

ERGONOMICS DEMONSTRATION PROJECT

Mechanical Contractor Shop

December 2001



**AN ERGONOMIC EVALUATION OF A MECHANICAL CONTRACTOR SHOP FOR
COMPLIANCE WITH THE WASHINGTON STATE ERGONOMICS RULE**

prepared by

Peregrin Spielholz
SHARP Program
Washington State Department of Labor and Industries

in conjunction with

Gary Fadden
McKinstry Company

May 4, 2001

Executive Summary

This project was completed as a joint demonstration of work-related musculoskeletal disorder (WMSD) risk factor evaluation and mitigation between the McKinstry Company and Washington Department of Labor and Industries. McKinstry is the largest mechanical contractor in the state, constructing and installing HVAC, plumbing and piping systems in many large projects. All jobs in the company office and shops were evaluated by walkthrough assessments and limited work sampling over six sessions. Two Hazard Zone jobs and one Caution Zone job were identified in the office, while five Caution Zone jobs were identified in the shop and warehouse. A potential Hazard Zone risk factor was observed in a shop job on further analysis, and was mitigated by a simple administrative control.

Progressive implementation of work aides and methods has already eliminated hazard zone risk factors in the evaluated jobs. Providing low-cost office workstation accessories easily mitigated the Hazard Zone risk factors in the office jobs. Recommendations were made in the five Caution Zone shop jobs and in the office jobs for further improvement, though not required under the Ergonomics Rule. No economic or technological feasibility issues were found in resolving Hazard Zone risk factors. Good work practices at McKinstry were documented for dissemination to other companies. The use of materials handling aides, enforcement of a strict lifting policy, and good work design demonstrated at this work place may aid other work places in reducing levels of risk factors and increasing productivity. A written ergonomics program and company-specific Caution Zone checklist were also developed during the project. These are contained in the Appendix as examples.

Project Purpose

The goals of this project were to perform an evaluation of all headquarters and shop jobs for the presence of “caution zone” and “hazard zone” risk factors, with identification of mitigating solutions for any identified “hazard zone” risk factors. Any economic or technological feasibility issues in resolution of Hazard Zone risk factors were identified. Also developed as part of this project were a written ergonomics program and a company-specific caution zone checklist.

Introduction

Washington State Department of Labor and Industries has committed to performing demonstration projects in different industries relating practical application of the Ergonomics Rule adopted in May, 2000. McKinstry Company, a large mechanical contractor volunteered to participate in a project with Labor and Industries initially evaluating the company’s headquarters and shop operations.

McKinstry is a contractor of HVAC, plumbing and pipe systems for large commercial projects. The company is a valuable leader in the industry, demonstrating both good work practices and a willingness to partner with regulatory agencies.

The Washington State Ergonomics Rule

The Ergonomics Rule requires employers to evaluate jobs routinely performed by their employees and determine whether one or more caution zone risk factors (WAC 296-62-05105 “What is a Caution Zone Job”) are present on the job more than one day a week and more frequently than one week a year. If at least one of these risk factors is present, then all employees performing this job need to be given ergonomics awareness education and their jobs must be further analyzed to determine whether hazard zone level risk factors (WAC 296-62-05174 Appendix B) are present. Performing hazard zone analysis requires more detailed assessments of the caution zone jobs using more formal methods to determine the level of risk. If a risk factor is in the hazard zone for a particular job, then it must be eliminated or reduced below the hazard level or to the degree feasible. Figure 1 shows the requirements for risk factors in the Caution Zone and Hazard Zone.

Caution Zone jobs are not out of compliance. Only those risk factors in the Hazard Zone need to be addressed by job/tool redesign, administrative controls, or job methods. Many jobs involved with building or demolishing work are classified as Caution Zone jobs, which will require workers performing these activities to receive ergonomics awareness training. Because of this, most workers in the highest risk jobs will receive ergonomics awareness education. Most demonstration projects in construction have thus focused primarily on identifying the Hazards and potential solutions to make these jobs compliant under the Ergonomics Rule.

