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Owens Corning
Amarillo, Texas

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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SUMMARY

On October 21- 23, 1997, representatives from the National Institute for Occupational Safety and Health (NIOSH) visited the Owens Corning fiberglass manufacturing plant in Amarillo, Texas, in response to a confidential employee request for a health hazard evaluation. The HHE request was prompted by the requestors' concerns about injuries and symptoms in the back, shoulders, elbows, and wrists among employees in the Roving area of the plant. The requestors were concerned about the repetitive work, long hours, and production standards with which the Roving Area employees at Owens Corning worked.

During the visit, the NIOSH team obtained information to assess the following: (1) the nature and extent of the employee-reported health hazards, (2) the physical characteristics of potentially hazardous jobs, and (3) the workers' perception of the health risks associated with selected jobs. During the visit, the team reviewed the Occupational Safety and Health Log and Summary of Occupational Injuries and Illnesses (OSHA 200 Logs) to determine the extent of the recorded injuries and lost time, observed work practices of evaluated jobs to determine the physical demands on the upper extremities and the manual materials handling activities, and interviewed 59 workers in the Roving area on two shifts who perform the selected jobs to determine the workers' perception of physical workload and symptoms of musculoskeletal disorders (MSDs). Roving area employees reported high prevalences of back, shoulder, hand, and wrist symptoms. Moreover, the majority of workers indicated that they had a poor relationship with the local management, and they reported low levels of control over their work and low job satisfaction.

During the 2 ¾- year period from 1995 to 1997, in the entire facility there were 262 reported work-related MSDs, which resulted in 2,772 lost workdays (an average of 4.2 per worker per year) and 3,850 restricted workdays (based on a total of 800 employees). One hundred and seventy (38%) of the entries involved the upper extremities and 92 (21%) involved the back. The incidence rates of MSDs in the Roving area jobs were much higher (up to 24.5 incidents per 200,000 person hours) compared to the overall illness rate which include MSDs in the Pressed and Blown Glass Industry (8.9 per 200,000 person hours.)

The ergonomic assessment consisted of observation and assessment of musculoskeletal hazards associated with the Roving area jobs, discussions with Roving Employees regarding musculoskeletal hazards associated with their jobs, and review of previous evaluations of the area by a university ergonomics program. Workers in the Roving Department were found to be exposed to increased risks of injury to the musculoskeletal system due to repetitive movements, awkward postures, and unnecessary bending and lifting that could be reduced by engineering and administrative controls.

On the basis of our interviews, analysis of records, and review of previous ergonomics analysis of selected Roving jobs, NIOSH investigators determined that work in the Roving area at Owens Corning in Amarillo, Texas, was associated with high incidence and prevalence of MSDs including the shoulder, hand/wrist, and back. Recommendations for modifying or eliminating these problems are presented in the Recommendations Section of this report.

KEYWORDS: SIC 3229/pressed blown glass, back pain, upper extremity, shoulder, carpal tunnel syndrome, musculoskeletal disorders, ergonomics, NIOSH Lifting Equation, lifting, materials manual handling, shift work, work organization, psychosocial, production standard, job control, vigilance

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INTRODUCTION

On October 21-23, 1997, representatives from the National Institute for Occupational Safety and Health (NIOSH) conducted a site visit at the Owens Corning fiberglass manufacturing plant in Amarillo, Texas, in response to a confidential request for a health hazard evaluation (HHE) from three employees. The request was prompted by concerns regarding the causes for injuries and symptoms in the back, shoulders, elbows, and wrists among employees in the Roving area of the plant. The requesters were also concerned about repetitive work, shift work, production standards, and the working environment at the plant. The jobs of interest included operators in the M74 and M75 Roving areas.

There were six objectives of this evaluation:

1. Determine the prevalence and incidence of work-related musculoskeletal disorders (MSDs) associated with jobs in the Roving area.
2. Document the presence of physical stressors associated with activities (e.g., repetitive, forceful exertions) that are known to increase the risk of work-related MSDs.
3. Develop recommendations for reducing the risk of work-related MSDs at the Owens Corning Amarillo facility.
4. Review the medical management system for work-related MSDs currently in use at the Owens Corning Amarillo facility, and provide recommendations as needed.
5. Assess the work organization and psychosocial aspects of the work in the Roving area and make recommendations as needed.
6. Provide employees with information about the health aspects of shift work.

BACKGROUND

Plant and Job Description

The Owens Corning plant in Amarillo, Texas, manufactures continuous filament fiberglass, including Fiberglass Type 30, Rovings, and Chopped Strand products. It has been in operation since February 1979. The plant employs about 800 people, with Roving Fabrication employing a large number of employees (the company considers the specific number a trade secret). A number of the jobs in the Roving area are entry-level jobs; although many workers remain for years. Turnover among personnel is low. Employees work on rotating shifts. The Roving area is located in a large open area of the plant.

The main responsibility of Roving area personnel is to maintain the continuously running creels. The creel is a framework used to hold 10 to 33 spools of thin glass fiber strand product, "cakes", which are wound or roved onto high-speed winders which collect the continuous filamentous glass into Roving doffs. The cakes weigh about 27 pounds (lbs.) and are delivered to the Roving area by an overhead conveyer. Operators manually lift the cakes from the conveyer system and carry them to an "end-finding" table located at the end of the creel panel. The distance from the conveyer to the table can be anywhere from 5 to 8 feet. After the cake is placed on the table, the operator performs an "end finding" maneuver to manually locate the ends of the continuous filament fiberglass strands. This is done by pulling on the individual continuous filament fiberglass strands on the interior side of the cakes. After the ends are found, the cakes are carried a distance of about 5 to 15 feet and are lifted onto one of three shelves of the creel. To reach the top shelf, many of the operators have to lift the cakes above shoulder level. Placing the cakes on the bottom shelf requires stooping or squatting. Once in place, the continuous filament fiberglass strands of the cakes are threaded into a guide eye and then tied in with 10 to 33 threads from the other cakes. These threads are then wound onto high-speed winders, which collect

the continuous filament fiberglass into balls or "doffs" on a spool (mandrel). The completed wound product of continuous filament fiberglass twine is called a 'Roving doff.' After a period of approximately 10-15 minutes, the winding of the strands is completed, and the Roving doff (a large spool) weighs approximately 50 lbs. It is then covered in plastic pack-wrap and moved off the mandrel and onto the assist (doff assist) by a lever, and is then pushed onto a conveyer by the operator.

The cakes are not all of uniform size; that is, they all do not have the same amount of continuous filament fiberglass strand. Therefore, the different cakes on the creel shelves periodically and randomly run out of continuous filament fiberglass strand, and so must be replaced by new cakes. This requires that the operator return to the conveyer and carry more cakes to the end finding table, find the ends of the continuous filament fiberglass strands, and insert the cakes into the creel shelves. As this is a continuously running process, the operator walks up and down the creel isles, maintaining, inspecting, and replacing the cakes during a work shift. This requires a high degree of vigilance. The worker must also meet a required rate of production. If the creel machine becomes unable to run because of a "birdnest" (a tangled bundle of glass strands which will not run through the guide eye into the Roving creel) then the operation must be stopped and fixed. When this occurs, the operator must figure out the problem and fix it, or call her/his supervisor. If a "break" or a "birdnest" occurs in the operation and it takes several minutes to repair and restart the process, the operator can request a remittance from the supervisor so that it will not affect her/his production quota.

METHODS

Medical Evaluation

The medical evaluation included a review of the Occupational Safety and Health Administration (OSHA) Log and Summary of Occupational Injuries and Illnesses (Form 200), workers' compensation records, company medical records, and previous consultant reports; and confidential medical interviews, including a structured questionnaire with employees in the Roving Area.

