, it is more appropriate to use the calculated rates to compare incidence of lifting-related injuries between departments, rather than comparing rates in any one department to some absolute standard.

Using this approach, the Refire Department clearly has the highest rate of injuries, while Casting and GIS have injury rates higher than the overall rate for the plant. It should also be noted that all four individuals with a history of carpal tunnel syndrome work in the Casting Department, which suggests a potential problem of wrist stress in this area.

A possible explanation for the high rate of injury in the Refire Department is the fact that part of the job involves holding the chinaware at arm's length while it is placed upon the kiln cart. (See Figure 1) The manual material handler performing this task must assume a very awkward and precarious posture, e.g., standing on the edge of the lower shelf, in order to reach the center and furthermost areas of the top shelf of the cart. Moreover, the ware has already been fired and has a glossy finish which is slick and is, thus, harder to handle. Davis and Stubbs[2] reported that loads held at arms' length should not exceed 10 Kg or 22 lbs; most of the loads in this job far exceed this amount.

The physical stress job analysis approach used to determine the Action Limit and the Maximum Permissible Limit for the jobs analyzed in most cases underestimates the hazard associated with these tasks. The assumptions upon which the formula in the NIOSH Work Practices Guide is based are not always met by the jobs to which the equation was applied at American Standard. Many factors such as asymmetric lifting, twisting movements and handling slippery loads, which tend to reduce the amount of weight which can be safely lifted, cannot be considered by the NIOSH formula. Also, the calculation assumes that between lifts the worker is resting and that other materials handling activities are minimal. In making chinaware such as toilets, however, other activities such as "topping off", applying gooey, punching holes, cleaning up, flipping toilets and wetting them down, typically occur. Workers must also push loaded carts to the drying area. On the other hand, factors which tend to increase the amount of weight that can be lifted in a given situation, such as transfer of body momentum while lifting, also cannot be considered in the formula. This particular assist to lifting occurs in most of the observed lifting jobs at American Standard.

Numerous studies have documented a high prevalence of back disorders in workers involved in frequent heavy lifting[3]. Repeated lifting also increases the frequency and severity of other musculoskeletal strain/sprain injuries[4]. The accident and workers' compensation records at American Standard document numerous injuries directly related to manual handling of chinaware.

The most frequent management recommendation for dealing with lifting-related injuries at American Standard is to review proper lifting procedures with the affected employee. Snook et al[5] demonstrated that training in safe lifting procedures is not an effective control for low back injuries. Designing the job to fit the worker (ergonomics), while not a panacea, can help reduce the rate of low-back injuries. The ergonomic method may be initially more costly than training in safe lifting procedures, but this is offset by the costliness of workers' compensation claims for low back injuries[5]. Thus, by reducing the injury toll among workers and the cost to the company of workers' compensation claims, the ergonomic approach makes good medical and economic sense. Placement programs using strength performance criteria have also been shown to be effective in matching worker capabilities to job demands[6].

VIII. RECOMMENDATIONS

An ergonomic evaluation of operations at American Standard, Inc. identified several potentially hazardous manual materials handling tasks, based on information contained in the NIOSH WPG. This document represents the current state of the art in lifting hazard identification and control. The guidelines contained in it are accepted as being reasonable and reflecting sound ergonomic principles. Accordingly, the recommendations made to American Standard are considered to be technologically feasible, particularly in view of the fact that each one satisfies one or both of the following criteria:

1. the use of a work practice or piece of equipment currently in place at the plant.

2. the use of devices found in other similar factories, e.g., mechanical lifts and overhead drying areas, or the implementation or work practices and equipment used commonly in general industrial plants, e.g., job/worker matching programs and textured gloves.

The following recommendations are offered:

1. Provide mechanical lifts for transporting toilets in the MAB area onto two-and three-tiered carts. The lower shelf is too low on each type of cart (Figure 2). The weight of the toilets is the greatest biomechanical stress-producing factor. Redesigning carts and work stations would reduce the hazard of manual lifting, but would not be as effective as the use of mechanical lifting aids.

