SESSION 2: INTERVENTIONS CURRENTLY USED IN THE TRADES TO CONTROL MSDS AND SOFT TISSUE INJURY RISK FACTORS

[Please note: The following presentation summaries are transcriptions from the 2-day meeting. These transcriptions have been edited and reworded for clarity of meaning. The presentations, including questions and answers, are included in the proceedings as documentation of the meeting. The content, however, might not reflect current NIOSH policy or endorsement.]

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SESSION 2: 2-1
INTERVENTIONS USED IN THE ELECTRICAL TRADE SOFT TISSUE INJURIES PROJECT

Bert Mazeau, Corporate Safety Director
Rosendin Electric, San Jose, California

The general risk factors for soft tissue injuries are force, lifting, pushing and pulling, awkward postures, cramped work area, repetitive work, and contact stress. Tasks in the electrical trades that can involve these risk factors include:

- Twisting wire nuts on wire ends;
- Installing conduit overhead and to the floor line (there is a lot of overhead work in the trade);
- Pulling wire;
- Installing light fixtures;
- Moving and installing switch gear, transformers, and generators;
- Bending conduit; and,
- Drilling into ceilings and floors.

Rosendin Electric focuses on the pre-job planning process to address lifting and body positioning. As part of the pre-task plan, we use a soft tissue protection plan and a safe lifting plan. For anything weighing over 50 lb, we develop a safe lifting plan for the crew, and the crew signs off on it. In the soft tissue protection plan, we identify types of hazards, the body position, the exposure, the control measures, and the personal protective equipment requirement.

Another thing we do is prefabrication of assemblies. This can be done in the shop, on tabletops with stools, to minimize strains. We can assemble them in large quantities and then ship them out to a job site, rather than having on-site people assemble them in ones and twos.

For New Hires

Hand tools are generally provided by employees. We check a person's tools to determine whether they are adequate for the job. When tools are first purchased, they are bought by a low-wage apprentice, and they carry them as long as they can. They seldom get ergonomically-designed tools. We interview new hires using an experience and training form. The person lists the types of training they have had on various tools and equipment, such as scissor lifts and benders. The form helps us decide where to place that person. New hire orientation is key: our training deals with soft tissue injuries and proper lifting techniques. At our weekly tailgate meetings, these things are discussed again, so that we can re-train people who are not doing things the proper way. Our training reaches both supervisors and employees. Quarterly supervisors' meetings target these areas. This year's target areas are MSDs and cuts to the hands. We have had an ergonomist and physical therapists come in, to provide information to the supervisors.

Awkward Body Positions

It is not always possible to engineer things in this business, but we try. Here are examples of the types of situations people get into.

In the following picture, (Figure 2-1.1) a worker is handling a piece of pipe that weighs 110 lb. It was team-lifted into position. He is in cramped quarters, under a building, down on his knees, in the dirt. It is an awkward position for his back and shoulders.

Our company tries to set up pre-job stretching, warm-ups, and pre-task stretching, to get the person warmed up for the particular task they will be doing.*

Our company uses scissor lifts a tremendous amount. We try to get people to position the platform at the proper level, so they do not have to overly extend their arms. We also use fiberglass ladders rather than wood. Fiberglass ladders result in less rattling and shaking, and fewer falls, and they are lighter.

The worker in the picture below (Figure 2-1.2) is working extremely hard. The crew came by and assisted him; five people pulled on that rope.

The following picture (Figure 2-1.3) shows a worker installing pipe on a deck. The worker is securing the pipe with wire. His position is tough on his back, and he is not wearing kneepads. One thing our company uses in this situation is plastic tie-wraps instead of wire, to allow the concrete to be poured. We also instruct workers to change positions frequently.

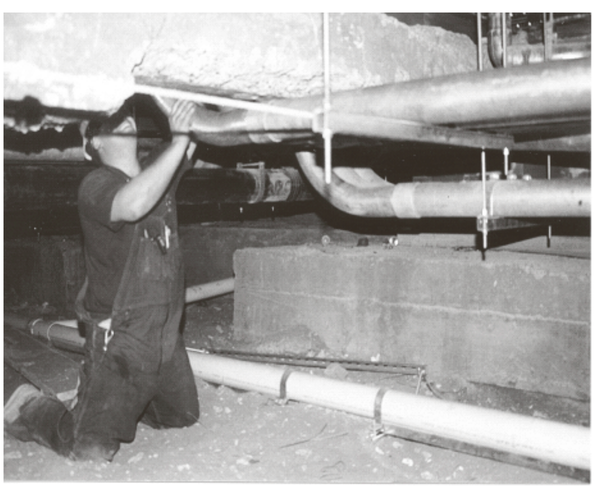

Figure 2-1.1. Worker installing pipe

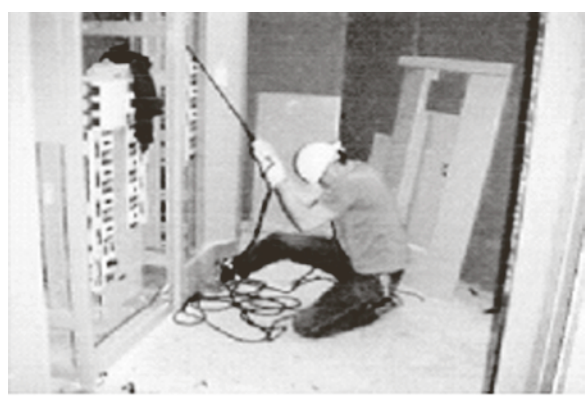

Figure 2-1.2. Worker tugging on rope

*The effectiveness of stretching exercises in preventing injuries from work has not been proven. For more information on this topic, see Hess et al., 2003.

Equipment and Materials

Different types of ergonomic equipment are available for pulling conductors (e.g., wires and cables), and much more power can be used. The picture below (Figure 2-1.4) shows a cable tugger/cable puller. This piece of equipment can do a lot of the work. In addition to the cable pullers, our company also uses cable feeders.

The following picture (Figure 2-1.5) shows a creeper, which is something we designed for a particular job in tight quarters. We built this creeper for the individual. It has an adjustable backrest and neck and lumbar supports. The worker was able to change positions, and he is wearing kneepads. The worker could get off the creeper at times. We also had a material cart attached, that he could bring with him.

The next picture (Figure 2-1.6) shows an elevated reel, an intervention a general foreman devised. We raised this reel of wire to give it a gravity feed, rather than having to pull it off a reel on the ground. One person can work the elevated reel.

Our company is trying to work smarter, not harder. Nobody in the business should have to give up their body.