OSHA 200 Logs

OSHA 200 logs for the period 1995 to mid-1997 were obtained from the company. These logs (along with the supplementary record for each entry) are the official report of occupational injuries and illnesses and are required by OSHA. Information on the total number of hourly employees for each year was used to calculate incidence rates of MSDs for each year. All musculoskeletal problems (including such conditions as sprains, strains, tendinitis, and carpal tunnel syndrome) involving the upper extremities, neck, and back recorded on the OSHA 200 log were included in this analysis. Since it is often difficult to determine from the OSHA 200 logs whether a musculoskeletal strain or sprain is due to acute or chronic trauma, all of these events were included. Musculoskeletal contusions, lacerations, and foreign bodies, which are likely to be more acute events, were not included. Data on the number of lost and restricted workdays for each case were also tabulated.

Interviews

On October 22, 1997, employees working on two shifts in the Roving Department were interviewed and given a structured questionnaire by two NIOSH physicians. The Owens Corning management provided NIOSH investigators with an employee roster, including name, department, and current job title. All employees were notified by management on the shop floor and brought to NIOSH medical personnel. Employees were then invited to participate in the interview and structured questionnaire after they were informed about the investigation. The questionnaire included items about perceived physical workload of the job, symptoms of pain and discomfort associated with musculoskeletal injuries, and injuries in the previous year. Questions were also included concerning the

overall workload and the workers' perceived control over their workload.

Assessment of Perceived Workload

The Borg scale[1,2] was used to illicit an overall assessment of the perceived physical workload of the Rovers' job. This scale consists of a 15-point numerical list, anchored by adjectives describing increasing levels of physical effort (Table 1). The Borg scale was initially developed through laboratory experiments using exercise bicycles and has subsequently been used at the worksite to assess the perceived physical effort of persons performing manual tasks. Studies have shown a good correlation between perceived workload and objective measures of physiologic workload such as heart rate.[1,2]

TABLE 1 - The Borg Scale

20
19 - very, very hard
18
17- very hard
16
15- hard
14
13- somewhat hard
12
11- fairly light
10
9 - very light
8
7 - very, very light
6

Employees Perception of Job Demands and Job Control

A series of questions were asked to determine workers' perception of their job demands and control. These questions were chosen based upon a decision latitude model of job stress.[3] This model suggests that a combination of high job demands and low job control will produce high job strain and could lead to problems such as stress and job dissatisfaction.[4]

Ergonomic Assessment

The ergonomic assessment in the Roving Department consisted of: (1) discussions with Roving area employees regarding musculoskeletal hazards associated with their jobs; (2) videotaping the Roving process; (3) observation of musculoskeletal stress during manual handling of the cakes; and (4) review of previous evaluations of the area carried out by a university ergonomics program.

RESULTS

Medical Evaluation

Interviews and Questionnaire Results

Fifty-nine employees from the Roving area were interviewed and were administered a questionnaire. The mean age of those interviewed was 36 years (range 21 - 52 years), the mean time working at Owens Corning was 5.2 years (range 2 months to 14 years). Thirty-four workers had been employed less than 5 years at the plant, 11 workers had been employed 5-10 years at the plant, and 14 workers had worked more than 10 years at the plant.

Pain or Discomfort

Thirty-five employees (59% of the 59 interviewed) reported pain or discomfort lasting more than one week in the previous 12 months. These reports

included: 37% for the hand/wrist, 34% for the low back, and 31% for the shoulder region. (Each person interviewed could report symptoms in more than one area.)

Workers' Compensation

Fifteen workers (25% of those interviewed) had applied for and received workers' compensation for musculoskeletal injuries sustained on the job at Owens Corning.

Borg Scale

The average physical effort level demanded by the job was rated to be "hard," (score = 15). Scores ranged from a low of 9 (very light) to a high of 19 (very, very hard).

Meeting Production Requirements or Standards of the Job

Of the 59 employees interviewed, 12% reported that it was "very difficult" and 41% reported that it was "somewhat difficult" to meet the production requirement of their job. Twenty-four percent answered that it was "a little difficult" or "not at all difficult" to meet the standards. There were 23% who did not respond to the question.

Rest Breaks

Sixty nine percent of the 58 employees answering the question reported that the extent that they could work ahead and take a short rest break during work hours was "very little" or "little."

Influence Over Work and Work-Related Factors

Sixty-one percent of the 59 interviewed employees reported that they had "very little" or "little influence" over work and work-related factors.

OSHA Injury and Illness Logs

From January 1995 to September 1997, in the entire facility there were 443 entries on the OSHA 200 logs, of which 262 (59%) were either back or upper extremity MSDs (these included upper extremity strains of the shoulder, elbow, arm, wrist, or hand , as well as those entries listed as CTDs). One hundred and seventy (38%) of the entries involved the upper extremities and 92 (21%) involved the back. During this period, these disorders resulted in 5,772 lost workdays and 3850 restricted workdays. This is equal to an average of 4.2 lost or restricted workdays per worker per year (based on 800 workers).

For 1995, strain/sprain injuries of the upper extremities or back accounted for 53% of the total 166 recorded illnesses and injuries, and contusions and lacerations accounted for 10% and 3%, respectively. For 1996, strain/sprain injuries of the upper extremities or back accounted for 61% of 196 recorded illnesses and injuries, and contusions and lacerations accounted for 7 % and 3%, respectively. For the nine months of 1997, strains/sprain injuries of the upper extremities or back accounted for 68%, contusions 4%, and lacerations 1%.

Table 2 compares the incidence rates of MSDs in Roving jobs for 1995, 1996, and 1997 to the incidence rate in the Pressed and Blown Glass Industry [Standardized Industrial Classification (SIC) 3229] for 1995. The rates given for the Pressed and Blown Glass Industry are for all cases of all occupational illness and injury (which include upper extremity MSDs and lower back MSDs, as well as other work-related illnesses and injuries) and for occupational illness alone (where disorders due to repetitive trauma would be placed). The MSD rates in the Roving jobs were much higher (up to 24.5 incidents per 200,000 person hours) compared to the rates for all illnesses (which included MSDs) in Pressed and Blown Glass Industry (8.9 per 200,000 person hours.)

Medical Records Review

A review of the medical records provided by Owens Corning for the years 1995 -1997 found in the Roving area that there were almost twice as many upper extremity disorders among employees requiring medical treatment as back disorders. (The number of employees is considered trade secret by the company, so that the specific number of disorders cannot be given.) Six shoulder surgeries, three carpal tunnel surgeries, and one elbow surgery occurred during that 2-3/4-year period among the employees in the Roving Department. All disorders requiring surgery were attributed by the physicians of record to repetitive, forceful work.

We also compared the number of MSDs in the Roving Department recorded in the OSHA 200 logs with the number of MSDs that required medical treatment recorded in the medical records. We found that over time, the proportion of agreement between the two records has declined by greater than 40% from 1995 to 1997. Several of the entries listed on the Owens Corning Employee Report of Injury/Illness form were not recorded on the OSHA 200 logs. For some of these entries, recommendations were made for restriction of work or motion and for different modalities of treatment, either of which make the illness or injury recordable on the OSHA log.

Review of Owens Corning Safety Culture Report

We reviewed the report from June 1997 by a company consultant evaluating the "safety culture" of the Amarillo Owens Corning plant. The consultant had administered a questionnaire survey to around 600 plant personnel and conducted one-on-one interviews, group interviews, and focus groups with various levels of management and employees from different departments. The consultant reported that the results of the survey showed that overall, relative to other industrial sites, the Amarillo Owens Corning plant had a weak safety culture. When compared to nearly 100 other facilities and plants across North America, they found that the composite score placed it among the lowest-rated plants and, correspondingly, among those with the highest accident rates. A more detailed summary is included in Appendix B.

Ergonomic Assessment University Ergonomics Program Analysis of Roving Job

A comprehensive ergonomic analysis of the lifting activities in the Creel area (M-74 and M75 Roving areas) was previously conducted by the Texas Tech University Ergonomics Program. The analysis included: (1) an elemental task breakdown of the Roving job, (2) a comprehensive posture and motion assessment; and (3) an analysis of lifting demands using the revised NIOSH lifting equation.[5]

The following is a summary of the methods and findings from the Texas Tech University ergonomic analysis.