2. Encourage workers to use mechanical devices and safe work practices which already exist, for example, lift platforms in the mold soak area, the flipping mechanism in the MAB area, and two-man lifts in the mold soak area.

3. Replace the bladder in the MAB area with an hydraulic gooey machine similar to the one used in the conveyor line.

4. Eliminate all manual lifting above shoulder height (Figure 5) In most situations, this would preclude the use of the third tier on three-tiered carts.

5. Provide workers in the Refire and Inspection Departments with rubber or textured gloves to make slippery surfaces easier to handle (Figures 3 & 4).

6. Instruct workers in the Packing and Refire Departments not to reach across pallets or kiln carts when loading (Figures 1 & 4), but rather to position themselves so that reach distance is minimized.

7. Institute a job/worker matching program based on strength performance criteria in all areas where ergonomic analyses were done in this survey.

8. Install mechanical lifts in all areas or situations where three-tiered carts are used: unloading onto conveyor line, and unloading conveyor after Glost, and H-station.

9. Provide a mechanical lift device for kiln loading and unloading.

10. Consider installing overhead drying areas for greenware to eliminate the necessity for loading fixtures onto carts and moving them to drying booths.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. Work Practices Guide for Manual Lifting. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. DHHS (NIOSH) Publication No. 81-122.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. International Brotherhood of Pottery and Allied Workers, Local 301, Wauregan, Connecticut
2. American Standard Inc., Wauregan, Connecticut
3. American Standard Plumbing Products, New Brunswick, New Jersey
4. NIOSH, Region I
5. OSHA, Region I

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1

Type of Injuries by Department

	Before	Casting	GIS	Shipping	Packing	Glost	Mold Shop	Maintenance	Kiln	Total
Muscle strain, sprain, pull or tear										
Back	8	13	4	1	3			1		30
Shoulder	3		2						1	6
Groin		1	1			1				3
Wrist		1				1				2
Hand/arm		2	1				1	1		5
Chest		1	1							2
Unidentified			1							1
Carpal tunnel syndrome		4								4
Tendonitis										
Wrist		2				1				3
Arm			1							1
Muscle spasms										
Arm		1								1
Back		2	1							3
Bursitis		2		1						3
Tenosynovitis, arm		1								1
Torn cartilage, knee		1								1
Thoracic outlet syndrome		1								1
Total	11	32	12	2	3	3	1	2	1	67

Table 2

Injury* Rates by Department: May 1, 1981 - June 30, 1982

Department	No. injuries	Man-hours	Injuries/200,000 man-hours
Refire (Incl. epoxy)	11	80,281	27.4
Casting	32	322,241	19.9
Misc. & shop (Incl. MAB, BCV, Bench)	22	198,685	22.1
Conveyors	10	123,556	16.2
Bowl	7	76,727	18.2
Tank	1	13,232	15.1
Lava	2	33,597	11.9
GIS	12	132,525	18.1
Shipping	2	29,639	13.5
Packing	3	73,186	8.2
Glost Inspection	3	81,810	7.3
Mold shop	1	30,910	6.5
Maintenance	2	121,123	3.3
Kilns	1	65,253	3.1
Slip house	0	16,133	0.0
Glaze room	0	11,219	0.0
Store room	0	8,422	0.0
QA	0	1,076	0.0
Warehouse	0	3,969	0.0
	67	977,796	13.7

*Includes injuries sustained while lifting, pushing, or pulling chinaware (See Evaluation Design for details)

