THE Water Research FOUNDATION

PROJECT NO.
4694B

Implementing a Participatory Ergonomics Program

A Handbook for Water Utilities

Columbus Water Works
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CONTRA COSTA WATER DISTRICT

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San Francisco Water Power Sewer

Implementing a Participatory Ergonomics Program: A Handbook for Water Utilities

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Co-sponsored by:

Columbus Water Works

Contra Costa Water District

East Bay Municipal Utility District

Los Angeles Department of Water and Power

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THE Water Research FOUNDATION

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Background

Worker safety and health and, particularly, the prevention of work-related musculoskeletal disorders are key goals of the water districts.

In the 2003 project funded by the WRF, Identifying and Prioritizing Emerging Safety Issues in the Water Industry (Puglionesi et al. 2003), the section on Recommendations for Future Research, they identified "Effectiveness of Techniques for Prevention of Lower Back and Shoulder Injuries and Other Musculoskeletal Disorders" as a priority. Another WRF-sponsored project, Water Utility Safety and Health: Review of Best Practices #3104 (Borowski and Adams, 2010), finds that greater emphasis should be placed on ergonomics initiatives aimed at preventing overexertion injuries and establishment of ergonomic guidelines for water utilities as an area of future research.

This is consistent with the experience of Contra Costa Water District (CCWD), who reviewed the above research and initiated this research project. CCWD 2016 injury data indicates there are more injuries from repetitive motion and sprain/strain injuries than any other cause. Over half of lost time and recordable injuries were related to overexertion or repetitive motion, typically resulting in sprains and strains. In response to this data, CCWD solicited other water utility management organizations to participate in an investigation into the effectiveness of a participatory ergonomics (PE) program at reducing ergonomic injury risk among water and wastewater workers. Those utilities that elected to take part also stated their goal of reducing musculoskeletal injuries and provided commitment statements to support this at the commencement of this research project.

The Bureau of Labor Statistics (2017) reports that the water industry has an incident rate of 5.4, which is over 50% higher than the overall industry rate including government and state agencies. CCWD is a medium-sized water utility that serves about 500,000 people with a staff of approximately 300 employees. Over the last four years (2014-2018), CCWD has incurred total worker compensation costs of 1.8 million dollars, of which 70% is related to musculoskeletal injuries. The average cost of claim in FY2016, across all five participating utilities, was $250,000.

With the combined factors of ergonomic hazards and an aging workforce (Bureau of Labor Statistics, 2017), it is predicted that the severity and frequency of musculoskeletal injuries will continue to rise as workers, as a function of higher average age, become less physiologically capable of withstanding the stressors of physically demanding work. These injuries can have far-reaching consequences, including early retirement of experienced and knowledgeable workers, increased costs, increased burden to other workers due to overtime to cover for injured employees, and increased fees to the public to cover rising worker compensation costs. (Chengalur et al., 2003).

Introduction

The aim of this handbook is to demonstrate the effectiveness of using participatory ergonomics teams to lower risk and prevent injuries among water and wastewater workers, and to provide the reader with guidance on how to establish their own participatory ergonomics program. Since water and wastewater workers are considered the experts in their jobs, participatory ergonomics seeks to maximize their involvement by empowering them to use their knowledge to identify and address ergonomic problems, and develop effective solutions to improve working conditions, safety, productivity, quality, morale, and/or comfort.

The information in this handbook is derived from a two-year research project conducted at five water utilities. Each group received training and ongoing facilitation from a Certified Professional Ergonomist (CPE). Data was collected on perceived exertion levels for selected tasks, and the number of ergonomic risks present prior to intervention. Groups met on a regular basis throughout the study period to identify and implement solutions. A repeat exertion survey and risk assessment was performed following implementation of solutions.

After analysing data collected from each utility, the results showed that the utilities with the most well implemented consultation and communications frameworks in place prior to the commencement of the study achieved more substantial results than those who attempted to implement a participatory ergonomics process in the absence of any pre-existing frameworks. One utility elected to participate in this study by having their health and safety team participate, rather than front-line employees. This utility was not able to generate any data for the purposes of the research study, although they were nevertheless able to identify some necessary changes and implement ergonomic improvements.