Elemental Task Breakdown

The job was broken down into three phases: Phase I - End Finding, Phase II- Creel, and Phase III - Doff. Phase I was further subdivided into two main elements: (1) Tilt Carrier - unload package from carrier and lift/carry to end table, and (2) Find Inner End - end finding operation. Phase II was subdivided into six main elements: (1) Turn Carrier, (2) Decreel Hull, (3) Replace Runout, (4) Transfer Package to Creel, (5) Inspect Creel, and (6) Repair Breakout. Phase III was subdivided into three main elements: (1) Walk to Winder, (2) Cut/Knot End/Position Film Dispenser/ & Tack Wrap Doff, and (3) Doff Assist. A job analysis was performed for each element of the job to determine the extent of possible ergonomic hazard.

Posture and Motion Assessment

Posture and motion was assessed for each of the task elements using a standard job analysis method. The method included collection of arm and trunk motions, back, upper limb, and lower limb posture. Posture was assessed using the Ovako Working Posture Analysis System (OWAS),[6] an analysis

system that provides a practical method to identify and evaluate work postures. The OWAS is a computerized technique for determining the postural requirements for the back, arms, legs, and trunk during a physically demanding activity. For this method, the analyst reviews a videotape of a worker performing the work process and rates the posture at fixed time intervals. This technique is especially useful in documenting the relative time spent in bent or awkward postures, a known risk factor for low back disorders.

Additional data collected included hand position, load weight handled, whether repetitive motion or twisting was involved, and whether lifting, lowering, carrying, pushing, or pulling was involved in the task. Prior to the analysis, angles of twists, bends, flexion, and abduction were estimated and agreed upon by all the members of the analysis team. According to the OWAS approach, postures are then assigned to one of four classes (Class I to IV) depending upon the postural demands of the job, with Class I representing low demand and Class IV representing the highest demands. It was suggested that task elements identified as Class III would require near future attention, and that those identified as Class IV would require immediate consideration. Six elements of the Roving operation were identified as Class III and five elements were identified as Class IV. The elements classified as Class IV involved lifting and carrying the package from the carrier to the end finding table, moving the package from the end finding table to the creel, and doffing the final package.

Lifting Analysis

To assess the physical demands associated with the Roving job, the lifting activities performed during the Roving operation were analyzed with the revised NIOSH lifting equation. The revised NIOSH lifting equation is a mathematical formula for determining the recommended weight limit (RWL) for a two-handed manual lifting task. The RWL is defined for a specific set of task conditions as the weight of the load that nearly all healthy workers could perform over a substantial period of time (e.g., up to 8 hours) without an increased risk of developing lifting-related low back pain (LBP).[7] The equation considers the geometry of the lifting activity (where the load starts and ends), the frequency rate of lifting, and the quality of the hand-to-object coupling. The lifting index (LI), a term that provides a relative estimate of the physical stress associated with a particular manual lifting task, can then be determined for the lift by dividing the actual weight lifted (L) by the RWL for the job. According to NIOSH, it is likely that lifting tasks with an LI > 1.0 pose an increased risk for lifting-related LBP for some fraction of the workforce, and that lifting tasks with an LI > 3.0 pose an increased risk of LBP for many workers. Thus, as the LI of a job increases, the risk of LBP for a population of workers likely increases.

In the Texas Tech analysis, two factors were added to the NIOSH equation calculations that were not included in the official NIOSH version. These two factors were added by the Texas Tech group to allow computation of recommended weight limits for 12-hour shifts and for the additional physical demands associated with requirements for significant control associated with the small clearances for placing the cakes on the creel. Since the original NIOSH equation did not have a duration factor for 12-hour shifts, the addition of a factor for an extended shift seems appropriate in light of the additional demands placed on the workers. Moreover, the addition of a factor to account for the added physical demand associated with maintaining significant control at the destination due to the small load placement clearance also seems appropriate. In order to evaluate the impact these additions had on the calculations, we recalculated the LI values without the additional factors. Our findings revealed that the additional Texas Tech factors decreased the RWL values by 20%, and increased the LI values by approximately 0.5 above what they would have been if these factors had not been added. Although the original NIOSH equation did not apply to 12-hour shifts, we think it is reasonable to expect that the acceptable weight of lift for 12-hour shifts would be lower than for 8-hour

shifts. Therefore, we believe the Texas Tech results are appropriate for these jobs.

The distribution of LI values for the lifting activities for the Roving job were grouped into the following categories: 0.5-0.99, 1.0-1.49, 1.5-1.99, 2.0-2.49, and > 2.5. The distribution of lifting index values in the Roving job are shown in Table 3. The task elements with the greatest LI values included, (1) transfer of package from end table to creel (LI values of 2.1-2.9), and (2) transfer of package from carrier to end table (LI value of 2.2).

Review of Videotapes

The videotapes of the workers performing the Roving job obtained during the NIOSH visit were reviewed to determine whether the elemental task breakdown and ergonomic analysis conducted by the Texas Tech University was accurate and appropriate for the Roving job. Based on our analysis of the videotapes, we concluded that the Texas Tech assessment was appropriate and provided an accurate representation of the physical demands of the Roving job.

DISCUSSION

Work-related Musculoskeletal Disorders

NIOSH investigators found that incidence rates of both upper extremity and lower back work-related MSDs were higher in the Roving Area at the Owens Corning Amarillo plant than in the pressed blown glass industry as a whole (Table 2). A review of the medical features of these disorders and known workplace risk factors is included in Appendix A.

Ergonomic Assessment

The ergonomic analysis of the lifting activities in the Creel area (M-74 and M75 Roving areas) conducted by Texas Tech University appeared technically sound and accurate. That evaluation concluded that a small fraction of the tasks pose concern from a postural standpoint, particularly the task of moving packages from the tilt carrier to the end table. According to the Texas Tech University report, some operators performed this task with a bent and twisted torso while bending their knees or standing on one leg. This seemed to be brought about by variation in stature and mobility between operators. The Texas Tech University group also concluded that a number of the lifting activities resulted in high lifting-index values and that the horizontal and vertical reach factors, and the frequency of lifts and shift duration factors, mainly affected the RWL and LI values. Following review of the initial findings for the lifting analysis, Owens Corning asked Texas Tech University to perform a secondary analysis of the lifting activities to see whether an alternate shelf design for the creel would reduce the LI values. Based on the results from the secondary analysis, the Texas Tech University concluded that, although the alternate creel shelf heights were an improvement over the current creel heights, the LI values would still be significantly above 1.0. They indicated that a better solution would be to re-design the creel process such that the operators perform minimal lifting of the packages. Finally, it should be noted, the Texas Tech University analysis did not assess upper extremity MSD risk factors from repetitive or postural activities, such as the end finding activity.

Development of Alternate Creel Design

Based on the history of lifting problems in the Roving area, and the findings from the Texas Tech University ergonomic analysis, Owens Corning has developed a prototype for a new creel design which eliminates carrying packages from the end finding table and placing them onto creel shelves. Operators have been involved in the design of the prototype creel, and a plan has been developed to begin evaluating the effectiveness of the new design. The new design will provide the following:

1. Adjustable height end finding table;
2. A delivery system for packages that eliminates carrying them from the end table to the creel;

3. Two shelves instead of three, eliminating the bottom shelf, which will help address some stooping and bending;
4. Better access to packages for tying-in strands; and
5. Easier maneuvering of guide eyes for tying-in strands and replacing packages.

End-Finding and Tying-In Operations

We observed that the end-finding and tying-in operations require rapid repetitive hand motions that could possibly lead to musculoskeletal disorders of the wrist or shoulder. Although the hand and finger forces are probably quite low, the repetitiveness of the activity and the duration of the shift may be a cause for concern. Moreover, the new prototype creel design for the Roving area does not address these specific repetitive activities. It would be worthwhile to perform an ergonomic analysis of these job elements to determine if this particular task represents a health risk.