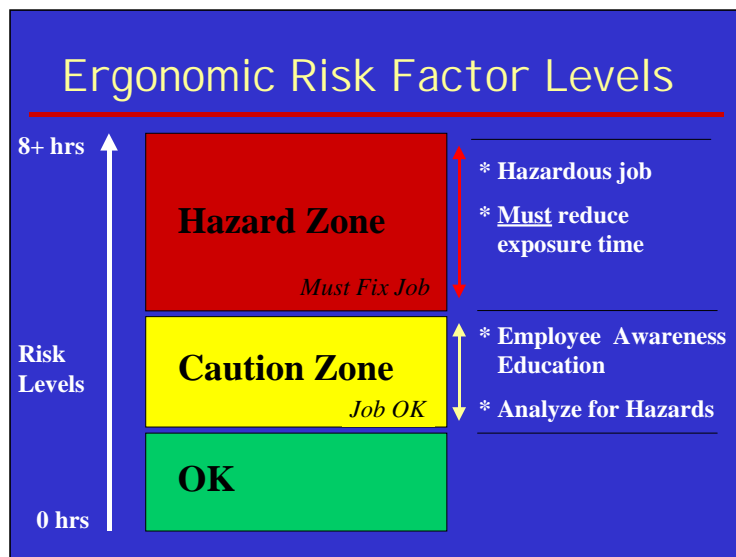


Figure 1. Risk factor levels based on the Washington State Ergonomics Rule.

Project Methods

The McKinstry Safety Director jointly with an ergonomist from Labor and Industries did a walk-through analysis of all jobs. A checklist was completed for each job summarizing the presence or absence of caution zone risk factors. Work sampling analyses were performed by Labor and Industries ergonomists for jobs where caution zone risk factors were found, to determine whether hazard zone levels were exceeded.

Six meetings and walk-through analyses were performed between November 2000 and February 2001. Each discussion and walk-through lasted approximately 2 hours, and resulted in analysis of all caution zone risk factors, hazard zone risk factors, and recommendations for future workplace improvement. Existing practices were documented which already mitigated ergonomic risk factors in potentially hazardous areas.

Results

Office Areas

The work areas in the headquarters office were evaluated on a half-day walkthrough that included interviews with workers and observation of activities. The areas evaluated included: receptionists, engineers, data entry, project management, and support staff.

One payroll entry job and one invoice entry job were determined to be in the hazard zone for intensive keying with awkward hand postures more than 4 hours per day, and in the caution zone for neck bending. The hazard zone risk factors for the hands were largely due to repetitive entry of data at workstations that lacked adjustability and arm support. The payroll supervisor job had repeated hand impact as a caution zone risk factor due to repeated stapling.

The payroll supervisor was given an electric stapler to remove the hand impact as a Caution Zone risk factor, though this improvement was not required under the Ergonomics Rule. The workers in the two entry jobs will receive ergonomics awareness education and workstation improvements including portable, tilted worksurfaces, adjustable keyboard trays and adjustable chairs with armrests to reduce necessary awkward hand/arm postures. The addition of adjustability to the chair and keyboard would remove the awkward postures for the hands/wrists, leaving the intensive keying risk factor but at less than 7 hours per day. These improvements should assure that no office jobs could be classified as having hazard zone risk factors.

Sheet Metal, Plumbing and Pipefitting Shop Areas

Several walkthrough evaluations were performed in all areas of the shop including sheet metal fabrication, pipefitting, plumbing, tool room and warehouse. Assessment of risk factors was based on tasks that were observed and possible task situations described by workers. Table 1 summarizes the evaluated jobs and corresponding risk factors.

ERGONOMICS DEMONSTRATION PROJECT

Air-bending/Crimping and Assembly in the sheet metal shop are caution zone jobs due to hand repetition. However, assembly would only be a hazard zone job in the case where a worker spends a whole day simply hammering small pieces together. This may happen occasionally but is not the normal practice. The shop policy was altered to assure that job rotation or job sharing would occur as directed by the supervisor in these cases. This would remove the only observed hazard zone risk factor in the shop areas.