Factors such as management participation, allocation of resources for solution implementation, and levels of trust between employees and management also affected each utility's ability to affect a change in perceived exertion levels and risk levels for their selected tasks.

Three of five utilities have sustained the participatory ergonomics process beyond the conclusion of the study period, integrating the process into their existing consultative frameworks, which in all cases is some type of workplace safety committee with employee and management representation. All utilities were able to identify and implement ergonomic solutions that reduced ratings of perceived exertion and reduced the number of risks identified for the associated task.

The research and this associated handbook will provide a framework for implementing a participatory ergonomics program following the outline from the two-year project. The process will be reviewed from beginning to end in order to highlight what makes a successful participatory ergonomics program.

Ergonomic Risks: Background

Ergonomic risk is present to some degree in any manual task. Ergonomic hazards and risks can be grouped into the following six categories:

- Force
- Repetition
- Awkward postures
- Sustained postures
- Contact stress
- Vibration (hand or whole body)

When exposure to these risk factors exceeds the limits of tolerance of the human body, musculoskeletal injury or disease can result. These injuries are commonly known as musculoskeletal diseases (MSDs) or work-related musculoskeletal diseases (WMSDs) when the injury occurs at work. Commonly, multiple risk factors are observed for a given task when attempting to identify which ergonomic risks are associated with that task. Combining exertion of high force with an awkward posture increases the risk of injury when compared to the risk associated with exposure to just one of those

Force

Forceful exertions involve lifting, carrying, pushing, pulling, twisting, or otherwise bringing force to bear on an object. A single exposure to a very high force, or prolonged exposure to moderately high forces, can lead to damage to soft tissues and resulting MSDs. Examples of forceful tasks examined as part of this project include working with grease guns and wrenches, lid lifting, moving jackhammers, operating tap machines, and lifting and throwing sandbags.

Repetition

Repetitive movements involve performing the same movement multiple times within a short amount of time. The more repetitions performed, particularly when time between repetitions is low, the greater the risk of injury associated with the task, owing to shorter recovery and reoxygenation times between repetitions. This is particularly true when the task also involves exposure to high forces or awkward postures. Examples of repetitive tasks examined as part of this project include opening and closing, valves, raking weeds from canals, climbing water towers, and potholing utilities.

Awkward Postures

Awkward postures involve working in a posture where the body is positioned out of its neutral, comfortable posture. Neutral posture of a joint is the angle of the joint when not in flexion, extension, abduction, or adduction. These awkward postures can reduce the body's capacity to generate and sustain force, by reducing their efficiency from working at a muscle length that is too short or long. Awkward postures become more of a problem when combined with other risk factors like high forces, repetition, or holding the posture for a long time (sustained postures). Examples of awkward postures evaluated as part of this project include pipe cutting, using the tap machine, accessing locks on the service truck, and potholing utilities.

Static/Sustained Postures

These involve holding a posture for a prolonged period. This reduces circulation to soft tissues, increases compression on nerves, and inhibits the ability of soft tissues to metabolize oxygen as efficiently as possible. This can all lead to an increased risk of injury. Examples of static postures examined as part of this project include valve operation, pipe cutting, working the tap machine, and jackhammering.

Contact Stress

Contact stress involves an object coming into contact with part of the body and exerting a compressive force on that body part. This compression inhibits the mechanical function of soft tissues like tendons and ligaments, the conduction of nerves, and circulation through blood vessels. This reduction in function can lead to injury with enough exposure. Examples of contact stress examined as part of this project include handling the rake when raking canals, holding hand tools like circular saws for pipe cutting, pinbarring, and grasping sheets of plywood.

Vibration

Vibration can either involve whole body vibration, as seen when operating trucks and other heavy machinery, or hand-arm vibration when operating hand tools. Both serve to disrupt the normal functioning of soft tissues and can lead to long term loss of function. Examples of tasks involving vibration assessed as part of this project include jackhammering, pinbarring, and pipe cutting.