Body Savers

Following are some tools and equipment that can reduce exposures to work-related WMSD risk factors:

- Ratchet sets, instead of openend wrenches. These are especially helpful when you are putting together heavy things, such as switchgear and other large objects

Figure 2-1.3. Worker installing pipe on deck

Figure 2-1.4. Worker operating cable tugger/puller

- Fixture lifts, so the worker does not have to lift and hold the fixture;
- Scissor lifts to give the worker a mobile platform on which to work;
- Power tuggers;
- Multi-ton rollers to move switchgear and heavy objects around without making a worker pull the entire crew over to "muscle" something up;
- Air packs (which are like air tables) on which a heavy object can be placed and moved around with a flow of air;
- Cordless (battery) screwdrivers. It takes 10 partial wrist twists to put on a wire nut. A worker can use an adapter on a battery; screwdriver—all the worker has to do is hit the trigger and it turns the wire nut onto the wire;
- No tool belts. Our company uses carts instead. The worker can take his tools, connections, and pipe with him;
- Forklifts, including reach forks;
- Cranes;
- Pipe racks. We put pipe on racks instead of on the floor;
- Wire feeders; and,
- Battery drills.

Questions from Presentation 2-1

Question for Bert Mazeau: How do workers react to your implementation?

Answer: It runs the gamut. Some say pain and aches are part of the trade. Younger journeymen and apprentices seem more interested. More information is available to them through their newsletters and journals.

Question for Bert Mazeau: Have lost-time injuries (LTI) decreased?

Answer: To some extent. It's a little too early to tell. We use leading indicators observations—to see how people are performing. The lagging indicators are the metrics. Over time, we will get a better feel for it.

Figure 2-1.5. Worker using customized creeper

Figure 2-1.6. Elevated reel to assist installation

Session 2: Presentation 2-2
Ergonomic Injuries, Repetitive Motion Trauma, WMSDs, and Soft Tissue Injuries

Mike Murphy, ***Safety Coordinator***
National Electrical Contractors Association-International Brotherhood of Electrical Workers (NECA–IBEW) Electrical Training Center, Portland, Oregon

I work for 4,000 journeymen, 600 apprentices, and 125 contractors. I work for both the contractors and the union. The contractors pay my wages; the unions ask me to do things.

At an OSHA hearing on ergonomics, the president of an Idaho logging company testified about the reason her company did not need an ergonomics standard. She said their people do not have to quit work due to ergonomics, because their major problems are caused by chainsaws—the stress and the vibration. She talked about the choker setters (the people who operate the big equipment). She was defining soft tissue injuries, but she had no idea that what she was describing was exactly what the hearing was about. That is the same problem we have with our contractors. We try to make them understand the frequency of soft tissue injuries—that the biggest amount of money paid out is for soft tissue injuries.

The workers in NECA-IBEW are asking each of our employers to voluntarily fill out an Injury/Illness Report Form, and the majority of our employers are turning in the forms. We have been able to show our employers where the injuries are, which are the same as what has been reported here today.

What we are doing to correct the problem is a boot camp for new apprentices. Two weeks prior to going on a job site, we bring them into the training center. We teach them how to use hand tools, and how to use their bodies. We furnish tool belts: two pouches with a belt and suspenders. We buy their hand tools—ergonomic ones—screwdrivers that fit their hands a lot better, and wire strippers. The apprentices can show the journeymen on the job site. We have found this is a cultural thing. We get resistance from the journeyman: "This is the way I've done it for 20 years, and I'm going to do it this way for another 10 or 15 years."

At our last Trust meeting (I work for four employers and four union people), they agreed that for one day in a two-week period, we would bring in a doctor and a person who deals with ergonomic injuries, and go through range-of-motion testing for all apprentices. The apprentices can learn what restrictions they have, and what they can do to overcome problems they might have. The majority of accidents happen to apprentices, or people who have been in the trade less than five years. Those are the reversible injuries. Older workers, with at least 15-years of experience, have cumulative injuries to their backs, knees, hips, and shoulders. We make an example of them, by showing them to the apprentices. We will say, "You're working with Charlie—He never climbs a ladder. He can't. His knees are shot. He does all the work on the ground; you do all the work in the air." Of course, we talk to Charlie beforehand. So, the apprentices see what has happened to a person who has been in the trade for 20 or 30 years.

We were recently awarded a grant from Oregon OSHA to do an ergonomics study at two job sites. We will buy battery-powered hand tools for the workers and watch them for 8 to 12 months to see what changes occur. We will talk to them about what hurts, why, and what tasks make them hurt.

We are using job hazard analyses done by Rosendin Electric and other employers. Through our monthly joint safety committee meetings, we hope to take these ergonomic changes to all 125 employers.

Questions from Presentation 2-2

Question for Mike Murphy: Did you have to get approval from management for boot camp? Who's paying for it?

Answer: It's paid for by the industry on a cents–per–hour basis. It came out of the necessity to have a trained workforce when they went on the job site, so they knew about the noise and the constant motion. The average age when apprentices start is 22 to 23; they have been working in stores or going to school. They are not used to the hazards of the job site. We were having apprentices injured immediately when they went on the job site, just from the confusion. We're trying to take that confusion out of the job site.

It was hard to sell to employers. They didn't want it because of cost. Now they rave about it. It is saving them money. It has cut down on injuries. Apprentices are more productive, and they are not borrowing tools from journeymen. They know how to handle tools, how to bend conduit, and how not to hurt their body when they are bending conduit. We work with them on pulling wire, and make sure they understand the safety rules. They can train the journeymen that it is not a safe condition. They can say, "I've been told by Mike Murphy this is an unsafe condition, and I do not have to do it."

The other thing the training trust—JATC—has given me: If I go on a job site and there is intimidation of an apprentice to do something unsafe, I can take that apprentice out of that shop and put him in a shop I know is safe. If the employer gives me problems, I take all the apprentices out of that shop, and the employer doesn't get an apprentice for two years. So, the employers pay attention.

We're also changing to a day-school concept—so we have apprentices eight hours at a time, instead of three hours on two nights a week.

Session 2: Presentation 2-3
Construction Ergonomics: A Participatory Process

Tony Barsotti, ***Safety Director***
Hoffman Construction, Portland, Oregon

I'm a "hybrid person", who bridges between the employer and the worker. I'm a pipefitter by trade. Eight years ago, I went to work for Hoffman Construction. My experience is mostly in high-tech work, including Intel, an owner with multiple capital projects and a commitment to creating an injury-free work environment. An integral part of changing the industry is the support of the owners.

One of the biggest challenges we have faced in the years of working with the University of Oregon on a CPWR grant [funded by the NIOSH] has been, "What is it that keeps us from implementing these things?"

We have wrestled with the blend between specific techniques and tools, versus changing the work practices. I will talk most about work organization and the challenges to implementing solutions to musculoskeletal exposures. The challenge is not about what can be done. There are so many areas where we can make changes right away. It is about understanding the barriers that keep us from making changes.

To be successful, the process has to be participatory and involve the whole gamut of people who are involved in the project. The process is what counts. (Figure 2-3.1) The means will determine the ends.

We are asking people to be involved. We cannot succeed without the full knowledge and experience of everybody who is part of the organization. We cannot adapt to the changing environment without using the experience of the crews and the front-line supervision. The industry is one of the last bastions of the "command-and-control" chain of command. We have to let go of some of that if we are asking people to participate and create win-win situations.