Workplace Psychosocial/Organizational Risk Factors

There is evidence that working conditions play a primary role in causing MSDs. For example, a recent review of over 50 studies found support for a relationship between MSDs and monotonous/boring work, working under time pressure, low levels of social support at work, and low levels of worker control.[8] Working conditions and the way workplace tasks are designed may result in increased exposure to ergonomic risk factors; for example, the repetitive tying of the continuous filament fiberglass strands in Roving throughout the shift may be linked to workers' hand and wrist pain. Excessive workload demands and long working hours increase exposure to lifting hazards. Stressful working conditions may lead to a decrease in reporting of early symptoms by individuals if they view that the company is insensitive to their needs, or communication in the organization is poor, or workers perceive medical attention to be inadequate. Those workers with symptoms who participate on a team may be reluctant to report symptoms because of the perception that reporting would cause a disruption in the flow of the line and may affect team performance.

One important aspect of job design is work load. Excessive work load has been associated with negative health outcomes in several studies.[9,10,11] Just as working excessive hours or performing more than one job has been found to impact a worker's heart and circulatory status (excessive work load is associated with coronary heart disease and morbidity[3,4]), excess work load also impacts the musculoskeletal systems.[12,13,14] It is thought that some demanding work conditions, such as those found at Owens Corning, may be associated with increased physical demands and biomechanical stresses. Additionally, such demands may produce increased muscular tension and consequent biomechanical strain.[15] Research on machine-paced work (involving limited worker control of the job demands) has indicated a link with adverse health effects.[16,17]

Psychosocial and Work/Organization Environment at Amarillo Owens Corning

NIOSH staff noted several characteristics present at the Amarillo plant which seemed to foster tension between management and the employees. The tension which NIOSH investigators observed was corroborated by different levels of management and employees during our visit. In our discussions with the Amarillo Owens Corning management, we concluded that management seemed to view employee concerns as unwarranted invasions of managerial prerogatives, most of which would likely affect production quotas, which are needed to maintain competitiveness. On the other hand, the employees' concerns were focused on the need to make changes in the workplace to create what they viewed as more tolerable working conditions. The employees preferred that the Owens Corning management make global changes in the work process without delay, rather than slowly introduce

changes only in certain working areas over a period of years. While employees are aware that many things have been done to evaluate the work at the Amarillo plant, change is seen as occurring too slowly. For example, the experimental creel has been put into place, and other new creel tables are to follow, but these changes affect few workers. Employees are also aware of the Owens Corning corporate ergonomists, but these ergonomists are seen as outsiders, without the ability to make real change in a timely manner due to constraints put on them by Owens Corning headquarters and Amarillo management. Because top local management has changed in the last year, employees are unsure what ergonomic policies and procedures will be carried out.

NIOSH investigators noted an atmosphere of general distrust between management and employees. This distrust was voiced repeatedly by many of the employees interviewed, who were afraid of speaking out at work for fear of retribution, and who described a lack of a sense of job security, despite their seniority. These observations are consistent with those reported by the consultant group, hired by Owens Corning in May 1997. In their report, the consultants noted that the Owens Corning workers "manifest a deeply embedded culture of distrust, suspicion and skepticism. A high number of primary workers do not feel the company cares about them. There is a pervasive sense that the plant's norm regarding safety is either negative feedback or none at all." Our interviews found that because of this climate of distrust, workers were reluctant to report concerns about working conditions or symptoms of discomfort or potential injury to the management. They recounted incidents in which employees who reported possible work-related symptoms were not taken seriously or were intimidated. Because there had been no "alternate" or "light duty" jobs available at the time of our visit, reporting symptoms at an early stage was regarded by many of the workers as one step away from being placed off work. Alternately, they said that reporting symptoms to their supervisor meant that an interrogation of their work practices would begin, which they described as being more accusatory than informative or instructive.

Issues of Worker Control

Despite the fact that Owens Corning has had several consultants in the past few years addressing work issues (e.g., preferable shift schedules, the climate survey) and has at times included employee input, the majority of the Amarillo employees we interviewed continue to view the management as not having the interests of the employees as important a goal as production. One of the reasons given for this perspective, which has been found in many workplaces, is that companies tend to view workplace behaviors almost exclusively as problems of the individual employee. We noted this view among the managers to whom we spoke in the plant. Workers reported to us that although they were asked to participate in different directives for Owens Corning management, there was never a sense of having any real voice or control in decision-making.

In the Roving area at Owens Corning, several aspects of the job might lead to stress among workers. Workers at Owens Corning have specific work shift schedules over which most have little control. Also, workers are under a production standard which requires them to maintain constant vigilance of their machines. This production standard does not seem to take into account the combined effects of work schedule and task factors such as reductions in activation-arousal, physiological work capacity, and psychological motivation associated with extended work shifts and with night work. Work with the creels requires not only lifting close to 30 lbs frequently during the day, but lifting in a prescribed manner (with a penalty for not doing so). The operator supervises a highly automated process, which is stable most of the time, but the operator's primary task is to intervene when an unpredicted failure or disturbance (such as bird-nesting) occurs. The Roving Operator can seldom control her/his work pace, which most often is machine controlled, and work cycles or work rhythms cannot even be clearly distinguished in the process operator's work situation. Instead, long periods of passive monitoring and vigilance are interrupted by process failures and random replacements of cakes. The fiberglass string can

break or "birdnest", requiring that a line be shut down, and the employee has to decide whether this break is severe enough to affect their own production quota, or whether it can be repaired quickly.

We know that stress occurs when workers report that they cannot modify work demands placed upon them. According to research done by Kerasek et al.[18], high work demands, lack of clarity, and conflict at work are among the most important work-related characteristics which predict job dissatisfaction, work stress, and ill health. The effect of these characteristics is moderated by low control over work, poor career development opportunities, and poor social support at work. Particularly, the combination of high demands and low control at work has been reported to be stressful and related to adverse health effects. Reports looking at these issues have found relationships with stress at work and the development of heart disease, gastrointestinal problems, musculoskeletal disorders, or poor subjective health in general[19, 20, 21] Personal characteristics such as age, gender, experience, needs, and personality also have been found to influence coping capacity and stress at work.[8,18,20,22]

Job Satisfaction

The 1997 National Study of Changing Workforce[23] may provide insight to the problems identified at Owens Corning with regards to job satisfaction. This study found that the quality of employees' jobs and the supportiveness of their workplaces were far more important predictors of job satisfaction, commitment, loyalty to the employer, job performance, and retention than earnings or fringe benefits. Job quality was defined as autonomy on the job, learning opportunities, meaningfulness of work, opportunities for advancement, and job security. Workplace support was defined as flexibility in work arrangements, supervisor support, supportive workplace culture, positive coworker relations, absence of discrimination, respect in the workplace, and equal opportunity for workers of all backgrounds. Improving job quality and work environments was found to be generally much more challenging than providing more pay or offering new benefits, because it required organizational change. The study found that work life was actually an important source of employee's personal problems. That is, demanding jobs and unsupportive workplaces lead to spillover from jobs into worker's personal lives that created or exacerbated problems off the job that, in turn, spilled back into work and diminished productivity. Therefore, tackling problems identified at Owens Corning could potentially have a positive impact not only on the organization, but on productivity as well.

Other Issues

Organizational Response To Injury

Employees reported that when a worker is injured on the line, the established procedure at the Amarillo Owens Corning plant is to conduct an investigation of the incident to insure that safe and proscriptive practices had been used. This can be a useful method to explore the events that took place, to determine what might be responsible for the injury, and how preventive measures might be introduced. However, as it was described to NIOSH investigators by management and employees, this investigative approach frequently focuses on finding whether the injured worker used "proscribed working techniques." These techniques were taught at some of the educational sessions and led managers to believe that there were "correct" ways to perform an activity. If the worker did not use the prescribed technique, the worker usually received a "corrective action" citation. During our interviews with the employees, we were told that this disincentive has led to a decreased reporting of injuries.