The Role of Ergonomics in Preventing WRMSDs

One issue which can be examined is the underlying assumption that the causation of musculoskeletal disorders is, at least to some extent, related to activities undertaken at work. The seminal review of the evidence for the work-relatedness of musculoskeletal disorders was published by the National Institute of Occupational Safety and Health (NIOSH) in 1997 (Bernard, 1997). Detailed analysis of more than 600 studies resulted in the finding that there was strong evidence of an association between musculoskeletal disorders and high levels of exposure to physical factors, and particularly multiple physical factors. A subsequent review by the National Research Council (NRC, 1998) similarly concluded that compelling evidence existed for a relationship between work-related biomechanical stressors and the incidence of musculoskeletal disorders at the relevant body region.

The National Research Council returned to the topic again in 2001 (NRC, 2001) in another extensive document, concluding:

> The panel's review of the research literature in epidemiology, biomechanics, tissue mechanobiology, and workplace intervention strategies has identified a rich and consistent pattern of evidence that supports a relationship between the workplace and the occurrence of musculoskeletal disorders of the low back and upper extremities.

While the evidence considered in these reviews was largely cross-sectional, a more recent review of 63 longitudinal epidemiological investigations completed since 1997 concluded that reasonable evidence existed of a causal relationship between heavy physical work and the development of musculoskeletal disorders (da Costa and Viera, 2010). Aspects of work which were most commonly reported were heavy lifting, awkward postures and repetition. Mayer et al (2012) similarly reviewed 21 longitudinal studies examining the work-relatedness of neck and shoulder injuries and found strong evidence of causal links with exposure to work-related physical stressors. Even more recently, two three-year longitudinal studies (Coenen et al., 2013; Sterud and Tynes, 2013) assessed occupational predictors of back pain and concluded, respectively, that cumulative back loads were a significant risk factor for back pain and that highly demanding jobs, prolonged standing and awkward lifting were the most consistent and important predictors of low back pain.

There are undoubtedly open questions remaining regarding the mechanisms, relative importance, and interactions between task characteristics in the causal pathways leading to musculoskeletal disorders. However, there is ample evidence to support a conclusion that some workplace exposures to manual tasks increase the probability of musculoskeletal injury. The logical corollary is that implementation of a program which reduces exposures to undesirable task characteristics through elimination or redesign has potential to reduce the incidence of musculoskeletal disorders.

What Is Participatory Ergonomics?

Participatory ergonomics means actively involving workers in developing and implementing workplace changes which will improve productivity and reduce risks to safety and health – or as Wilson (1995) put it, the "involvement of people in planning and controlling a significant amount of their work activities, with sufficient knowledge and power to influence both processes and outcomes to achieve desirable

goals." The underpinning assumption is that workers are the experts (Stanton et al., 2005), and that when provided appropriate knowledge, skills, tools, facilitation, resources, and encouragement, these workers will be most capable of identifying and analyzing problems, and developing and implementing solutions to those problems. Stanton et al. (2005) suggests that this approach will increase the likelihood that solutions reduce injury risks and improve productivity. Additionally, it is suggested that this approach increases the likelihood that solutions will be easily accepted and implemented by employees (Brown, 2005). Typical models of participation include consultative or representative participation where employee representatives express ideas or opinions, and management makes decisions (Wilson, 1991). Here, however, we are more concerned with direct participation (Vink et al., 2006) in which workers have some degree of decision-making power regarding workplace changes.

This approach is put forward as a way of improving the overall safety culture of organizations (Rost and Alvero, 2018). Participatory ergonomics is viewed as an augmentation to a behavior-based safety program and can enhance and compliment the efforts organizations are putting into these initiatives. As workplace culture becomes increasingly democratized, these initiatives are becoming more prevalent, and increases collaboration within and between departments attempting to solve organizational problems. These problems are not necessarily confined to those within the sphere of ergonomics. Participatory ergonomics can be a structured program for the implementation of a behavioral-based safety program, encouraging focused end-user participation (Krause and Bell, 2015).