I brought with me a job hazard analysis for piping contractors and some analysis of their injuries, leading to some improvement plans we can look at in the breakout session.

The movement to develop a job hazard analysis and apply it to the job site is a good thing. The job hazard analysis has replaced the company safety manual as something the company has on their shelf. It exists as a document. In the compliance mode of, "I won't get into trouble because I have it." That is a good achievement, but it is not a living document that is part of the way the organization breathes, that is available as people are working on a project.

We are moving into the next phase, what we call an activity hazard analysis. This is the next step in the process, in which we want each organization to look at the specific scope of work, the specific environment, and the specific schedule. What are the activities and what are the hazards? What are the engineering controls, and what are we going to ask the workers to do through use of personal protective equipment (PPE) to control those hazards?

Many musculoskeletal exposures are common across the trades (Figure 2-3.2).

Barriers to Change

The level of understanding of risk factors for MSDs is high, but people are not necessarily seeing all of the risk factors. Even among safety professionals, there are so many other safety-related things to look for, that the person is not focused on the body position, the awkward posture, and how long they are doing it. This is because the person is still having to look at whether they are tied off, wearing their safety glasses, the housekeeping, and how their cords are strung. Even safety professionals may still be trying to figure out how many feet of pipe they got in today, or if they are making their units this week. It is a much further distance to see and understand these risk factors. Therefore, we have lots of work ahead of us to popularize these MSD risk factors.

Fast-paced projects challenge how communications flow inside organizations and across organizations on a multi-employer work site. We find people who constrict information for control purposes. Planning is a great tool, but what counts is who participates in the planning and when, in order to ask the right questions as decisions are made.

There is a general paradigm shift going on in society. The old views limit our ability to use the knowledge of the people who are doing the work: they are hierarchical; they do not support participatory notions. There is a competitive view, which is very different from what Bert Mazeau talked about in Presentation 2-1. People might have a great new approach, but they do not want to share it because it gives their company a

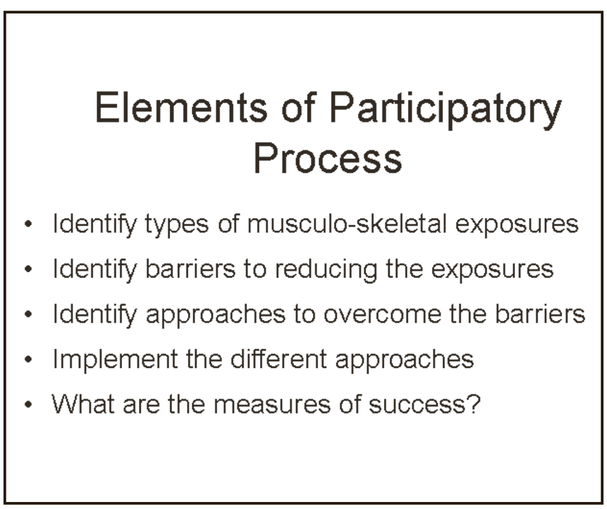

Figure 2-3.1. Elements of participatory process

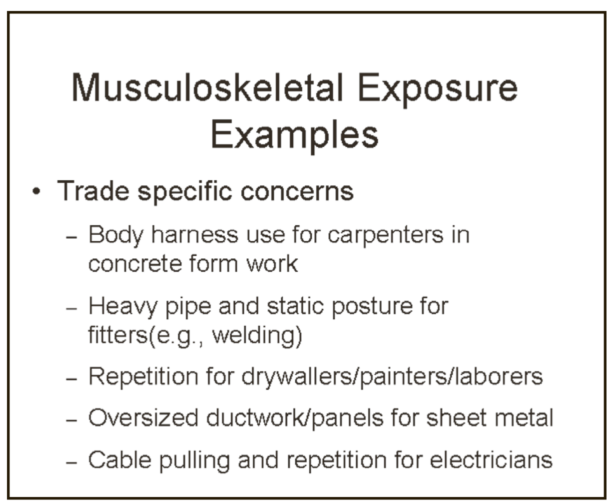

Figure 2-3.2. Musculoskeletal exposure examples

competitive advantage on the next bid. We have some progressive contractors who understand interdependence, and that we all go forward on a rising tide. However, we have other contractors who take the short view and advance their own interests in a short time frame. Lump sum bidding (which we are not going to change overnight) gets in our way. We are trapped in a project-to-project mentality.

We have taken some strides in bringing people into the process earlier, so that we are using the knowledge and experience not only of the crews and individuals, but also of the organizations, in the planning and the sequencing of the project itself. This means the design is better, since it considers constructing issues. The design considers how the job is set up, and where the materials and the lay-down areas are. These things can only happen when we have the right people involved at the times in the process when key decisions are being made.

We have to address the tension between a competitive environment, and one of collaboration and cooperation. In the field, cooperation gets the work done. We cannot impose this as another appendage, or another program. It won't work. It has to grow as a more organic model. If we are into empowerment, we have to let the organizations shape this process, so they can see how to make it work with their people. These concepts allow each of our organizations to become what they actually can be, so they must be participants in shaping the process.

The foreman-crew relationship is critical. If 95 out of 100 conversations with the foreman is about progress and production, and management talks with them about general safety concerns (let alone musculoskeletal injury) once or twice in 100 times, it is clear that production is what is important to management.

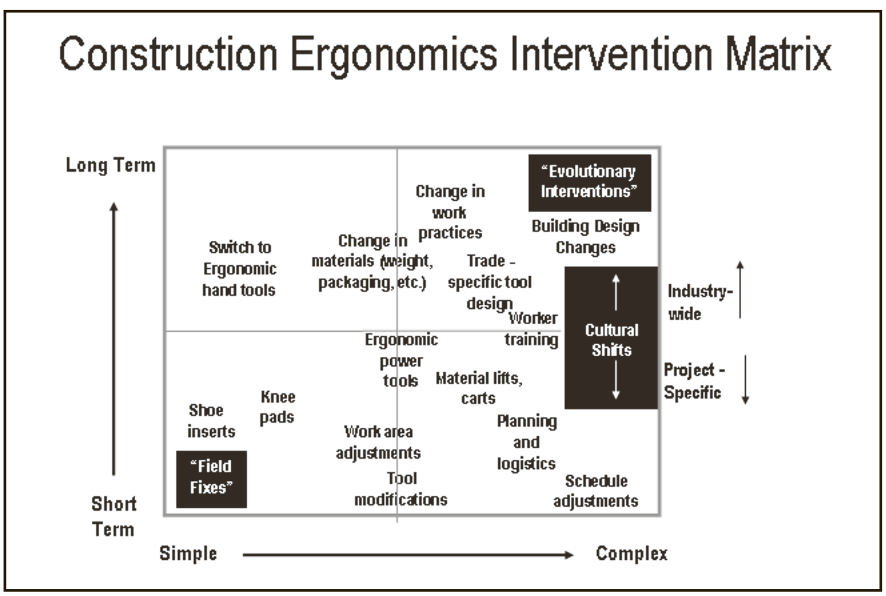

Figure 2-3.3. Construction ergonomics intervention matrix

The foreman-crew relationship is much more in our control than we appreciate.