Neck bending in Fab Assembly and Welding, and hand repetition in Plumbing Fabrication are only in the caution zone as a worst case, in fact these risk factors may not be present in these jobs much of the time. Other awkward body postures were observed for limited periods, usually due to a mismatch between the height of the cart worksurface and the duct piece. It is also recommended that some carts in the future either be fabricated at different heights or provide height-adjustability. This, however would not be necessary to reduce any hazard zone risk factors.

Table 1. Summary of Observed Risk Factors in Shop Area Jobs

Area	Job	Caution Zone Risk Factors	Hazard Zone Risk Factors
Sheet Metal and Pipefitting Shop	Forming and Bending	None	None
	Air-bending/Crimping	Hand Repetition > 2 hrs/day	None
	Plasma Cutter	None	None
	Securing Sound Liner	None	None
	Assembly Area	Hand Repetition > 2 hrs/day	Hand Repetition > 6 hrs/day
	Press Break	None	None
	Fab/Assembly Heavy Gauge	Neck Bending > 2 hrs/day	None
	Welding	Neck Bending > 2 hrs/day	None
	Spiral Duct	None	None
Plumbing Shop	Plumbing Fabrication	Hand Repetition > 2 hrs/day	None
Field Support	Warehouse	None	None
	Tool Room	None	None
	Fleet Maintenance	None	None

Demonstrated Best Practices

The McKinstry Company has been recognized as one of the best-run workplaces in Washington for good reason (AWB 2000 Workplace of the Year). Many recommended ergonomic interventions are already in place and have contributed to the company being a safe and profitable place to work. It is hoped that other workplaces in this industry and other industries will adopt some of the practices identified in this project. This section highlights some of the methods and equipment in place in the McKinstry shop that help reduce the risk of a musculoskeletal injury or illness. Table 2 summarizes best practices already in place at McKinstry to reduce possible risk factors.

Table 2. Implemented Best Practices at McKinstry and Mitigated Risk Factors

Job Activity	Mitigated Risk Factors	Implemented Solutions
Welding	Heavy, Frequent or Awkward Lifting Gripping > 10 lbs with Awkward Posture	Provision of Overhead Cranes and Carts Provision of Rotating Holding Jigs and Stands
Plumbing	Awkward Body Postures, Kneeling, Squatting Heavy, Frequent or Awkward Lifting	Pre-assembly of Components at Bench Height Assembly on Rolling Carts with Use of Crane
Warehousing	Heavy, Frequent of Awkward Lifting	Provision of Mechanical Lifts, Hand Trucks and Cranes Forklift Use/Design of Warehouse for Access
Sheet Metal	Awkward Body Postures, Kneeling, Squatting	Provision of Waist-level Carts for Working Surfaces
All Job Activities	Heavy, Frequent or Awkward Lifting	Enforced Company Policy of No Lifting > 50 lbs Alone Provision of Cranes, Carts, Lifts and Hand Trucks

Jigs and stands are provided to hold the material in a comfortable position for work. Fixed and rotating jigs are available for holding pipes during welding, eliminating the need to lift when used in conjunction with a crane, and the need to hold the pieces in place. Figure 2 demonstrates the use of the holding jig and a stand for welding. Figure 3 shows a rotating holding jig that rotates the pipe for welding, reducing awkward body postures while welding around the perimeter.



Figure 2. Welding with a holding jig and stand.



Figure 3. Rotating-welding jig to hold parts and place work area in position.

Pre-assembly of building systems is generally recommended when possible to allow more control over the work location and eliminate unnecessary lifting of materials. McKinstry assembles plumbing sub-systems in the shop on portable, rolling racks. This allows work to be completed at a comfortable height with tools and materials near at hand. Once the sub-system is completed, it is lifted with a crane and then rolled into

storage before it is trucked to the site. Figure 4 shows a plumbing sub-system under construction on a portable frame.



Figure 4. Pre-assembly of a plumbing sub-system on a portable, rolling framework.