Initial Considerations

A conceptual framework for defining the range of variations found in participatory ergonomics programs has been proposed by Haines et al. (2002). The dimensions defined (in order of importance, according to Hignett et al., 2005) are:

i. "Location of decision-making power" – whether retained by management and informed by consultation with individual workers or groups or delegated to the workers.
ii. "Mix of participants formed for the interventions" – front-line staff only, or including technical staff, middle management and senior management.
iii. "Remit" – that is, the extent of the participants' involvement in setting up and monitoring of the participatory ergonomics process, the identification of problems to be addressed, and the generation, evaluation, and implementation of solutions.
iv. "Role of 'ergonomics specialist/s'" – acknowledged as potentially changing and evolving, ranging from being a facilitator or leader, trainer, expert team member, or available for consultation as required (or not involved).
v. "Nature of worker involvement" – varying from direct face-to-face involvement of all affected workers to representative participation of selected workers.
vi. "Focus" – whether aimed at the level of design of tasks undertaken by individuals or teams, or broader work organization issues or policies.
vii. "Level of influence" – variations in the level of the organization at which the intervention takes place, whether at the level of the work team or department, through to the entire organization, or indeed, across an industry (e.g., Tappin et al., 2016).
viii. "Requirement" – that is, whether the participation is undertaken by volunteers, or an expected part of a job role, noting that this may vary across group members.
ix. "Permanence of the intervention" – ranging from a temporary program introduced as a means of solving a particular problem, to programs intended to be permanently integrated into the ongoing continuous improvement activities of the organization.

Haines et al. (2002) also noted that participatory ergonomics programs might differ regarding the complexity of the organization in which the intervention occurs. For example, while a single-layer structure involving workgroup(s) only might be involved, more complex structures including, for example, a second layer of "steering committee," might well oversee the activities of multiple working groups; and more layers are also possible in large multi-site organizations.

The effectiveness of a participatory ergonomics intervention may well vary as a function of different combinations of these dimensions. The characteristics and level of commitment of the organizations in which such programs are implemented also varies considerably and these factors are also very likely to influence the outcomes of such programs.

The Relationship between Safety Culture and Ergonomics

An organization seeking to implement a highly effective ergonomics program needs to pay consideration to their safety culture and safety climate and implement a program that aligns with the organization's current state of maturity.

Safety culture is best described as "the way we do things around here." Culture forms the context by which employees judge the appropriateness of their behavior. A safety climate survey provides

a snapshot of the organization's safety culture at a given point in time. It is usually assessed via an all employee survey.

A safety climate survey completed ahead of a participatory ergonomics intervention can be helpful at identifying weaknesses in the culture that may reduce the effectiveness of such an intervention (Bentley and Tappin, 2010). Those organizations that have not conducted prior initiatives involving heavy employee consultation and communication may need to complete groundwork, building the robustness and consistency in these processes, prior to embarking on a participatory ergonomics initiative. If the organization does not have an active and engaged workplace safety committee, and good internal communications processes around safety, it is worth establishing these and then using these as a framework for the participatory ergonomics program.

Where trust between employees and management is good, and frameworks exist for communication and consultation between management employees, participatory ergonomics can aid in building a more robust safety culture and a more resilient organization. Ergonomics is an area of safety that most employees can easily understand, touch, and see on a daily basis, and so changes made in this area can aid to improve employee engagement and drive efforts at participatory approaches in other areas of safety.

Is Your Organization Ready for a Participatory Ergonomics Program? – Priorities, Leadership, Commitment/Resourcing

Several considerations need to be made prior to embarking on a participatory ergonomics initiative. These considerations are key to the success of any organization's participatory ergonomics program.

Priorities

An organization with too many competing priorities or initiatives may find themselves subjected to "change fatigue." Too many initiatives running simultaneously may also limit the availability of management and employee resources to join meetings, research and trial solutions, and complete other tasks associated with a participatory ergonomics program. Prior to commencing a participatory ergonomics program, organizations should ensure this program integrates with other organizational initiatives, and that the organization is not experiencing "change fatigue" from successive major initiatives.

Leadership

Senior leaders in the organization should be actively involved in a participatory ergonomics program, showing visible support and commitment to the program, and holding staff accountable to delivering outcomes associated with a program. Before commencing the program, leaders should consider how they will communicate the organization's commitment to the program, how they will visibly show support, what mechanisms will be used to uphold accountability, and how participation in the program will be celebrated within the organization.