Medical Record-keeping

Our review found discrepancies among the OSHA 200 log data, information obtained from our interviews, and the company medical records. For example, the medical records frequently showed longer amounts of lost and restricted work-time than

was recorded on the OSHA 200 logs. We also found records of employees whose evaluation and treatment of either their upper extremities or lower back were reflected in company medical records but not recorded on the OSHA 200 Logs; this occurred more frequently in 1997 than in the previous two years. In the medical records, there were several instances of recommendations for restriction of work or motion and various modalities of treatment, either of which would constitute a recordable illness or injury, yet these cases did not show up on the OSHA 200 logs.

Review of medical records of physicians rendering treatment for MSDs did not show any particular type of illness or injury over-diagnosed, and there was no suggestion of an excessive number of surgeries by any one provider. This suggests that the MSD cases did not arise from an overzealous physician or a single provider with a bias towards MSD diagnoses. The case management by some of the individual providers did lack information about the duration, force, and postures that might have been associated with these disorders. All the surgical case reports referenced that work in the Roving department was a causative factor in the development of the MSD. In general, the patient assessment, treatment, and management conformed to the American College of Occupational and Environmental Medicine's Clinical Practice Guidelines.[24]

Task Vigilance

An issue that arose during our site visit concerned the duration of the work shift and the worker's ability to maintain full work capacity for the full shift. The managers were puzzled because the employees voiced continual concern over meeting the production standard and at times refused to take their scheduled breaks because of the concern that they might not achieve their quotas. Yet fairly consistently, 30 to 45 minutes before the shifts ended, most of the employees met the production standard, shut down their machinery, and retired to the break-room. Employees were concerned over what they perceived to be high rates of injuries, which they attributed to long shifts, maintaining vigilance for the duration of those shifts, and fatigue. We were asked to comment on this series of concerns and events.

The Owens Corning Amarillo plant runs a continuous industrial process which requires a pattern of shifts to provide 24-hour operational cover. Continuous 24-hour services, provided by rotating shifts and night shifts, have been found to lead to individual impaired productivity and safety in several studies, although these findings are not consistent in all studies. The sleepiness induced by irregular work hours also can cause increased accident rates.[25,26] Moreover, beside the problems experienced by individual shift workers (including impairment of objective and subjective health, a disturbance of social and family life, and disturbed sleep and chronic fatigue), performance capabilities of operators over a shift have been seen to deteriorate in several studies. Rosa et al.[27] has reported decreased performance, alertness, and increased subjective fatigue after 7 months of 12-hour shift work; these effects were still present after 3 ½ years of adaptation to this schedule. Knauth et al.[28] found similar results when studying fire brigade control room workers on a 10-hour-day/14- hour-night rotating compressed work schedule. Their study showed a significant decrease in alertness at the end of both 10-hour and 14-hour work periods. Work shifts longer than 8 hours have been found to increase the risk of fatigue-related injuries. Several studies[20-24] have demonstrated that both physiological functions and exercise capacity are diminished on long shifts, especially those involving night work. Reductions in activation-arousal, physiological work capacity, and psychological motivation combine with physical factors inherent in manual tasks to decrease the acceptable work duration. These factors can explain why the Roving workers maintain higher production at the beginning and through mid-shift, then decrease their performance and end their tasks before the end of the shift. Vigilance in activation-arousal, psychological motivation, and physiologic work capacity may not last the full shift. Many classic studies in shift work have demonstrated that errors and decrements in performance, and task vigilance occur on extended and night shifts, when alertness is decreased and fatigue is present. The reason for the reduced alertness associated with

irregular work hours is that displaced hours of work are in conflict with basic biological principles regulating the timing of rest and activity, namely the circadian and homoeostatic regulatory systems. Other research has found decrements in performance of a task over an extended shift, illustrating that vigilance and task performance is difficult to maintain over extended shifts.

Rosa et al.[26] found that workers became fatigued more quickly with increasing time on a longer shift and were more fatigued during night compared to day shifts. The lowest fatigue levels were maintained across a week of 8-hour day shifts, whereas the highest fatigue levels were observed during the week of 12-hour night shifts. These differences were more apparent at easier task levels. The result of lower fatigue during day shifts at easier task levels is consistent with previous time-of-day studies using physical tasks that were minimally taxing and performed briefly. At the difficult task level, few day versus night or time-on-shift differences were apparent. This was thought to be due to the fact that adding higher loads (for example, heavier boxes) overwhelmed the influence of other interacting factors such as work schedule.

Shift work

Currently, the workers at Owens Corning are on rotating shifts. We were asked by the requestors if we might address the different aspects of shift work, not limited to issues dealing with MSDs. NIOSH has recently published a document on shift work entitled "Plain Language about Shift Work",[29] which will be summarized in the following paragraphs.

In studies of shift work, most workers say they do not choose to work on extended shifts. They do it either because it is a requirement of the job, or no other job is available. Workers we interviewed at Owens Corning reported that shift work is required. A few told us that they preferred the compressed work week because of consecutive available days off work. Reasons for employees choosing shift work over a regular 8-hour work day include better pay, more available time during the day for childcare, more daylight hours for recreation, and more time to attend school. Some workers prefer the night shift because it is quieter and there are fewer supervisors.

Previous research has shown that extended workshifts (i.e., shifts of more than 8-hour duration) may be associated with lower levels of physical and mental health, and may be related to poor living habits, alcohol intake, and higher risk of cardiovascular disease. There is also a concern about the increased risk of unintentional injuries due to extended workshifts. It has been shown, for example, that the majority of unintentional injuries are caused by human error; sleepiness, fatigue and perception ability are essential factors affecting the probability of an error.[30,31] In shift work, the night shift is typically characterized by higher injury rates, presumably due to increased sleepiness.

NIOSH has found that it is important to consider the following features of shift work: (1) how long a shift might be; (2) how many shifts are worked before a rest day; (3) how many rest days on a weekend; (4) whether there is overtime; (5) how much rest is taken between shifts; (6) how much rest is taken during the shift; and (7) whether the work schedule is regular and predictable.

The time of shift is important because people who work in the late night or early morning hours often feel sleepy or fatigued. This is because their body rhythm (also called a circadian rhythm) tells them to be asleep at that time. Night workers must sleep during the day when their circadian rhythm tells them to be awake. Because of this, day sleep tends to be light and unsatisfying. Often, night workers do not get enough sleep during the day to combat nighttime fatigue and sleepiness. Also, workers sometimes must wake up very early and go to work. This usually causes them to abruptly cut off their sleep, which can make them feel overly tired during the day.

Shift times determine when a worker can see family and friends. Many social events take place in the evening, which means they might be missed by evening or night workers. Parents who work the evening shift might not see their children during the week because they are at work when the kids return

from school. If this happens too often, it can be stressful.

Health effects differ depending on whether shifts are permanent (fixed) or rotating. We might think that permanent night workers adapt to or get used to their work. Usually, the longer that someone does something, the easier it becomes. Research tells us that most permanent night workers never really get used to the schedule. That is, there are many nights when they still feel tired and sleepy. Fatigue occurs because most night workers go back to a day schedule on their days off. This is not surprising because family and friends are active during the day. Also many errands and chores must be done during the day. Because most night workers return to a day schedule, they never completely allow their sleep and body rhythms to adapt to being awake at night. They also sleep less during the day, so they can't recover from fatigue. This fatigue can carry over from day to day. Over several days, fatigue can accumulate to unsafe levels. People on rotating shifts face a similar situation. Because the shift times are always changing, they can never completely adapt to a set schedule. Rotating schedules are often used because they are considered fairer to all workers. Everyone in the workforce takes their turn at both the popular and the unpopular shifts. Rotating shift workers are always trying to get used to changing work times. This is not easy, which is why rotating shift workers have more complaints about physical health and psychological stress. Research has shown that rotating shifts have special features that might affect a person's ability to get used to the schedule.