TABLE 3

PHYSICAL STRESS JOB ANALYSES BY DEPARTMENT AND AREA

Department Area	Description of Task	Vertical Travel	Frequency* (per min)	Action Limit(AL) lbs	Maximum Permissible Limit (MPL) lbs	Maximum Weight of load (lbs)	Comments
I. CASTING							
A. Miscellaneous & Shop							
1. Mechanical Assist Bench (MAB)	3065 from 37" conveyor to 2-tiered cart	to lower shelf	0.17	----	----	73	a lower**
		to upper shelf	0.17	25.7	77.1		close to MPL
		average	0.33	23.1	69.4		average D=14.5"; exceeds MPL
	3082 from 37" conveyor to 3-tiered cart	to lower shelf	0.14	----	----	61	a lower
		to middle shelf	0.14	25.7	77.1		
		to upper shelf	0.14	20.8	62.4		close to MPL
		average	0.42	22.1	66.4		average D = 17.3"; close to MPL
	3089 from 37" conveyor to 3-tiered cart	to lower shelf	0.12	----	----	61	a lower
		to middle shelf	0.12	25.7	77.1		
		to upper shelf	0.12	20.6	61.7		close to MPL
		average	0.37	22.1	66.4		close to MPL
2. Battery Cast Unit (BCU)	350 and 351 from 31 1/2" conveyor to 2-tiered cart	to lower shelf	0.21	----	----	55	a lower
		to upper shelf	0.21	43.3	130.0		
		average	0.42	42.0	125.9		average D = 15.8"
	350 and 351 from 32" conveyor to 2-tiered cart	to lower shelf	0.43	----	----	55	a lower
		to upper shelf	0.43	44.8	134.5		
		average	0.87	42.5	127.5		average D = 15.8"
	9140 from 32" conveyor to 2-tiered cart	to lower shelf	0.19	----	----	64	a lower
		to upper shelf	0.19	44.3	132.9		
		average	0.38	43.4	130.2		average D = 15.8"
B. Automatic Conveyor							
1. Bowl	H-station 41" conveyor to 3-tiered cart	to lower shelf	0.22	----	----	60	a lower
		to middle shelf	0.22	31.7	95.2		
		to upper shelf	0.22	26.3	78.9		
		average	0.69	27.1	81.3		average D = 16"
2. Tank	30" conveyor to 3-tiered cart	to lower shelf	0.42	----	----	45	a lower
		to middle shelf	0.42	49.8	149.3		
		to upper shelf	0.42	41.4	124.1		
		average	1.25	41.8	125.4		average D = 19.7"
3. Lava	30" conveyor to whirler (38")	to lower shelf	0.25	----	----	46.5	a lower
		to upper shelf	0.25	44.6	133.9		
		average	0.50	39.3	117.9		average D = 15.8"
II. REFIRE	load 9140 from 2-tiered cart to upper shelf of kiln cart (52")	from lower shelf	0.21	34.1	102.2	64	figured on an average of 25 parts/hr
		from upper shelf	0.21	41.6	124.9		
		average	0.42	41.5	124.4		average V = 31.8", Average D = 20.3"
III. GLOST INSPECTION	load all finished products from hand truck to 31" conveyor	from lowest level	0.75	23.8	71.5	Variable up to about 70	close to MPL
			0.75	33.6	100.8		
			0.75	----	----		a lower
		from highest level	0.75	----	----		a lower
		average	3.0	28.9	86.7		average D = 15", Average V = 26.5"

TABLE 3

PHYSICAL STRESS JOB ANALYSES BY DEPARTMENT AND AREA

Department Area	Description of Task	Vertical Travel	Frequency* (per min)	Action Limit(AL) lbs	Maximum Permissible Limit (MPL) lbs	Maximum Weight of load (lbs)	Comments
IV. GREEN INSPECTION (GIS)	load from inspection/ finish line (34") conveyor to 3-tiered cart before manual spraying	to lowest shelf	1.23	----	----	Variable up to 73	a lower
		to middle shelf	1.23	43.7	131.2		
		to highest shelf	1.23	34.8	104.9		average D = 15"
		average	3.7	30.7	92.0		
	unload 3-tiered cart to to manual spray line conveyor (34")	from lowest shelf	1.23	35.2	105.8	Variable up to 73	
		from middle shelf	1.23	----	----		a lower
		from highest shelf	1.23	----	----		a lower
		average	3.7	29.1	87.2		average D =15"; average V = 41.3
V. PACKING	unload and stack final product from 12" conveyor onto hand cart-4-high	average (lavas)	3.0	30.0	89.9	Variable up to 70	average D = 16", H = 10 1/2"
		average (bowls)	3.0	16.3	48.9		H = 19 1/2"; most items will exceed MPL