Commitment/Resourcing

In addition to senior leadership commitment, middle managers, supervisors, and employees also need to be able to commit to participation in the program. Participants need to be able to dedicate time to team trainings and meetings; take time to research, trial, and implement changes to address identified risks; communicate their work with the rest of the organization; and sustain these activities over time. If the organization's ability to seek and sustain this commitment is questionable, then it may not be the right time for a participatory ergonomics program.

Getting Started

Forming Your Team

Selecting participants for your team should be done with care. At least one manager with authority to make decisions on operational changes, purchasing, and other key decisions should take part in the team. A mix of supervisors and employees should also take part, and there should be a greater representation from employees than supervisors and managers.

Participants should be engaged and ready to make a positive contribution to the team. Ideally, they should be held in good esteem by their peers and have some on-the-job experience in the area of focus for the program.

The organization should decide whether current circumstances, including the safety climate, lend better to a team focused on one area of the operation (e.g., water treatment plants), or a cross-section of the organization with one or two staff members representing a department on a bigger cross-sectional team.

Establishing Goals

The team should set some objectives by which to measure their progress. These objectives could include a minimum level of participation in team meetings, commitment to evaluating a certain number of tasks within a given time period, reducing risk by a certain margin, or trialing a certain number of proposed solutions. These objectives should be reviewed and approved by senior management, and the team should then be held accountable to those objectives.

Establishing Communication, Roles, Procedures

The organization should establish and communicate protocols prior to commencing team trainings and/or meetings, as “ground rules” for how the participatory ergonomics team will function within the organization. These protocols should make provision for how the team will communicate with the broader organization, particularly senior leadership and front-line employees. This could include scheduled updates in employee meetings, articles in newsletters, a regular update in leadership meetings, and/or a formal report from the participatory ergonomics team to leadership and/or the entire organization.

Sustaining Momentum

The team should ensure they meet at a frequency regular enough to sustain momentum. Teams who were most successful at generating implemented solutions met every 2-4 weeks. Meeting frequency should be sufficient to sustain momentum, but not so frequent that participants cannot complete actions between meetings, or experience “meeting fatigue.” Teams will generate momentum by implementing quicker, easier changes at the beginning of the project, e.g., replacing a manual grease gun with a powered grease gun. By actively communicating these quick wins, they will also secure the interest and contributions of the wider organization.

Using Data to Measure Success/Effectiveness

Generating data through the risk assessment and solution evaluation processes is an important means of measuring the effectiveness and success of the program. The exertion survey and risk assessment tools enclosed as Appendix A are useful tools for measuring the impact of a solution implemented in

response to an identified ergonomic risk. This data can be collected in addition to progress against metrics described in the preceding subsection.

Training the Team and Kicking Off Your Project

Providing your team with the time, tools, and most importantly training on their role and how to participate in this program is integral to the success of such an initiative. Teams require critical knowledge and skills on ergonomic hazards in the water industry, risk assessment, using the hierarchy of controls for ergonomic hazards, project management, and working as a team. This training is usually delivered by a Certified Professional Ergonomist (CPE) by the Board of Certified Professional Ergonomists, who may also act as a facilitator to the team on an ongoing basis after the program initiation period is complete.

The training used for this research project is included as Appendix B. The contents should be tailored to the tasks your team typically perform, before using the material in your own participatory ergonomics program.

The Ergonomist as a "Facilitator" Rather than a "Doer"

The ergonomist's role can vary considerably, from a facilitator who conducts initial team training and then steps away with minimal input provided, through to a dedicated resource to the project, assisting with task risk assessments, completion of exertion surveys, conducting pilots of solutions, and other hands-on tasks. The availability of resources within the organization to complete these tasks (i.e., in place of the facilitating ergonomist) is one factor that may determine the role of the ergonomist in the program. Other factors will include availability of internal expertise, the maturity of processes such as communication and consultation, and the overall size and complexity of the organization.