Adapting to rotating shifts can be affected by the speed of rotation and the direction of rotation. Speed of rotation means the number of consecutive day, evening , or night shifts before a shift change occurs. Direction of rotation means the order of shift change: a forward rotation is in the clockwise direction, from day to evening to night shift. A backward rotation is in the counterclockwise direction, from day to night to evening shift. Different rotation speeds also affect a worker's ability to get used to change of shift times. Longer rotations (for example, three to four weeks of working the same hours) are supposed to allow workers more time to get used to night shifts. However, workers usually return to a day schedule on their days off. A fast rotation (every two days, for example) allows no time to get used to night work.

Direction of rotation can affect the ability of circadian rhythms to adapt to the change in work time. Sleep, for example, is a circadian rhythm because each person sleeps for part of every day. Some researchers suggest that a forward, or clockwise, rotation is better for helping a worker adjust to new sleep times. This suggestion was made because it is easier to go to bed later and wake up later. Our body rhythms make us feel more awake and alert in the early evening. This makes it harder to fall asleep earlier. Backward rotations work against the body rhythm by forcing the worker to go to sleep earlier and earlier.

Although there are no hard numbers, NIOSH has found that a backward rotation schedule is used frequently in the United States. It is not completely clear why. It is partly custom and partly because workers like the "long change." In the long change, workers pick up an extra day off when going to evening shifts after night shifts. This happens because evening shift starts late in the day, which leaves most of that day free for non-work activities.

CONCLUSIONS

Workers in the Roving Department at Owens Corning are exposed to increased risks of injury to the musculoskeletal system due to unnecessary bending and lifting that can be reduced by engineering and administrative controls. In the current design of the job, there is excessive lifting of heavy and /or awkward loads over the extent of the shift. These physical demands can be reduced by changing the way the work is performed or by providing assistance for lifting. We recognize that attention to problems in the Roving Department is currently under way with the introduction of a new creel table. Presently, the plan that Owens Corning has for the introduction of this new creel system does not address the risk of injury to workers who will continue to use the older designed creel tables.

We observed that the end-finding and tying-in operations require rapid repetitive hand motions that other studies have associated with musculoskeletal disorders of the wrist and shoulder. This association is strengthened by the OSHA 200 log reports and the review of medical records, where multiple entries were found for work-related illnesses of the shoulders and wrist. Although the hand and finger forces are probably quite low, the repetitiveness of the activity, the concomitant lifting of heavy cakes, bending in multiple awkward postures, and the duration of the shift is a cause for concern. Based on our review of the new creel design, we have concluded that the new design should be effective in reducing the physical demands due to manual lifting of packages from the end table to the creel slots. However, the new creel design will not significantly reduce the physical demands due to lifting and carrying the packages from the carrier to the end table, and it probably will not significantly reduce the repetitive hand motions associated with the end-finding operation. It also will not reduce the bending required when the cakes birdnest.

We are concerned about continued worker exposure to existing ergonomic stressors from the existing creel because our discussion with the Amarillo Owens Corning management revealed that they had no firm time-line for installation of the new creel design *throughout* the Roving Area. At the time of our visit, the Amarillo Owens Corning management was unable to confirm that an improved creel design would be installed throughout the Roving area to replace the older design, even if the preliminary testing indicates that the new design effectively reduces manual lifting. Since our site-visit, Owens Corning has installed a new creel in certain lines and is evaluating its effectiveness, and is consulting with individual operators to gain additional feedback on the new creel. We support this inclusion of input from the operators.

We noted several negative work organization characteristics at the Amarillo plant which have been associated in other studies with adverse health outcomes. One example is the practice of incurring penalties ("occurrences") for non-work-related illnesses which may count towards suspension. Negative work characteristics such as this contribute to tension between management and employees, and may discourage early symptom reporting (especially if the worker does not recognize that the illness may be work-related). This may cause concern among the employees in terms of their health status and the psychosocial environment at work.

RECOMMENDATIONS

Our findings indicate the need to reduce exposure to ergonomic stressors on the lower back and upper extremities. Priority for job analysis and intervention should be given to those Roving jobs in which most people are affected by ergonomic stressors. Jobs associated with worker reports of fatigue and discomfort should be ranked next.

Engineering Controls

1. Change the way materials can be transported: In the past, Owens Corning had invested in a mechanical assist device for the tasks of load lifting and cake carrying. This mechanical lift was found to be awkward to use and had several problems identified with its use, so it was abandoned. We recommend looking again at mechanical lifts for the cakes.

2. Modify the parts presentation: In the Roving Area, there are doffing tasks that still use the lowest shelf, requiring the operator to stoop below knee level. This action requires too much bending, twisting, and stooping. Good ergonomic principles dictate that this lowest shelf be abandoned, as it has been in some of the Roving lines.

3. Address the work-related ergonomic risk to workers while instituting long-term changes. Until new creels are in place, other measures need to be taken to address the ergonomic risk to the workers who are using the old-style creels. Our findings indicate an immediate risk of low back problems and shoulder problems due to manual lifting. Because the company cannot predict how long it will take to install new creels, or if they will be installed throughout the Roving area, we believe that

something should be done in the meantime to reduce the risk of upper extremity and low back problems. Some possible approaches for Owens Corning to consider include: (1) addition of workers to the Roving area to provide fixed breaks, (2) job expansion or rotation of workers into jobs requiring different physical demands, or (3) reduction of production standards to decrease work pace.

4. Production rate and performance standards: Now that it has been in effect for over a year in the Roving area, we recommend that an independent evaluation of the performance standard be conducted with regards to its impact on workplace stress.

Administrative Controls

1. Periodic training related to MSDs and ergonomics should be made available to all employees. Once is not enough. The training should cover specific operations which have been identified by Owens Corning as causing or likely to cause MSDs, the ergonomic stressors involved, the availability of appropriate light/alternate duty, restricted work job, and record keeping, as appropriate.

2. We are aware that Owens Corning is in the process of examining different shift schedules. Owens Corning should strongly consider reducing shift length or offering more flexible shift work schedules. A common recommendation among work shift specialists is that the work pattern be developed through a successful participatory process within the company. There must be cooperation between the employer, the employees, and the safety and health department. An active review of the work shift plan is essential to maintain safe and healthy working conditions. Condensed work shifts may become problematic when other physical stressors exceed acceptable levels.

3. More breaks should be scheduled to allow for rest and recovery. Workers should be encouraged to take their break, and should receive information about increasing their risk of injury due to lack of break and rest time. Åkerstedt and Landström[22] reported that accident risk increased with decreased number of breaks on extended work shifts. This encouragement of breaks should take into account the requirements of set production standards.

4. During our visit, there were no "light-duty" jobs or modified work. Since our site visit, these have been reintroduced at Amarillo Owens Corning. Meaningful light duty jobs should be designed, allowing the worker to maintain contact with fellow employees, with gradual return to normal activities, while providing for specific medical accommodations. Employee representation should be included in identifying new light-duty jobs. Any light/alternate duty jobs should be analyzed for MSD potential. This analysis should include the procedures used in the performance of each job, including lifting requirements, postures, hand grips, and frequency of repetitive motion, and other risk factors. The results of such analysis should be reduced to written form and provided to nurses, doctors, and supervisory personnel involved in the assignment of light/alternate duty jobs with the goal being that a worker is assigned a job that will not further aggravate involved muscle/tendon/nerve groups.

5. The local medical management program in the Health Services Department needs to be re-evaluated. This program should include the following:

(a) The health care providers, including the nurses and physicians, whether contractors or employees of Owens Corning, should be trained in the early recognition, evaluation, treatment, rehabilitation, and prevention of MSDs, and in record keeping requirements, and physical assessment of employees.

(b) Health care staff who are trained in recognizing potential hazardous workplace conditions should perform workplace walk-throughs. This will allow the staff to directly observe individual work practices and remain knowledgeable about plant operations. This

should be done at least monthly and should be documented and reviewed with the ergonomist.