Figure 2-3.3 shows the interventions on a continuum of short-term to long-term, and of the complexity of the solutions. The interventions available to the crew, or to the foreman or general foreman, or even to the general superintendent are still the field fixes (see lower-left corner). Project specific interventions are shown in the bottom half of the matrix.

The industry-wide interventions (upper half) require our organizations to participate earlier in the process. Constraints are built in by decisions made earlier. They affect what is available for the crews on the construction sites. The industry-wide issues will take us a lot more time to achieve. We have to work in all of these quadrants at the same time. There is a tendency to work only in the field fixes, asking, "What is available for the crews right now?" and, "What can they do differently?" If we are not working in all of the quadrants simultaneously, we are going to restrict what is available to the crews right now.

Measures of Success

The notion of measuring performance is also changing. Figure 2-3.4 lists ways to measure success.

It is a good idea to always measure how we are doing against our plan. We should not be so worried about our results, because by the time we get the results, it is already too late to make changes. Instead, we should consider how we are doing along the way with these interventions.

Measures of Success?

- Amount of participation at all levels
- Numbers of interventions brought forth/developed
- Quality of interventions
- Number of interventions implemented

Figure 2-3.4. Measures of success

SESSION 2: PRESENTATION 2-4
ERGONOMIC INTERVENTIONS IN THE PIPEFITTING INDUSTRY

Joe York, ***Journeyman Training Coordinator***
UA Apprenticeship

In Local 290, I am responsible for training 5,000 people. I'm like a superintendent of schools: I hire the teachers and create the curriculum. Our area is bigger than Silicon Valley in terms of the number of tech plants. The majority of work our people are doing now is in high-tech industry.

The first class our people go through is use and care of tools. This is their introduction to ergonomics.

I have an unusual background. My father was a pipeliner, my mother was an Indian, and we traveled around the country in the late '40s and early '50s following the work on pipelines. In those days, pipeliners did not have much in the way of safety. They had only one thing that was necessary, and that was to do a day's work for less than a day's pay. What you got off for lunch was one glove. They did not have toolbox meetings or things like that, and people were killed. I have been on many, many projects where people died.

Today, we have finally become aware that people need to have some longevity in their work. I started welding while I was in high school. I have worked virtually all over the country. I thought I would talk about the pipeline industry and some of the changes that have occurred in ergonomics.

When I learned what ergonomics was, I discovered that I have been a friend of ergonomics all my life. I did not know it at the time. In fact, ergonomics has been around forever. Ten thousand years ago, my people went out to hunt the woolly mammoth, and they used spears to chuck at them.

Somebody came along and said, "If we put this device on the end of this thing, we will call it an "atlatl", and we can throw this thing at four times the speed we can chuck a regular spear. We do not have to get so close. It is a little bit safer." Then somebody else said, "Yeah, but if we take a stick and tie a string across it, we can fling arrows at them, and we can arch it out there; we do not have to be nearly as close."

In archery today, we have a compound bow. A bow rated at 70 lb draw weight will mechanically diminish the amount of weight by as much as 30% to 60%. The mechanical advantage gained is an ergonomic bonus: if you are only holding 30%, you can hold that for a long time and look around. Not only that—there is a device that hooks onto your hand called a release, and it snaps onto the string. If I were shooting an ordinary bow, I'd be pulling it back this way. With this device, I can pull it back like so, and turn. If you notice, when your hands are normal—like this—when you bring your hand up—like so—that is not the normal way to pull a bow. However, with the quick-release, you can roll it around, and this causes a lot less stress. So if you shoot an arrow about five bazillion times, it may keep you from having carpal tunnel.

When I first started welding, I was pretty small, so my arm was not as long as the welding rod. The contractor's main idea was to get as many pipeline welds as he could in a day, to make him more money. So I learned to put the rod in the stinger, bend it, and rip it around like so. That sounds easy. Then I could bend it at an angle, and then I could reach down and weld. Over a period of time I probably bent a boxcar load of those rods around, and it wasn't until John came along that I knew that carpal tunnel existed, and that I was probably at great risk.

We have a symbiotic relationship with the industry's contractors. They must provide us with a safe working environment. They must provide us with the tools, the equipment, and the materials so we can do a productive job. We have to make the attempt to do that job in a professional manner, in a way that we are not going to get hurt.

Several years ago, one of our young men, Donald Dunn, leaned a ladder against a fiberglass tank. The ladder slid off and it killed him. Because the engineers had engineered away the apparatus that was supposed to contain the ladder for support, his wife received a fairly large stipend. She blessed the Local 290 training center with a trust, of which Tony Barsotti and I are a part. We have been holding the Donald Dunn Memorial Seminar for 5 years. We have made every effort to involve ergonomics in our program.

Billy Gibbons has opened the eyes of many contractors in the high-tech industry to the knowledge that working safe can also be a production thing. If you do not have lost-time injuries (LTI), you can get work done sooner, faster, better, and at less cost.

Our people can retire at age 55. We do not really want them to, but if they have soft tissue injuries, it becomes imperative that they do retire, which means they take away from their retirement accounts for many more years than if they had lived to be an old person before they retired.

In 1960, my younger brother, 16 years old, had his leg cut off on a pipeline. He wanted to become a welder like his father and the others members of his family. He couldn't climb ladders, he couldn't work off forklifts, he couldn't even get around the project, and so he ended up becoming a wire welder on a station where the pipe rolls around. Moreover, because of that, it wore him out. Ergonomic interventions that are available now would have enabled him to work several years longer. The industry has learned to weld wire on the top of the big pipe, so the worker is in a position like so. My brother developed his skills to the point where he was a valuable asset to the contractor. He got to be the best wire welder in our local. He learned to weld down on the side, where it was more comfortable.

We did not know, then, that the National Aeronautics and Space Administration (NASA) was going to invent a product that would make really soft material—a lot of things that affect ergonomics today have come from NASA. A good example is orbital welding machines. We use them in the high-tech industry; we use them in the food industry and in pharmaceuticals. We will also be using them in hospitals. We will weld copper with them in the next five years. Automatic welding machines also came from the trickle-down effect from NASA.

I worked in Prudhoe Bay, Alaska, at -80^{o}F. Ordinary rubberized material cannot be used there. A regular cord will snap into two pieces. NASA developed material that was first used for seals on the space shuttles. Now, this material is used for coating on electrical connections.

(*Presentation slide not available.*) On my rig, I do pipeline welding. This slide shows two welders taking a test. Each of their welds will be X-rayed. That is an inside line-up clamp—those things are fantastic. They have been around a long time, but not at this level. I have pictures from back in the 1960s of 30 guys pulling on a rod to pull that thing up a hill. Nowadays, these things are automatic. They have air to them; they run right out; they will punch the pipe out to be perfectly round; and it gives these guys an opportunity to weld in a manner.