The research team highly recommends utilizing a Certified Professional Ergonomist (CPE) as a program facilitator. Professionals with this certification are experienced at managing ergonomic risk at both the micro-ergonomic (i.e., task and individual employee) level and the macro-ergonomic (i.e., the organizational level), and can help the team overcome any identified barriers to success at either level. The level of facilitation should be commensurate with the level of resources available within the organization, and the capabilities of the team members taking part in the program.

Maintaining a balance between the work done by employees and the ergonomist is important. Organizations should take care that the "e" in CPE does not come to stand for "everything" – maintaining the project as primarily employee-driven is key to success and ensuring that solutions implemented can be effectively sustained over time. Employees should still determine which tasks to assess; which changes to trial; and whether changes should be widely implemented across the organization. If the CPE takes over any of these decision-making processes, changes are less likely to be embraced by employees, which risks the overall effectiveness of the program.

Identifying Ergonomic Risk Factors

Teams should be provided with training on what ergonomics is, and how to conduct task observations to identify where and when these risk factors exist for a given task. This training should ideally incorporate videos of tasks performed by workers at that utility, to maximize the relevance of the training and assist with the accuracy of future observations for risk assessment purposes.

Using the Exertion Survey

The exertion survey is used to measure the degree of perceived exertion employees experience when completing a given task. This serves a number of objectives. It aids in determining which tasks employees find the most strenuous, as a means of triaging which tasks the participatory ergonomics

group may want to work on improving first. It also aids at evaluating the effectiveness of any solutions trialed, when the group performs a repeat exertion survey for the same task with the new solution in place. Performing repeat surveys as a follow up (post solution implementation) also helps evaluate the sustained effectiveness of the solution for a given task.

The exertion survey should ideally be administered by employee's peers rather than a manager or a member of the health and safety team. It should be emphasized that the survey seeks to assess rating of perceived exertion, not perceived discomfort.

Using the Risk Screening Tool

The risk screening tool is used to identify whether a given ergonomic risk factor exists for a particular task. It can also be used as a prioritizing tool by counting the number of risks present for a given task, and determining which tasks have a greater number of risks present. It should be used in combination with the exertion survey results to determine which tasks pose the greatest potential ergonomics risk. Completing a repeat risk survey post solution implementation can also help evaluate the effectiveness of a solution, by determining how many risks were reduced or eliminated through implementation of that solution.

Many of the questions on the risk screening tool involve a degree of time weighting, which needs to be considered when determining whether a given risk exists for a particular task.

Training on Other Necessary Skills

The team should also receive training on how to work effectively as a team, how to assess the return on investment on a proposed change, how to manage objections to change, and how to project manage an implementation of a solution. Training should also cover methods to analyze results from exertion surveys and risk assessments, to aid in triaging risk and deciding which tasks to improve first.

Providing training on use of the hierarchy of controls for ergonomic risks will ensure the team remains focused on implementing higher order controls, i.e. engineering solutions or elimination of the task altogether. Return on investment discussions should evaluate cost savings through productivity gains and injury cost reductions, and these discussions should take into account the number of employees affected by the problem being examined.

Choosing Tasks to "Improve"

In addition to evaluating results from the exertion survey and risk assessment tools, groups should also consider which tasks to 'improve' first. The group will generate momentum if they choose one to two tasks of relatively low complexity where a solution is obvious, before moving on to tasks of greater complexity and/or where solutions are more difficult to implement. These "quick wins" can aid in boosting morale, securing long-term engagement, and provide a framework for tackling those more difficult problems to solve.

More complex solutions should be associated with an action plan, including clearly defined actions, responsibilities, timeframes, and due dates, and these action plans should be summarized in reports to leadership. Regular communication should be provided between the group and the rest of the workforce, so the group and the wider workforce do not get discouraged by an apparent lack of progress.

Using the Hierarchy of Controls for Ergonomics

Wherever possible the group should be encouraged to implement engineering and higher order controls for improvements to the task. Elimination, substitution, and engineering controls reduce the magnitude of the risk (or may eliminate it all together), while administrative controls are less reliable and seek to minimize the duration of exposure to the risk, rather than removing or reducing the degree of the risk that initially existed.