(c) Surveillance should be performed to identify jobs needing intervention to reduce or eliminate ergonomic hazards. This should be done in coordination with the Owens Corning ergonomist. Health care staff and the ergonomists can provide input in the design and operation of a surveillance system for MSDs and can help identify high risk departments and jobs.

(d) Owens Corning's Health Services Department are responsible for entering the appropriate information onto the OSHA forms, or their equivalent as permitted under 29 Code of Federal Regulation 1904, and those responsible for the record keeping must be appropriately and adequately trained on OSHA's record keeping requirements. Review of the medical records made it clear that the nursing staff was carrying out medical treatment - including comprehensive medical regimes and even recommending job redesign without entering information of these injuries on the OSHA Illness and injury logs.

(e) The Health Services Department should have an on-site clinic log. It should have specific information about the type of illness or injury being reported or treated and the exact location of the illness or injury. In addition, the location and type of work being performed should be listed. Having this log available at the Amarillo site would allow the health care staff to monitor the nature and frequency of health problems and focus attention on those suggesting a need for control and prevention. A method to review the log on a specified, periodic basis would be required for the log to be useful in tracking MSDs and looking for trends. This log should be kept in a manner that protects worker confidentiality.

(f) Evaluation of the medical management program should be performed on a periodic basis (at least annually). The goal should be to ensure that the program is effective and that changes in treatment protocols are incorporated.

(g) All Production employees in Roving should be surveyed to establish the baseline frequency of upper extremity symptoms. An example of some useful assessment surveys can be found in NIOSH's Elements of Ergonomics Programs Document[32]. These surveys can contribute to Owens Corning's understanding of the magnitude of upper extremity MSDS, as well as help identify the existence and source of ergonomic stressors in the workplace. The survey should be used only as a tool for assessing workplace hazards in conjunction with other methods of analysis.

6. Workers should be encouraged to report symptoms of discomfort or pain without repercussions from management. Also, incurring penalties ("occurrences") for non-work-related illnesses, which may count towards suspension or eventual termination, discourages reporting of symptoms. Workers should feel free to report symptoms, which is a key component to an effective ergonomics program. Early reporting allows intervention measures to be implemented before the effects of a job problem worsen. Employees should not be discriminated against because she/he reasonably requests to visit the medical facilities or has diagnosed MSD problems and is undergoing medical rehabilitation. Owens Corning must continue to comply with the Americans with Disabilities Act, and all other Federal laws prohibiting discrimination.

7. Owens Corning should make the Family and Medical Leave Act, which addresses several specific topics involving time off from work, easily available to employees to read.

8. During our discussions with Owens Corning management, it was clear that subsequent to the ergonomic training sessions, there were assumptions about single "correct ways" to perform certain tasks, such as lifting objects. This assumption led to penalizing workers for not following specific movements during their work routines. It is very important that the Owens Corning Management realize that such restrictions are inappropriate. There

are guidelines and recommended approaches that can be used to improve the overall safety of a lift, but there can be more than one acceptable way to perform most tasks. Workers should receive training on a variety of lifting methods.

9. Owens Corning should expand opportunities for workers to participate in decision making. This could include modifying the job, supervisory training to develop a consultative style of supervision, and establishing problem solving groups involving the line employees. Committee minutes and decisions should be posted for all employees to keep track of progress.

10. Appendix C lists the work organization characteristics having the potential to intensify risk factors for MSDs: Amarillo Owens Corning management and employees should not only attend to the ergonomic design of the workstations but continue to focus on improving the quality of work. Two distinct approaches that other corporations have tried include are job enlargement and enrichment, and self-managing work groups. Appendix C lists the work organization characteristics having the potential to maximize or minimize risk factors for MSDs.

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TABLE 2
1997 Incidence Rates for All cases of Occupational Illness and Injuries for SIC 3229 and Incident Rates for MSDs in the Roving Area 1995-1997
HETA 97-0276
Owens Corning, Amarillo, Texas

1997 Incident Rate for All Cases of Occupational Illness, SIC 3229, Pressed and Blown Glass*	1997 Incident rate for all Cases of Occupational Illness and Injury, SIC 3229, Pressed and Blown Glass†	1995 Incident Rate for MSD, from OSHA Logs for Roving Dept., Owens Corning, Amarillo, Texas	1996 Incident Rate for MSD, from OSHA Logs for Roving Dept., Owens Corning, Amarillo, Texas	1997 Incident Rate for MSD (based on 9 months), from OSHA Logs for Roving Dept., Owens Corning, Amarillo, Texas
1.3‡	8.9	18	24.5	12.8

*Occupational illness rates include upper extremity musculoskeletal disorders (MSDs) but not back injuries
†Occupational illness and injury rates include both upper extremity and low back MSDs
‡Rates are incidents per 200,000 person hours.

TABLE 3
Percentage of lifting tasks, by Lifting Index (LI) Group,
Texas Tech University Data*
HETA 97-0276
Owens Corning, Amarillo, Texas

LI Range	Percentage of Lifting Activities
0.5-0.99	17.65%
1.0-1.49	41.18%
1.5-1.99	11.76%
2.0-2.49	17.65%
>2.5	11.76%

*Institute for Ergonomics Research, Department of Industrial Engineering, Texas Tech University. Ergonomic Analysis: Roving Area (M-74 & M-75) Report, page 22, 1996.

APPENDIX A

Work-related Musculoskeletal Disorders

These disorders have been called a variety of terms, including cumulative trauma disorders (CTDs), repetitive strain injuries (RSIs), repetitive motion disorders, occupational overuse disorders, occupational cervicobrachial disorders. We call them musculoskeletal disorders (MSDs) in this report.

Considerable scientific research has provided increasing evidence that workplace factors play a major role in the development of MSDs. This research demonstrates that some attributes of work, both working conditions and the performance of work, interact in a multi factorial fashion to contribute to the development of work-related MSDs of the upper and lower extremities as well as the low back. Similar risk factors acting on different parts of the musculoskeletal system have similar effects on muscle, tendon, peripheral nerve and vessel, as well as joints. In general, those risk factors which overload the soft tissues combined with inadequate recovery time for those tissues are likely to lead to musculoskeletal disorders.

With MSDs, the body's muscles, tendons, cartilage, and nerves are affected by both the external work stressors (for example, the lifting, pushing, and pulling of heavy materials) and the individual physiologic factors which can lead to a variety of disorders. As a result of exposure to many workplace factors, repeated or continuous insult may take place in musculoskeletal tissues, affecting their ability to function normally and result in MSDs. The end result may be inflammation, restrictive movements, temporary or permanent damage to muscles, tendons, ligaments, cartilage, blood vessels, or nerves.

Workplace Risk Factors

The term "workplace risk factors" is used to refer to the workplace conditions that can cause or aggravate a MSD. The attributes of the worker's tools, materials, environment, work station, and work methods influence work conditions, and are important determinants of risk for MSDs. Workplace risk factors are present at varying degrees for different occupations, tasks, and individual workers.

A review of the literature on MSDs indicates that for most workplace risk factors there is a relationship between the risk of developing MSDs and the level or magnitude of each of the known causal factors and the number of factors present. Evidence also exists to indicate that the relationship between causal factors may be multiplicative rather than additive.[33,34] This means that the risk of injury from being exposed to more than one factor may be greater than the sum of the two individual risk factors taken together. In combination with the workplace risk factors, aspects of the social and cultural work environment, requirements of the work task, and personal attributes of the worker may also contribute to the development and course of MSDs.[10, 14]

Although current scientific research has been more extensive in identifying certain MSDs and their workplace risk factors than others, studies have indicated key risk factors for the development of these disorders. Examples of recognized workplace risk factors for upper extremity disorders include: (1) repetitive exertions, (2) static exertions, (3) forceful exertions, (4) localized mechanical or contact stresses, (5) awkward postures, (6) vibration and (7) lack of control over the way the work is performed (for example, machine pacing, working under deadlines, inability to take frequent rest breaks particularly while performing precision work).