Materials handling is performed to limit worker exposure to WMSD risk factors. McKinstry strictly enforces a 50 lb. limit for a one-person unassisted lift and provides means to accomplish the work without the need to lift heavy items. Overhead cranes are available to move and hold heavy material throughout the shop. Hand-crank lifts are used in the tool room to place/retrieve tools, while material in the warehouse is palletized and moved by forklift. Hand-trucks and carts are provided to place and move heavy material such as metal sheets or gas cylinders. Engineering and administrative controls are preferred as mitigating solutions. However, where no easy assisting device is present, such as when lifting metal sheets, two people move the material. Carts are used to work on and move sheet metal material, which reduces lifting and provides a portable work surface. Figure 5 illustrates the use of a cart during sheet metal fabrication. Figures 6 through 9 illustrate materials handling methods used at McKinstry.



Figure 5. Use of a cart for storage and working on sheet metal ductwork.



Figure 6. Two-person lifting of sheet metal when mechanical aides are not feasible.



Figure 7. Lifting a pipe piece with an overhead crane.



Figure 8. A lift used in the tool room for placing/retrieving material over the head.



Figure 9. Use of a handcart to move gas cylinders.

Conclusion

This project demonstrated that shop activities and office jobs relating to sheet metal work, plumbing and pipefitting can be performed under the Washington State Ergonomics Rule in a well-run workplace with few modifications in jobs or procedures. A simple administrative control and low-cost accessories for two office workstations will assure that no jobs in the McKinstry Company shop or offices have hazard zone risk factors.

Appendix:

Company Written Ergonomics Program and Caution Zone Checklist

McKinstry Company Ergonomics Program (Internal Company Document – Not Required by Labor and Industries or the Ergonomics Rule)

Ergonomics is the science and practices of designing jobs or workplaces to match the capabilities and limitations of the human body. It is also a tool that can be used to make jobs, workstations, and tools to fit the worker. Implemented ergonomics programs in the workplace have been found to greatly reduce injury claims and costs. Other benefits have been found, such as increased productivity and product quality, and improved morale among employees.

Ergonomics also help to identify jobs and tasks in the workplace that may pose a hazard for work related muscular skeletal disorders (WMSD's). Work related muscular skeletal disorders are occupational disorders that involve soft tissues such as muscles, tendons, ligaments, joints, blood vessels and nerves.

Caution Zone Jobs

This rule only applies if you have caution zone jobs. It's important to note where caution zone jobs are identified, they are not prohibited in any way and depending on the results of a further look at these jobs, may or may not require the job to be controlled in some manner to reduce hazards. Look for these indicators: Awkward postures, high hand force, highly repetitive motion, repeated impact, heavy, frequent or awkward lifting and moderate to high hand-arm vibration. Only a reasonable determination is needed to be made as to whether caution zone jobs are present in the workplace. Use of existing knowledge or information about the jobs, or an estimation of exposure to employees, if any, are helpful in determining caution zone jobs. A lot of caution zone jobs depend on how long the employee is exposed to risk factors for injury. The duration of exposure is the amount of time an employee is exposed to the actual risk factor, not the time that they spend on the job that the risk factor is part of.

Awkward Postures:

Being in these work positions for more than 2 hours total per day.
Hands above head, Elbow above shoulder, Back bent forward more than 30 degrees, Neck bent more than 30 degrees, Squatting, Kneeling.

High Hand Force:

Using a lot of hand force increases the risk for hand, wrist and elbow injuries, and in some cases shoulder injuries. Holding something between the tips of the fingers and the thumb is called pinch grip. This type of grip used very small muscles in the hand and wrist, so even holding something that weighs only 2 pounds can be a risk for injury if it's done for more than 2 hours per day. When you grip something with your whole hand you're able to use the larger muscles in your forearm, and this gives you a grip that's five times stronger than a pinch grip. You're also able to get a better grip, so the amount of grip force you use is pretty much equal to the weight of the object you're holding. Grip force only enters the caution zone if it's 10 or more pounds of weight held or 10 or more pounds of force exerted, and it's done more than 2 hours per day.

Highly Repetitive Motion:

Workers repeat same motion every few seconds for more than 2 hours per day with – the neck, shoulders, elbows, wrists and/or hands. Intensive keying for more than 4 hours per day is a good example.

Repeated Impact:

Using hands or knees as a hammer – more than 10 times per hour – more than 2 hours per day.

Heavy, Frequent, or Awkward Lifting:

Just about every job requires some lifting, but lifting only becomes a risk for injury if it's heavy lifting, if the lifting is done frequently, or if it's done in an awkward posture.