Solutions Identified

This section serves to depict the problems and solutions that each team identified and implemented. All these solutions were trialed in a "pilot" prior to full implementation. This trial would usually involve renting a piece of equipment for a trial period or purchasing one item for a "test" in the field. If employee feedback was favorable, the group would move to full implementation of the solution.

Contra Costa Water District (CCWD)

Lid Pulling

"Lids" are metal covers for manholes, valves, and other pieces of water infrastructure underground, that need to be accessed by utilities workers. Pulling lids, including valve covers, required a high degree of force (in excess of 75lbf), particularly when valves were stuck. Before the use of this solution, teams would often need to use a sledgehammer or other hand tool to "knock" the lid loose enough to be pulled free. The lid lifter used prior to the implementation of a solution is shown in Figure 1 below.

The solution was a modified valve lid pulling tool (Figure 2), which reduced the degree of force required, as well as reducing the amount of time required to pull a lid from a valve cover. The modified design also redistributed forces and effort to the larger muscle groups of the lower limb (i.e., the quadriceps, hamstrings, and gluteals), rather than concentrating effort in the shoulders, as was seen in the methods used prior to the implementation of this solution. Several design iterations were required to identify a metal type, and lid "key" design, that would not bend under the weight of a stuck lid as it was being maneuvered open.

Figure 1. Before: Lid Lifter.

Figure 2. After: "Bottle Jack" Lid Lifter.

Throwing Sandbags

The CCWD manages more than one hundred miles of irrigation canal. The sides of the canals consist of embankments, which are prone to slippages. These slippages are mitigated through the installation of sandbags and plastic sheeting. This work is typically performed prior to, and just after, heavy rains. This

makes this task more difficult as the ground is usually slippery and muddy, making it harder to maintain traction and generate high forces to move objects.

Installing plastic sheeting on dam embankments required workers to remove sandbags from the back of a truck and install them on the embankment. Workers form a line down the embankment and throw them to each other (Figure 3), until they are in the desired position on the embankment. A stake is then hammered into the embankment to keep the sandbag in place.

The solution was to load sandbags into a "sled" (Figure 4) next to the truck which was then winched from the back of the truck, down the embankment. This served to eliminate the throwing motion from the task and increase the rate at which sandbags could be installed on an embankment. The weight of the bags was also reduced, from 60 lbs. to 30 lbs. per bag, reducing the corresponding amount of force required to remove the sandbags from the sled.

Figure 3. Before: Throwing Sandbags Down a Slope.

Figure 4. After: Moving Sandbags with a Prototype "Sled."

Loading/Unloading Plywood Manually

Sheets of plywood used for excavation shoring was previously loaded and unloaded from trucks by hand (Figure 5). The method of storage for plywood sheets was changed so they could be loaded and unloaded from trucks using a forklift (Figure 6).

Additionally, holes were cut into each plywood sheet to act as a handle, making it easier to grip the plywood sheet when installing it for shoring. This hole also allows a sling to be attached and for the job site backhoe to be able to lift and set the sheet into place.

Figure 5. Before: Lifting Sheets of Plywood Manually.

Figure 6. After: Using Forks to Move Sheets of Plywood.

Raking Weeds from Canal

Nuisance weeds grow on the bottom of irrigation canals. They periodically break away from the canal floor and are swept downstream, where they are caught in and block filter screens that are fitted to weirs on the canals. This can impact water flow and quality.

This task required workers to use a standard garden rake to remove weeds that had been caught in the screens of water supply canals (Figure 7). The work required a high degree of force, repetition, and awkward postures. Initially, a mechanical harvester (Figure 8) was used to cut the weeds and load them onto a pontoon, and then transfer them into a front-end loader for removal from the canal area, as a substitute for using a hand-held rake to remove the weeds from the screens.

As an additional solution, the utility piloted a UV light-driven buoy (Figure 9). This buoy was mounted on a small boat and floated down the canal. The water was treated with this UV light to inhibit weed growth. Test sections of the canal were treated to determine the effectiveness of this equipment. Preliminary results suggest the buoy inhibited weed growth, in turn reducing water turbidity, and may negate the requirement to remove weeds from the canal at all, if further testing indicates that these results will be replicated at scale.