* Frequency = average lifts per minute while performing lifting task; rounded to nearest hundredth
** Lower = item lowered rather than lifted

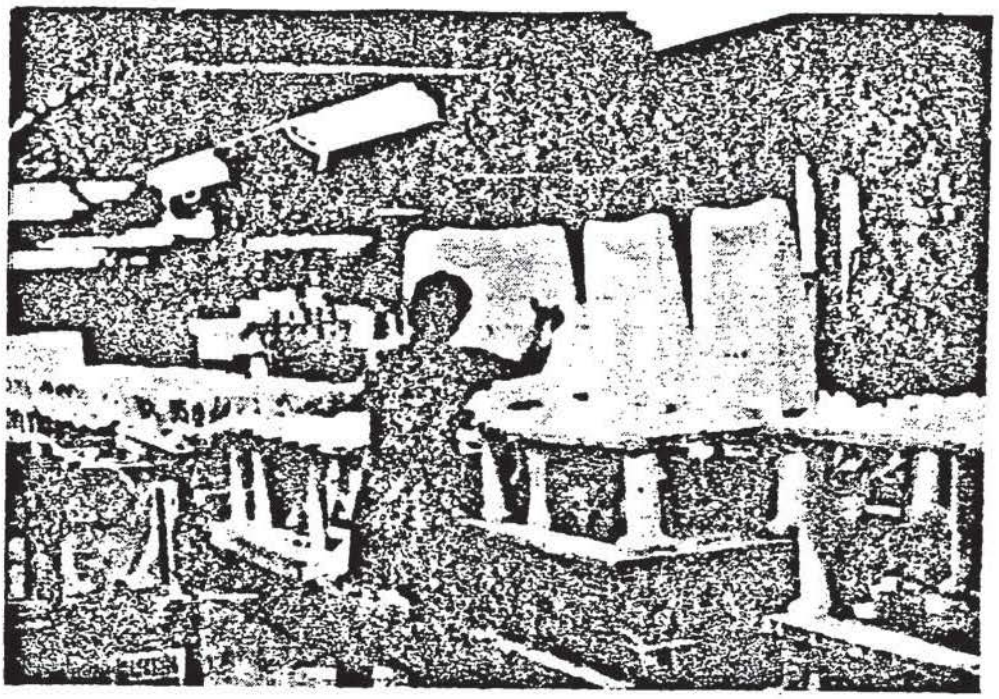

Figure 1. Loading and unloading product at arms' length may cause excessive muscular fatigue or shoulder or back strain.