(*Presentation slide not available.*) This is called a stinger lead, and because that material is coated with the same material that was developed for NASA, over a period of an 8- to 12-hour day, the worker is going to have less fatigue. His quality of welds will be maintained.

(*Presentation slide not available.*) Notice a mud board there. I built myself a ladder. In most areas where fitters are encouraged by the employer to provide themselves with a safer way to do something, our guys are very creative.

If you ever visit Kinetics, a high-tech fabrication shop in Wilsonville, Oregon, you can see people working in a clean-room environment. (*Presentation slide not available.*) You will see all kinds of inventions these gentlemen have made to make it easier for them—clamping devices, material handling, bending and fabrication jigs. And, because it is easier, production increases. But contractors do not want you to learn what they can do, because you will become a competitor for them.

(*Presentation slide not available.*) Already on the market, are all kinds of tools that are ergonomically designed. This is a 3/8-inch ratchet. It does not have much leverage on it, but after I break the bolt free, I am going to leave the Craftsman in the toolbox and use something like this. It will fit in my pocket, but more than anything else, it fits in my hand. Sandvik, in the Portland area—a usual participant at our Donald Dunn seminar—makes all kinds of ergonomic tools. These kinds of tools will promote ergonomics in our field.

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SESSION 2: PRESENTATION 2-5
ERGONOMIC INTERVENTIONS IN THE SHEET METAL INDUSTRY
PART 1: SUCCESSFUL SHEET METAL INTERVENTIONS TO CONTROL MSD RISK FACTORS AT STREIMER SHEET METAL WORKS, INC.

Phil Lemons, ***Safety Coordinator***
Streimer Sheet Metal Works, Inc., Portland, Oregon

Streimer Sheet Metal is probably the smallest group presenting today, compared to these great organizations and universities. I will bolster our position by talking for the group of contractors throughout the state of Oregon; 29 companies that are part of our local Sheet Metal and Air-conditioning Contractors' National Association (SMACNA) chapter.

When I got the call from Jim Albers, I took the idea to the SMACNA safety committee. I talked to people in the member companies and came up with seven or maybe eight people who had a general awareness that performing certain jobs would increase the risk of musculoskeletal injuries. Less than one-third of the contractors have a designated safety officer, and half of those are part-time.

Those of us active in safety areas did further research. Some of the things we are doing are:

- Promoting the Sheet Metal Occupational Health Institute Trust (SMOHIT) stress management book [1999]. We have a complete program at the association level, promoted throughout the state and at job sites.

- Submitting a proposal to Oregon OSHA for a grant to copy the electricians' proposal from Mike Murphy to increase SMACNA awareness of MSDS, so that members can identify it and have some tools available.

Here are some of the things that have been done in Oregon. Most of these we have done at our company:

- Placed scrap tables beneath all shears, bringing scrap closer to the worker for both clean up and recycle.

- Designed and built handles that easily snap onto the top of these heavy steel tables, allowing them to be pulled to a vertical position to get them out of the way for further clean-up, or moved back so we can get by the shear.

- Built and installed exterior wheels for manual blade movement on our shear. Prior to this, we had to take up the housing; a man had to get down on his knees on a concrete floor and jimmy the pulleys to slowly move the shear blade to get it to incremental positions for maintenance. Now, we have eliminated that by installing a 14-inch-diameter steel wheel on the outside, which turns the material inside the housing. It is much safer, as well as much better physically, to do that job standing up.

- Modified all portable welders with pull-down ramps so oxygen and acetylene tanks roll on and off the welder, eliminating the need to ever lift these tanks, which can be quite heavy, even when empty.

- Modified our cylinder storage room areas to eliminate lifting of the tanks, as well.

- Purchased handcarts specifically for transportation of acetylene and oxygen tanks.

- Built drill bit extensions for overhead work, to keep the tool and the workers' hands below their shoulders, primarily at the waist. We have various lengths of drill bit extensions.

- Built various, specifically sized tools for safe removal of system components and high-efficiency particulate air (HEPA) filters at our high-tech plants and for other often awkward or heavy maintenance items.

- Built various types and sizes of scissor lift attachments to reduce or eliminate manual material handling (MMH), primarily for our architectural division, which puts panels on the outside of buildings.

- Converted all work tables in the shop and field into rolling tables.

- Modified our chemical process tasks (bonding processes to join sections of round fiberglass pipe, or duct) so the work can be done near waist height.

- Changed to using carts, and away from using tool bags.

- Built and utilized push sticks for placement of overhead electrical cords, to eliminate ladders as much as possible on that task.

- Modified Rubbermaid™ tool carts with taller handles, eliminating bending.

Three primary factors prevent ergonomics from getting more into the mainstream of our daily work in the shop and the field:

1. The reluctance on our workers' part to change work practices, especially those who are older or who have trained younger workers that this is the way to do a job. So, we are looking for interventions earlier on, primarily through our joint apprenticeship

and training center. We are seeing a lot of resistance to embracing ergonomic solutions.

2. Fear at management level that introducing ergonomics will generate more claims and costs than it will prevent. We see a lot of misunderstanding at the owners' and managers' level in many companies.

3. In Oregon, there is a lack of regulatory requirement. In other words, the "hammer" isn't there.

Finally, speaking for our company, the one big thing that will get us over the hump is safety plus productivity. We have to combine these as two sides of the same investment dollar. One task I'm working on this year is a training program for foremen to help them recognize basic risk factors in ergonomics and to adjust basic work practices, or to order engineering adjustments, as necessary, consistent with their needs to maintain high levels of productivity and low cost. We are not getting foremen to make changes if they think it is going to make the bottom line look bad. So, we are getting top management support; we are getting permission for them to do this. We think in the long run we are going to find a number of areas where we can make tremendous strides that are low-cost and high-impact.

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Session 2: Presentation 2-5
Ergonomic Interventions in the Sheet Metal Industry
Part 2: Streimer's Ergonomic Intervention to Facilitate Ductwork Assembly

Kelly True, ***Project Manager***
Streimer Sheet Metal Works, Inc., Portland, Oregon

Introduction by Phil Lemons: Kelly has 15 years' experience with Intel projects, and with crew sizes up to 130 workers. He is working on the largest semi-conductor facility (aka, "fab") that Intel has ever built, where he does research on ergonomic interventions on this campus, along with Billy Gibbons and Steve Hecker. In 1996, our program got going because of a report that Billy Gibbons and Steve Hecker did for us.

We have come up with several devices to get our work done in a safe fashion. One came from the craft folks and the project superintendent—a fine example of what you can do if everyone on the project is involved. That is one of the keys to success.

One of the definitions of ductwork is a lot of air with a little bit of metal around it. Typically, a duct job comes out from the shop assembled, and you are in a material-handling mode getting it from the delivery truck into the building, and then to the place where you have to install it. On this project, due to site logistics, we were faced with constraints on moving in material. So, Project Superintendent Dave McBride wanted to put ductwork together out in the field. I thought it would be inefficient. I had ergonomic concerns, and there were weight limitations. I said, "If you can do it safely without putting anyone at risk, productively, [and] without exceeding the 35 lb weight limitation that we have on site, I'll take a look at it." He surpassed all of my expectations.