Examples of recognized workplace risk factors for low back injuries include: (1) heavy physical work, (2) static work postures, (3) frequent and forceful manual handling (which takes into account several important elements: frequency, weight, horizontal and vertical distance, posture, twisting, coupling, and forceful movements), (4) frequent bending and twisting, (5) and whole-body vibration.[10,35] Any of these risk factors may be found alone or in combination with one another. There is sufficient epidemiologic evidence for a number of workplace risk factors to make a causal association with MSDs. However, with few exceptions, there are insufficient normative data to make a precise determination as to a threshold level of harm or when exposure is "safe."

Examples of Upper Extremity Disorders

MSDs of the neck and shoulder often involve tendons, muscles, and bursa; nerves, cartilage and blood vessels may also be affected. Because of the simultaneous involvement of several regional structures in neck and shoulder MSDs, there may be positive signs and/or symptoms in more than one structure (e.g., tendons and muscles).

Rotator cuff tendinitis is a shoulder tendinitis. This is thought to be due to pressing the inflamed tendon between the bone of the upper arm (the head of the humerus) against the acromion bone of the shoulder blade, resulting in what is referred to as an "impingement syndrome." Those who are affected commonly have pain in the front of the shoulder which worsens when they attempt to raise the arm away from the body (abduct the arm); other movements may be painful as well. They may have trouble sleeping with their arms and hands placed above their heads. The tendon has limited blood supply, which may make it vulnerable to injury and slow to repair. Studies have suggested that sustained and static tension in the tendon, occurring with work tasks requiring elevation of shoulders and/or arms, may also be a factor in the occurrence of this MSD.

Tension neck syndrome affects the muscles and ligaments of the neck, either from acute or sustained contraction, or increased intramuscular pressure of these pain-sensitive tissues, causing pain or tenderness. It is characterized by pain and tenderness over the lower portion of the trapezius muscle that extends from the back of the neck into the shoulder areas.

Epicondylitis is a tendinitis which affects the tendons at the elbow, and causes pain in the elbow area. When this occurs in the parts of the elbows furthest away from the body (laterally), it is commonly referred to as "tennis elbow" (lateral epicondylitis); when it occurs on the parts of the elbows that rest on the body (medially), it is referred to as "golfer's" or "pitcher's" elbow (medial epicondylitis). In the great majority of cases, however, people with this disorder play neither tennis, golf, or baseball.

MSDs of the hand and wrist can involve a variety of structures: tendons, nerves, muscles, and blood vessels. The tendons are affected most frequently. Tendon disorders can involve a number of flexor or extensor tendons at the hand or wrist, particularly where they cross bony structures at the joints. Disorders involving the nerves, muscles, and blood vessels occur less frequently. Concurrent involvement of more than one structure is common, so that carpal tunnel syndrome and a tendinitis may occur at the same time.

Tendon related disorders may affect any of the tendons which cross the wrist joint and result in the signs and symptoms of inflammation, or early on, they may just result in symptoms of pain and discomfort. Pathological conditions include inflammation of tendons themselves (tendinitis), of the tendon sheaths (tenosynovitis), and

of the area directly surrounding the tendon and tendon sheath (peritendinitis). Clinically, all of these conditions present with localized pain, tenderness, swelling, and sometimes heat, redness, or crepitation over the affected tendon. In addition, active contraction or passive stretching of the affected muscle-tendon unit causes acute pain. Early cases may present with symptoms but no overt physical findings. In the hand and wrist, the extensor muscle-tendon units are most often affected.

Carpal tunnel syndrome results from compression of the median nerve at the wrist as it passes under the thick tendon sheath through the "carpal tunnel". A combination of factors, including repetitive extension or flexion of the wrist with forceful movements, is thought to cause inflammation of the tendons, and result in reduced volume of the carpal tunnel. This in turn causes compression of the median nerve, which can initiate symptoms of CTS. Injury of the median nerve, either by ischemia or compression classically results in pain and symptoms of burning, numbness, or tingling in the first three fingers of the hand and the base of the thumb. Symptoms tend to be most severe at night, due to flexion of the wrist during sleep, causing compression of the median nerve. Because of its occurrence at night, workers may not relate their symptoms to their work tasks during the day. Advanced cases may include wasting of the muscles at the base of the thumb with resulting weakness and clumsiness of the hand. The occupational factors associated with CTS include repetitive hand motions, forceful hand motions (gripping and pinching), extreme postures of the hand or wrist, contact stress at the base of the palm. Vibration has also been shown to be associated with CTS.

Low Back Pain is common in the general population: lifetime prevalence has been estimated at nearly 70% for industrialized countries. Studies of workers' compensation data that low back pain represents a significant portion of morbidity in working populations: data from a national insurer indicate that back claims account for 16% of all claims and 33% of total claims costs.[36,37]

Low back pain can be defined as chronic or acute pain of the lumbosacral, buttock, or upper leg region. Sciatic pain refers to pain symptoms that radiate from the back region down one or both legs; lumbago refers to an acute episode of low back pain. In many cases of low back pain, clinical signs are absent. Low back impairment is generally regarded as a loss of ability to perform physical activities.

REFERENCES - APPENDIX A

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APPENDIX B

Review of the Consultant's Report

We reviewed the report from June 1997 by the consultants evaluating the "safety culture" of the Amarillo Owens Corning plant. The consultants had administered a survey to around 600 plant personnel, including primary workers, technical/administration workers and managers or supervisors. The consultants conducted one-on-one interviews, combined interviews, and focus groups with various levels of management and employees from different departments. Telephone interviews were conducted with the company ergonomics expert, the Human Resources leader, and the previous Rovings platform leader. The consultants reported that the results of the survey showed overall, relative to other industrial sites, the Amarillo Owens Corning Plant had a weak safety culture. When compared to nearly 100 other facilities and plants across North America, they found that the composite score placed it among the lowest-rated plants and correspondingly with those with the highest accident frequency rates. In eight of the twelve sub-scales of the survey, there was a "considerable difference in perception between management and other work groups." However, the consultants did find that the safety training information updating, policies and procedures, and the safety manager's orientation all received relatively high ratings. They found that wearing personal protective equipment was an accepted norm throughout the plant. The consultants reported that the Owens Corning management had directed major efforts and resources towards safety in the past three years, substantial capital had been expended in lift-assist devices and other stress and strain reducing equipment, though these efforts were only modestly acknowledged by primary workers. They also reported that primary workers manifested a deeply embedded culture of distrust, suspicion and skepticism. The consultants found that a high number of primary workers did not feel the company cares about their own employees.

The consultants reported that there was a pervasive sense that the plant's norm regarding safety was either negative feedback or none at all. Safety recognition efforts had been attempted, but many programs had been abandoned, giving an overall impression that management lacks consistency. However, the consultants found that many in management were striving to create and maintain an environment for all employees, eliminating fear, encouraging open two-way communication and foster teamwork. Nevertheless, the consultants found that most everyone in this plant would agree that for many, these goals were more an objective than reality.

APPENDIX C

Organizational Characteristics of Work

NIOSH has recommended assessing the following aspects of work, and making efforts to maximize (+) or minimize (-) the presence of these conditions as indicated parenthetically:

Temporal aspects of jobs:
- opportunity for rest and adequate work-rest cycles(+)
- shift work (-)
- long work hours (-)
- intense work pace (-)
- high workload variability (-)

Job or task content:
- opportunity to use skills (+)
- sufficient resources (control) (+)
- participation in decision making (+)
- narrow/repetitive tasks (-)
- monotonous work (-)
- heavy vigilance/mental workload demand (-)

Work role:
- clarity of roles, expectations (+)
- conflicting demands, expectations (-)
- excessive number of roles (-)

Interpersonal relationships:
- supervisory support (+)
- peer support (+)
- group conflict (-)

Individual/Career:
- opportunity for development/advancement (+)
- opportunity for learning (+)

Organizational Climate:
- open communications (+)
- respect for individual differences (+)
- spirit of partnership and teamwork (+)
- high priority for health and well-being (+)
- commitment to learning and development (+)