For the caution zone, heavy lifting is any lift of 75 lbs or more once per day, or 55 lbs ten or more times per day.

Frequent lifting is 10 lbs or more, more than twice per minute, for more than 2 hours per day.

Awkward lifts are lifts of 25 lbs or more above the shoulders, below the knees, or out at arms' length done more than 25 times per day.

Moderate to High Hand-Arm Vibration:

Quite often our work requires the use of High Level Vibration tools.

Using impact wrenches, chain saws, percussive tools (jack hammers, scalers, riveting or chipping hammers) or other hand tools that typically have high vibration levels more than 30 minutes total per day.

Moderate Level vibrations work consists of using grinders, sanders, jig saws or other hand tools that emit moderate vibration levels more than 2 hours total per day.

Analyzing Caution Zone Jobs for Hazards

Employees whose jobs involve one or more of the risk factors previously stated, are in the caution zone and they need to receive the awareness education. McKinstry will analyze these jobs to see if they are hazardous and need to be corrected. The analysis needs to go beyond just whether or not there are risk factors, to try and find out what about the workplace or the job is creating the risk factors.

The Specific Performance Approach will be used to help analyze jobs and identify specific hazard control levels. Physical demands include the risk factors previously stated, but also the pace of work, whether the tasks are all the same or if there's variety, and how much recovery or rest time there is between tasks.

Layout of the work area includes things like reaches, height of the workstation, chair, conveyor or whatever it is the employee works with or on to see if it is causing awkward postures.

The point of the analysis is to see if a caution zone job is hazardous, and to help figure out the best way to control the hazard.

The Job Has Been Defined as “Caution Zone”

All McKinstry Co. employees and their supervisors, involved in caution zone jobs will be provided with general ergonomic awareness education. These jobs will be looked at in more depth to determine if they have hazards that require controls and to discover what is causing the hazards identified. If hazards are identified, they will be reduced below the hazardous level, or to the degree feasible.

Engineering or administrative controls such as changes to work stations and tools, process redesign to eliminate unnecessary steps, or job rotation might be methods to control such hazards. If these methods of control are not effective in reducing the hazards below the hazardous level, then an evaluation of individual work practices or personal protective equipment (if feasible) as interim measures to supplement the other hazard controls.

Ergonomics Awareness Education

Ergonomics education is for employees and their supervisors working in “Caution Zone” jobs. Training is part of the new hire orientation process and refresher training is to take place at a minimum of every 3 years. Training will provide information on “Caution Zone” risk factors associated with each work station function. It will show the types, symptoms and impacts of work related muscular skeletal disorders, along with the importance of early reporting of symptoms, the identification of hazards and measures to reduce them.

Job specific training is required in cases where measures to reduce work related muscular skeletal disorder hazards have resulted in changes in a job or work practice. Training needs to include:

- hazards of the job or work activities.
- safe work practices
- proper use and maintenance of the control measures.


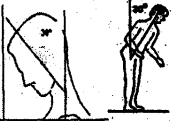



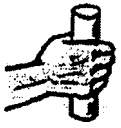
Employee involvement is a very important element of our Ergonomic Program. The company Safety Committee will be directly involved in choosing the methods to be used for employee participation in analyzing caution zone jobs and what measures will be used to reduce WMSD hazards.

Caution Zone Analysis Form

Employee Name: _____ Date: _____

Craft Position/Job Title: _____ Job Location: _____

- Please review the risk factors and duration categories below. If you feel that you perform any of these risk factors with the listed duration, please mark the corresponding box to the right. If you do not fit into any of these categories, then mark the last box "No risk factors present" located on the second page. If you are borderline in meeting a category, please check the box, as it will be analyzed further at a later date.
 - You must perform the task more often than one day per week and more often than one week per year for it to be included.
 - Duration refers to the total amount of time per day you are exposed to the risk factor, not how long you spend performing a work activity that includes a risk factor. Use your best guess to determine the length of time.