Otherwise, the person uses an air hammer, which requires a significant amount of force. With an electric one, your hands are in a more ergonomically desirable place, and you need to put less pressure on the ductwork to put it together.

Figure 2-5.1 shows a typical joint of duct. It usually comes out in an L shape, or there might be four rails that you have to put together. At the bottom, are the feet of the duct-handling device that the crew devised, which I will be describing.

In Figure 2-5.2, the duct seams are tacked together. The base plate and riser are part of the crew's duct-handling device.

Figure 2-5.3 shows the strut piece with the top portion of the clamp of the device. Normally, the duct would be put together in the shop, requiring several people to manhandle these pieces. Workers are on

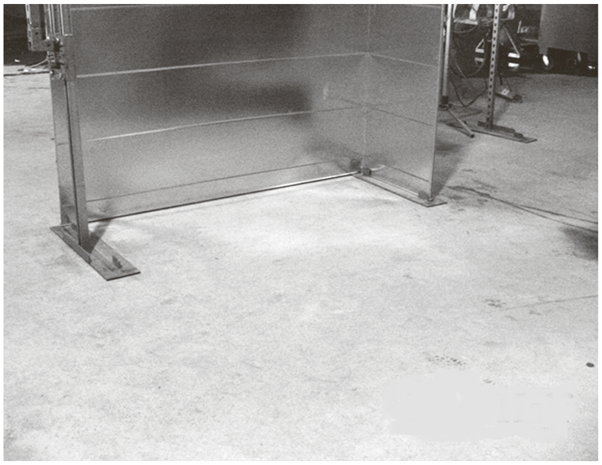

Figure 2-5.1. Typical joint of duct (duct half)

Figure 2-5.3. Clamp device

their knees a lot while pounding the sections together. They turn big pieces over and are at risk for strain, stress, and pinch points. Some of this ductwork is 10 foot wide by 36 inches, and it would require a wide-load permit to ship it out to the work site.

Figure 2-5.4 provides a good idea of what the duct-handling device looks like. There is a top clamp, a bottom clamp, and a pivot. Brackets with some simple hardware are available–UnistrutTM parts and clamps—common materials, which are easily obtained.

Overhead is a beam that is hooked up to a hoist, which is attached to the embedded strut on this particular job. It could be done with an A-frame, or something else. However, this beam allows those arms to telescope in and out to accommodate different widths of duct. So the workers get the ductwork into this device, hold it into place, and tack the sides together.

The duct is picked up, pivoted, and then placed on the cart shown in Figure 2-5.5, which is on rollers. It puts the assembly work at a desirable height, so the workers do not need to stoop over, or bend down

Figure 2-5.2. Tacking duct together

Figure 2-5.4. Setting up the clamp

on their knees to tack the corners. Plus, they do not have to handle the weight.

Figure 2-5.6 shows another example of setting a Pittsburgh seam: You have a male part that goes into the female part, and you have an edge you hammer over, which clasps them together. This is a modified mason's tool, in which the worker is setting the Pittsburgh seam. It has a nice, ergonomically-designed handle and a guard to keep the worker from smashing his hand. Typically, the worker has to hit a very small target.

Figure 2-5.7 shows the duct-handling device. The workers opted for an overhead control. You reach up for a short duration to activate the hoist, and then lift up the duct. One person can do the task, and we rotate this job. To move some of this ductwork with Streimer's weight limitations would take up to eight people, just to flop it over. So from a productivity standpoint, it is much more efficient. You can see how easily it pivots and can be placed back onto the work cart.

In Figure 2-5.8, the worker is essentially putting this corner piece in, which can be done either on the horizontal, or on the flat. The workers mostly prefer to have that on the ground when they set the corner in, and hammer those edges over to lock that into place.

Figure 2-5.5. Horizontal assembly

Figure 2-5.6. Setting a Pittsburgh seam

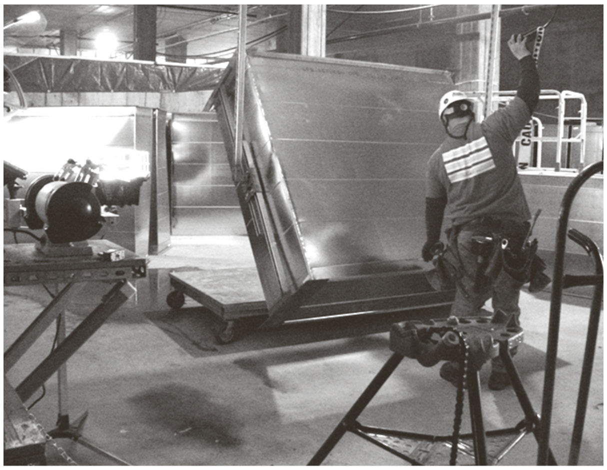

Figure 2-5.7. Pick-up and rotate duct

In Figure 2-5.9, the workers opted to go with the hand truck to move the joint of duct out, once the upper portion of the device was raised out of the way. They pulled the jointed duct out and could take it into the work area. They left the larger pieces lying horizontally on the cart, pushed the cart directly out to the job area, grabbed it with the forklift, raised the duct up into the work space, attached it, and hung it.

This duct-handling device was a brilliant idea devised by the crew and the superintendent. They have all bought into it and offered suggestions on how to improve it. They like it because it doesn't burn them out at the end of the day. They can do a considerable amount of work safely and feel more productive. Their estimates were 30% to 50% productivity gain because of reduced head count and impact to crews. The device wasn't very expensive—about $750, not including the cost of the hoist.

When we reduced the ergonomic risks, we created some mechanical ones. To mitigate those, we instituted a daily checklist to review the equipment and make sure the cable, hoisting system, and fasteners were all secure and tight.

We also did some operator training. The operator worked with a partner, until he understood the proper operation of the device.

In summary, it is a simple device, made from common materials, and is easily transportable. It is an effective way to get the job done safely on the job site, when conditions are normally a little more difficult.