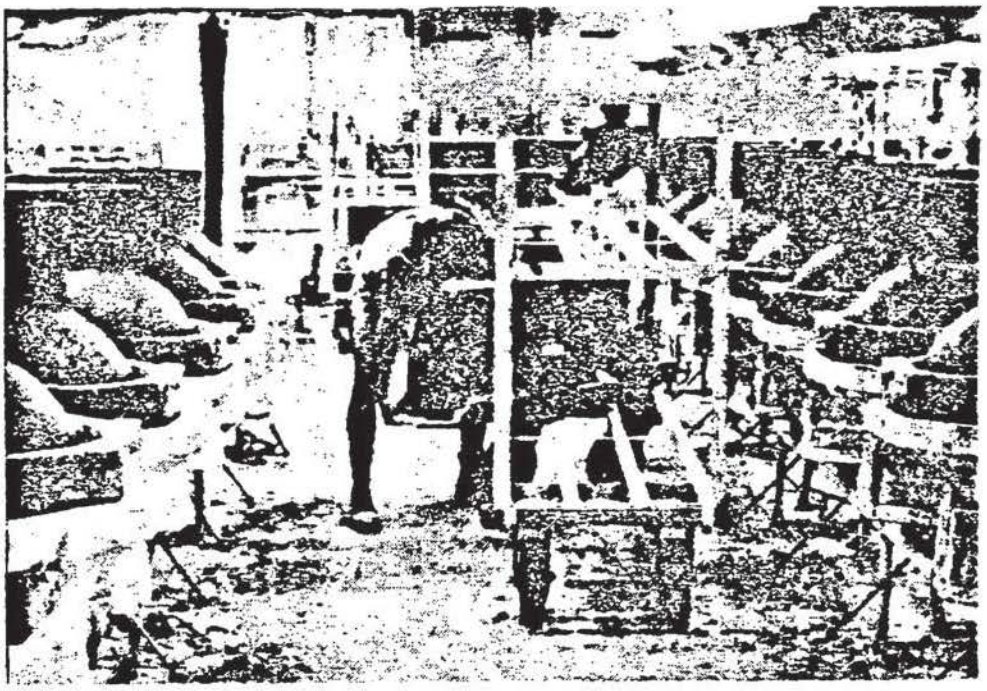

Figure 2. Low shelf on cart requires excessive torso bending and increases probability of back strain.

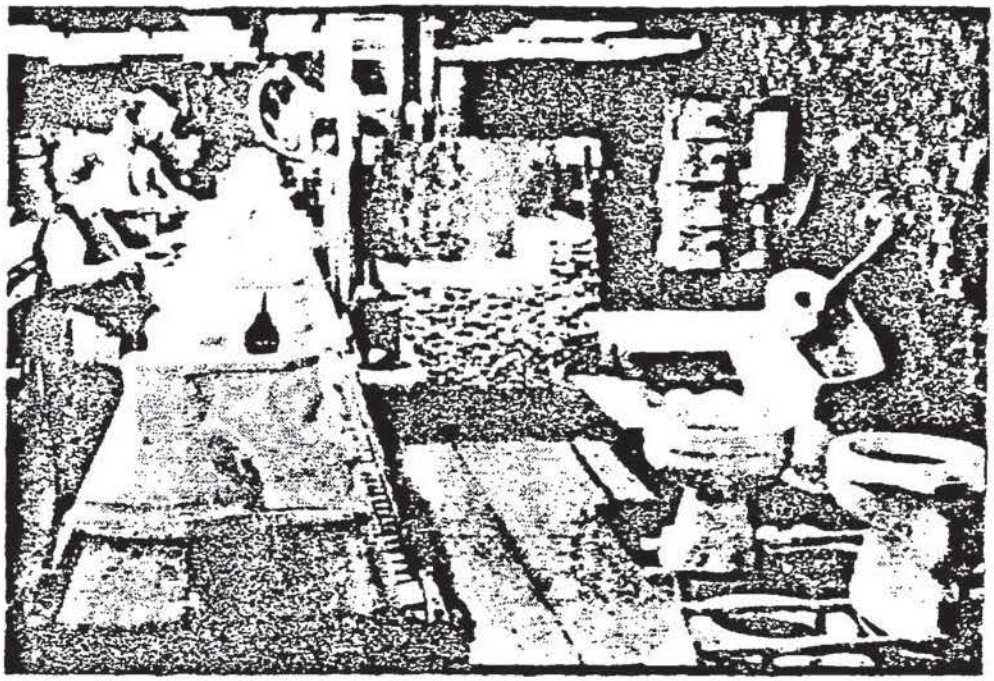

Figure 3. Textured gloves can make slippery product easier to handle and thus reduce the likelihood of dropping.