Physical Risk Factor	Duration	Visual Aid	Check box if you fit under both the risk factor and duration
Awkward Posture:			
(1) Do you work with your hand(s) above your head, or your elbow(s) above your shoulder? _____ The posture must be related to the way the job is set up and not due to individual technique. <i>Example Task: Putting mail into slots that are located higher than eye level.</i>	→ And more than 2 hours total per day		<input type="checkbox"/>
(2) Do you work with your neck or back bent forward more than 30 degrees without support or the ability to vary posture? _____ The posture must be related to the way the job is set up and not due to individual technique such as using a microscope due to the equipment design.	→ And more than 2 hours total per day		<input type="checkbox"/>
(3) Squatting? _____ The posture must be related to the way the job is set up and not due to individual technique.	→ And more than 2 hours total per day		<input type="checkbox"/>
(4) Kneeling with one or both legs? _____ The posture must be related to the way the job is set up and not due to individual technique.	→ And more than 2 hours total per day		<input type="checkbox"/>
High Hand Force:			
(5) Do you pinch an unsupported object(s) weighing 2 or more pounds per hand, or pinching with a force of 4 or more pounds per hand (comparable to _____ pinching half a ream of paper)? <i>Examples: Pulling 1" thick or large files, using a claw style staple remover, fastening materials using medium black file clips, closing a 2" 3 ring binder.</i>	→ And more than 2 hours total per day		<input type="checkbox"/>
(6) Do you grip an unsupported object(s) weighing 10 or more pounds per hand, or grip with a force of 10 or more pounds per hand (comparable to _____ campling light duty automotive jumper cables onto a battery)? <i>Examples: Using a manual day stamp, holding onto a manual stapler to staple materials.</i>	→ And more than 2 hours total per day		<input type="checkbox"/>

ERGONOMICS DEMONSTRATION PROJECT

Caution Zone Analysis Form, Page 2

Physical Risk Factor	Duration	Check box if you fit under both the risk factor and duration
Highly Repetitive Motion:		
(7) Do you repeat the same motion with your neck, shoulders, elbows, wrists, or hands (excluding keying activities) with little or no variation every few seconds? _____	→ And more than 2 hours total per day	<input type="checkbox"/>
(8) Do you perform Intensive Keying: Keying with the hands or fingers in rapid, steady motion with few opportunities for temporary work pauses? <i>Example: Inputting continuous data into the computer from forms or Dictaphone. If one is composing the information or has frequent interruptions such as phone calls, they would <u>not</u> qualify under this category.</i>	→ And more than 4 hours total per day	<input type="checkbox"/>
Repeated Impact:		
(9) Do you use your hand (heel/base of the palm) or knee as a hammer? <i>Example: Using ones palm to staple materials while using a manual stapler on the desk.</i>	→ And more than 10 times per hour more than 2 hours total per day	<input type="checkbox"/>
Heavy, Frequent or Awkward Lifting:		
(10) Do you lift objects weighing a. More than 75 pounds? _____ b. More than 55 pounds? _____ <i>Example: 19" monitors = 55 pounds</i>	→ And a. once per day b. more than 10 times per day	<input type="checkbox"/>
(11) Do you lift objects weighing more than 10 pounds? _____ <i>Example: 2 reams of paper, full 4.5" 3-ring binder.</i>	→ And more than twice per minute or more than 2 hours total per day	<input type="checkbox"/>
(12) Do you lift objects above the shoulders, below the knees or at arms length weighing more than 25 pounds? _____ <i>Example: paper box = 50 pounds, boxes of printed materials = 40-60 pounds</i>	→ And more than 25 times per day	<input type="checkbox"/>
Moderate to High Hand-Arm Vibration:		
(13) Do you use impact wrenches, carpet strippers, chain saws, percussive tools (jack hammers, scalers, riveting or chipping hammers) or other hand tools that typically have high vibration levels? _____	→ And more than 30 minutes total per day	<input type="checkbox"/>
(14) Do you use grinders, sanders, jig saws or other hand tools that typically have moderate vibration levels? _____	→ And more than 2 hours total per day	<input type="checkbox"/>
No Risk Factors Present _____ →		<input type="checkbox"/>
Employee Comments:		
Supervisor Comments:		
Supervisor's Signature: _____ Date: _____		