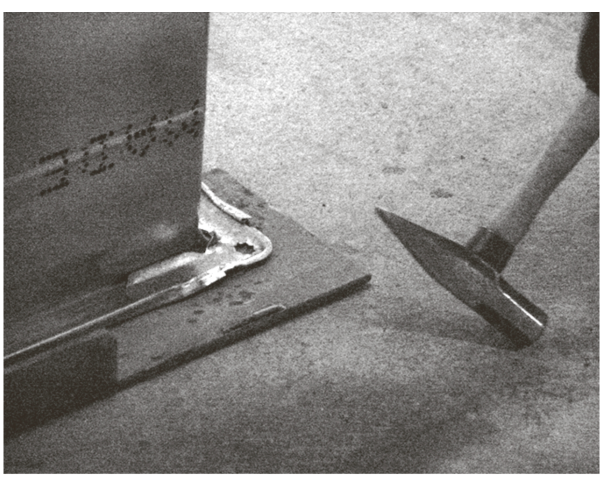

Figure 2-5.8. Corner Installation

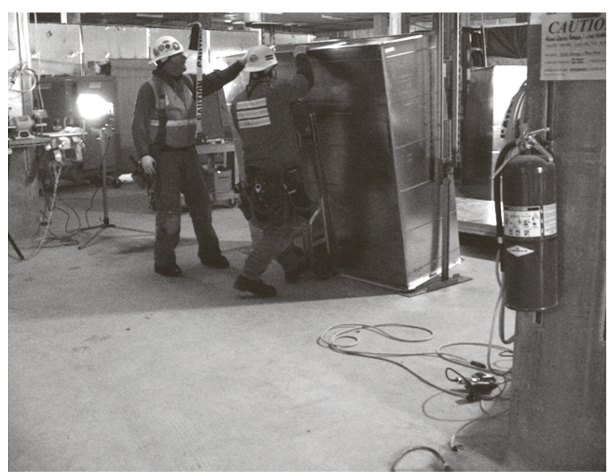

Figure 2-5.9. Removing the completed duct

TRAINING TOOLS FOR OWNERS, CONTRACTORS, AND WORKERS

Charles Austin, ***Industrial Hygienist***
Sheet Metal Occupational Health Institute Trust (SMOHIT), Alexandria, Virginia

I will talk about the ergonomic interventions on which SMOHIT is working. When I started working there five years ago, training primarily came from the workers or from the contractors' own training programs, or the owners might also take part in developing materials. When we developed materials just for workers, they did not deal with the issues of the contractors or the owners. We tried to develop programs that could speak to each group. The Physical Stress Management Program [SMOHIT 1999] came out of this effort to involve all three groups. We also worked with the insurance company—Robin Johnson (CNA Insurance) worked with us—as well as Phil Lemons (Streimer Sheet Metal), and also James Struthers.

The package includes a CD-ROM with PowerPoint®, a booklet on warm-up and stretching*, and a booklet on talking points for training. At the back of the booklet is a list of various control measures for the sheet metal industry.

We developed a program called Sound Advice [SMOHIT 2002]. We took research information and put it in chart form, so that workers can use it out in the field, or for pre-planning before starting the job. With this chart, a worker can determine, at a certain decibel level, what the risk level would be after 10 years. In the back of the booklet, are common tools with which sheet metal workers work. The chart indicates, "If you wear no hearing protection, this is the decibel level. If you wear earmuffs, this is your decrease."

Owners know what tools they are going to use on a job; they can use this chart and preplan what kind of safety equipment will be needed.

One of our biggest projects was developing a welding chart. First, we catalogued the whole sheet metal industry. We had applications from food service to structural steel—every part of a sheet metal job is catalogued in this chart. With that, I listed all the health symptoms and all the material that goes into welding, so an owner or a contractor could say, "We are going to work in carbon steel with this kind of electrode. We know the gases we are going to work with; we know the contaminants; we know the non-gas sources." What I have here is a coded system that will tell the workers the health

*The effectiveness of stretching exercises in preventing injuries from work has not been proven. For more information on this topic, see Hess et al., 2003.

effects of those particular things. We know if the work involves a potential respiratory exposure, or skin exposure. Then, in the back of the booklet, they can pre-plan what type of controls can be implemented. So, the tools and interventions are hands-on materials that can be used before the work is started, during the work, and even after. We created a large and a small chart.

The focus for our interventions is two-pronged. One is to incorporate contractors, owners, insurance companies, and workers into every project. The other is to have it interactive, so that results can come out of the field research that I perform.

For the hearing chart, I did real-time monitoring on 20 tools that are most commonly used in the sheet metal industry. We are going to try to measure all the tools, so we can say, "If you work with this tool, you will need earmuffs and plugs."

We have an interactive CD that goes along with a chart that simulates hearing loss. It shows, for example, how it sounds to have 25-decibel hearing loss. It also does risk analysis and can be geared toward the individual person. You can put in your age, you can search for a particular tool, and it will tell you what type of protection you need.

I will go over part of the CD we created on physical stress management—the task and methods section. We wanted to develop a chart of information gathered in the field. So, we looked at all possible tasks in forceful exertion, and on the chart we tell the workers what they can do onsite or before the job starts. It is the same for sustained postures—twisting, reaching, and bending. Methods of control are the following: (1) Reposition the body to a more neutral posture. We might show on the chart what is considered a neutral posture. (2) Select tools that reduce awkward posture. We have some pictures that show some tools and correct postures that might be used.

Here are some controls for some common problems:

- Repetitive motion (such as constant lifting and placing of ductwork): Use a mechanical lift device.
- Hammering in awkward posture: Use spring-loaded hand tools with protective grips. This is done in our apprenticeship program, so that from the first year, the person will be exposed to ergonomics. When they become a journey person they will have a background in the methods of control.
- Extreme climates: Increase or decrease air temperature.
- Improperly designed tools: Use tools that reduce wrist deviation. Also, use tools for their intended tasks.
- Increased work pace: Better job planning and communication. Inventory and inspect tools and equipment. Coordinate better with other construction crafts, which is important in pre-planning the job.

The reason we did the welding chart is that welding cuts across all trades. The chart can be used for all crafts and will help in pre-planning control methods.

Questions from Presentation 2-6

Question for Charles Austin: On noise measurements on the tools: did you take the information back to the manufacturers, or give them a chance to promote their tool if it doesn't produce a lot of noise, or make them think about designing tools that don't produce as much noise?

Answer: When the manufacturers determine noise levels, they don't actually do it in a work environment, and we found that their levels were much lower than what we measured out in the field in actual use. This wasn't something they wanted to hear, because just about every tool was above 90 or 80 decibels. The few manufacturers we did contact did their measurements in more of a laboratory setting, so when they saw our measurements, it was disheartening.

Question for Charles Austin: Did you have any system for labeling the tools as to the different noise levels? So that people have a choice.

Answer: No, we just went to different shops and picked out the tools that are used the most, and the brand names that are used. In the sheet metal industry, there are one or two manufacturers. That's an excellent idea: look at what other tools are out there. The last thing we want to do is implement hearing protection. The first thing should be engineering controls, if that's possible.

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SESSION 2: PRESENTATION 2-7
AN ERGONOMIC EVALULATION OF A MECHANICAL CONTRACTOR SHOP FOR COMPLIANCE WITH THE WASHINGTON STATE ERGONOMICS RULE

Peregin Spielholz, ***Ergonomist***
Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor & Industries.

Washington State has (had[1]) an ergonomics rule, and we have done 24 or 25 public demonstration projects in respect to the rule. I will talk about a project we did with a large mechanical contractor, McKinstry Co. McKinstry is a mechanical contracting shop that does sheet metal, pipefitting, and plumbing. A lot of this information is on the Internet, and all of these reports can be downloaded [SHARP 2001].