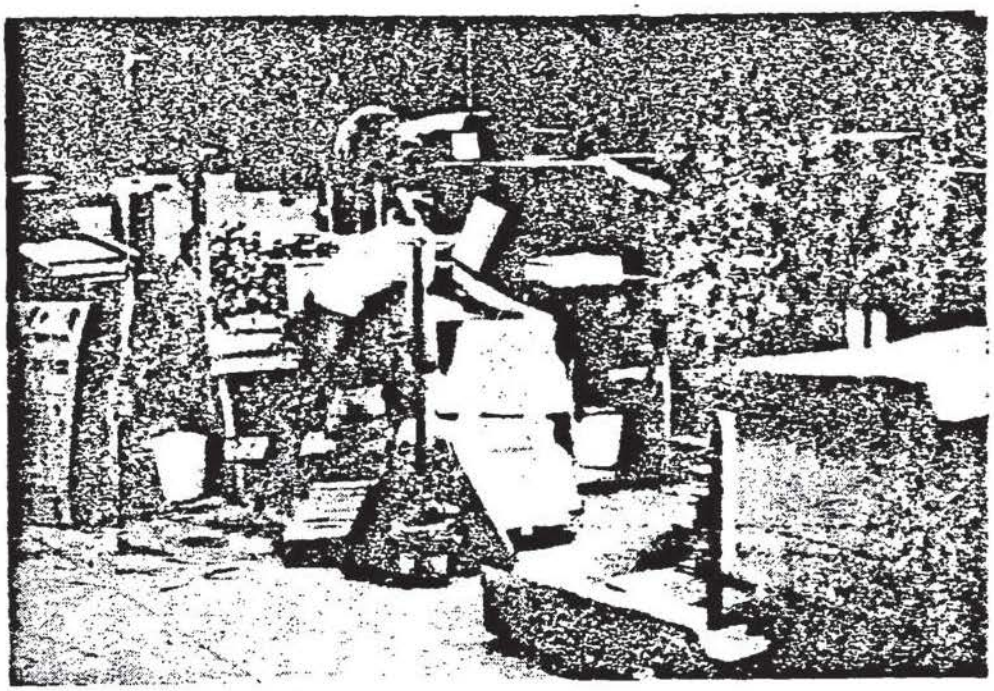

Figure 4. Excessive reach distance while loading and unloading may result in increased probability of shoulder or back strain.

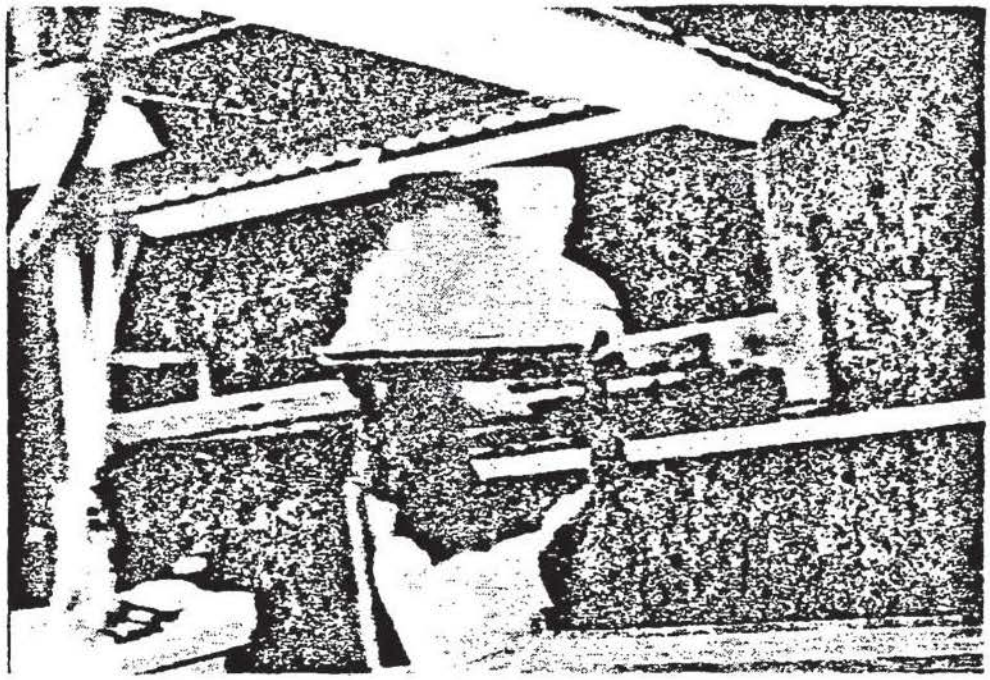

Figure 5. Lifting product above the shoulders can result in excessive fatigue and can increase the probability of shoulder or back injury.

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