In the Washington State Ergonomics Rule, there is first a Caution Zone level. That is the level where most ergonomists consider there might be risk factors—such things as back bending or kneeling for 2 hours a day—things commonly seen in checklists. The company must provide ergonomics awareness training and look at jobs further to see if they have risk factors at the Hazard Zone level.

The Hazard Zone level usually represents twice as much exposure to a given risk factor as at Caution Zone level. At Hazard Zone level, the company must implement controls to mitigate the risk factors, as long as it is technologically and economically feasible.

We looked first for Caution Zone risk factors and then looked further to see what higher-level risk factors and solutions needed to be implemented.

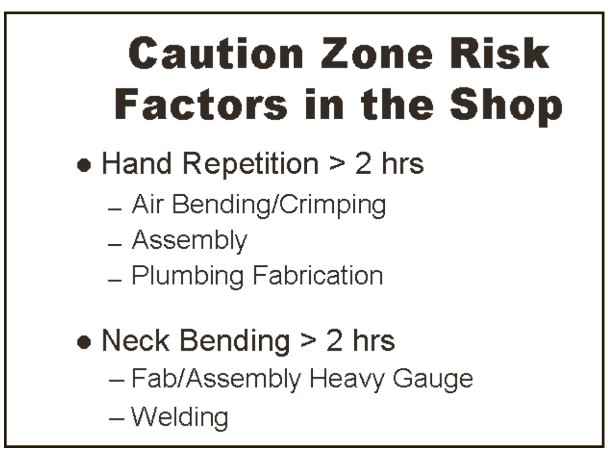

Figure 2-7.1. Caution zone risk factors in the shop

[1]Voters in the State of Washington passed an initiative on November 4, 2003 to repeal the Washington State Department of Labor and Industries ergonomics rule, effective December 4, 2003.

This is what we found in the Caution Zone: hand repetition in sheet metal assembly jobs, especially where workers were putting together smaller duct work and smaller fittings, which involved hand crimping and hammering. There was also significant neck bending, while they were working on welding and heavier gauge material (Figure 2-7.1).

At Hazard Zone level, we found things in the office controllable. The only things we found that would be classified under the Hazard Zone were very intensive data entry, where someone is normally keying all day in awkward postures.

In the sheet metal shop, the only area we found that could possibly be at the Hazard Zone level was hand repetition, when putting together some of the smaller parts. This was only on a limited basis (Figure 2-7.2).

Solutions for Hazard Zone Jobs

Office: Provide what most employers now provide as standard equipment: adjustable chairs and keyboard trays.

Assembly Shop: Only one time did I notice someone hammering together parts all day. Normally, a work-cell process would be used, in which a worker does each stage of the process. But, this day somebody was out sick, they had a big job and were behind, and someone was stuck doing this all day. The company implemented a policy that in these situations, they would enforce a rotation schedule. Figure 2-7.3 lists some of the solutions for Hazard Zone risk factors.

We ended up documenting best practices that the company had already implemented. One reason we did the study at McKinstry is that they are a progressive company and had already implemented many of the solutions. They have been very helpful in sharing their information with other contractors and with SMACNA.

Control Lifting Hazards: McKinstry Company has a policy that nobody can lift over 50 lb. To back that up, they provide a way for workers to do the work: cranes to lift pipe, hand trucks, holding jigs, cranes, and hand cranks they can use to get material up or down from tool shelves (Figure 2-7.4).

Welding Controls: Welding has many potential problems, and even with their

Hazard Zone Risk Factors

- Intensive Keying with awkward posture > 4 hrs
  - Payroll Entry
  - Invoice Entry
- Hand Repetition > 6 hrs
  - Assembly Area

Figure 2-7.2. Hazard zone risk factors

Solutions for Hazard Zone Risk Factors

- Office Jobs
  - Provide adjustable keyboard trays, chairs with armrests and document holders
    - Removes awkward posture without support and ability to vary posture
- Assembly Shop Job
  - Hand repetition > 6 hrs very infrequent
    - Administrative control implements a policy that no one assembles one small part intensively more than one day per week or more than 4 hours per day

Figure 2-7.3. Solutions for Hazard Zone risk factors

Control of Lifting Hazards

- 50 lb Lifting Limit Company Policy
- Use of Cranes, Carts, Lifts, Hand Trucks and Holding Jigs

Figure 2-7.4. Control of lifting hazards

controls, McKinstry has possible issues. They have set up the workshop so that heavy pieces are lifted by overhead cranes. They lift directly onto a holding jig, attached to a workbench. The jig rotates so they can attach the part to it, rotate the part around and weld it, and then re-attach it to the overhead crane and lift it into a parts bin. They never have to hold the part or maintain the weight of a part. This eliminates gripping and lifting problems. Figure 2-7.5 lists these welding controls.

Welding Controls

- Control of Heavy lifting and gripping > 10 lbs with awkward posture
- Use of overhead cranes to move parts
- Provision of rotating holding jigs and stands

Figure 2-7.5. Welding controls

Plumbing Controls

- Control of awkward postures, kneeling and squatting, heavy lifting
- Pre-assembly of sub-systems at bench height
- Assembly on rolling carts and use of crane

Figure 2-7.6. Plumbing controls

Plumbing Controls: Figure 2-7.6 refers to a pre-assembly of plumbing components for a bathroom and lists some plumbing controls. The entire assembly is being built on a workbench, instead of doing it on site. The workers build the assembly on a frame (with wheels) on the workbench, and then lift it by crane onto the floor. They will roll it into a cart, onto a truck, and will then lift it by crane into a building, and roll it directly into place. It allows people to do the work at bench height, with all of their tools right there, and in a more comfortable environment than on site.

Sheet Metal

- Control of awkward body postures, squatting, and kneeling
- Use of waist-level carts for working surface and material movement

Figure 2-7.7. Sheet metal controls

Sheet Metal Controls: All sheet metal is stored at waist height on carts. It is moved from cutting machines on the carts, by sliding. Normally, the material is never lifted. If it is lifted, it usually involves two people. Much of the work is also done on these carts. The only other thing we noted, which the company is now going to start doing, is to provide carts of different heights for different workers. They may also provide carts that can be adjusted. Figure 2-7.7 lists sheet metal controls.

Field Installation: We have done less work in the field. Figure 2-7.8 shows a picture of field installation. In the field, workers have been putting together duct pieces in 50 to 60 lb sections. It is usually done with two people and is always lifted into place with a hand crank lift. However, the availability of this device has not eliminated the need to sometimes lift and move these pieces manually.

McKinstry Ergonomics Process: As part of the project, McKinstry Company developed a written program and its own internal checklist. They also have detailed descriptions of every job in their union categories. This information is available on the Internet at *www.lni.wa.gov/wisha/ergo.*

Washington State has completed similar projects in many different trades, including drywall, masonry, carpentry, rebar, and concrete finishing. These Demonstration Project documents can be accessed on the Internet at *www.lni.wa.gov/wisha/ergo/demoproj.htm.*

Figure 2-7.8. Field installation