Figure 7. Before: Lifting Weeds with Rake.

Figure 8. After: Mechanical Weed Harvester.

Figure 9. UV Light Buoy, Mounted on a Boat Used at CCWD.

Valve Operation

Valves in the water system require periodic opening and closing ("exercising") to stop them from freezing shut. Manual hand tools were used to open, close, and exercise valves (Figure 10). This method required a high degree of force (in excess of 50lbf of torque), repetition, and awkward postures. Some valves required up to 300 turns to fully open or close.

A few powered valve openers were implemented, including the Valve Boss (Figure 11), which counts the number of turns produced by the machine, and the Wachs ERV-7 truck mounted valve exerciser (Figure 12). Both served to significantly reduce the amount of force and repetition required to operate a valve, made it easier to keep count of the number of turns completed, and produced a more consistent amount of torque, reducing the likelihood of valve damage.

Figure 10. Manual Valve Operation.

Figure 11. Valve Operation with the Valve Boss.

Figure 12. A Truck-Mounted Valve Turner.

Columbus Water Works, Georgia (CWWGA)

Climbing Water Towers

Water towers require periodic inspection to ensure optimum performance and ensure no maintenance on the infrastructure is required.

To inspect a water tower, an operator was previously required to ascend and descend the ladder of the tower, to perform routine inspections at the top of the tower. This required a high degree of repetition, involved force from the leg muscles to climb and descend the ladder, and presented a risk of falls from height. An unmanned automated vehicle (UAV) (Figure-14) was purchased to perform routine tower inspections, eliminating the need to climb the tower unless an issue was identified.

For those instances where climbing a tower was necessary, a modified climbing system was installed to assist the operator with descending and ascending the ladder, reducing the overall effort required to use

the ladder (Figure 13). This is a winch-style system which takes some of the operator's body weight, so less force is required from the leg muscles to move up the ladder.

Figure 13. Climbing a Water Tower.

Figure 14. An Unmanned Aerial Vehicle (aka Drone).

Operating Valves

This task is identical to that assessed and changed by CCWD. A high degree of force and repetition was required to manually open, close, and exercise valves (Figure 15). Operators ran the risk of losing count of the number of turns completed and could also possibly over- or under-torque valves when performing the task manually. A powered valve operator was identified and sourced to reduce the amount of force and repetition required, keep track of the number of turns completed, and ensure more consistent application of torque (Figure 16). The new valve operator weighs 32 lbs., while the previously used operator weighed 85 lbs. Valves requiring many turns to operate could take an eight-hour day to open and close with the old machine and can now be exercised in 45 minutes. Fewer valve breakages are reported with the new machine.

Figure 15. Manual Valve Operation.

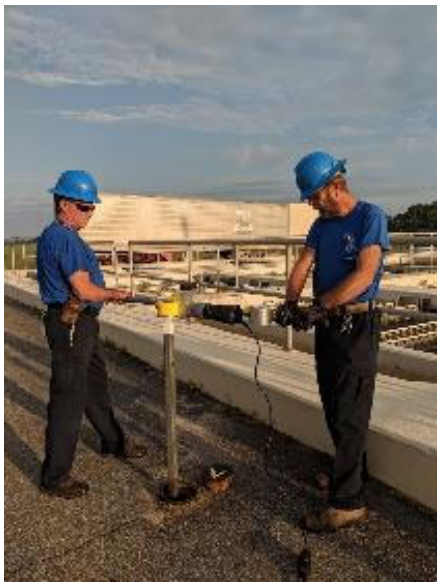


Figure 16. Operating a Powered Valve Operator.

Pipe Cutting

PVC pipe needs to be cut to length and beveled to receive a fitting. Previously, the circular saw used to cut the pipe was also used to bevel the end of the pipe, by using the saw blade as a pseudo-grinder

(Figure 17). This resulted in high forces (up to 50lb) through the back and shoulder to hold and control the saw. A hand tool with a beveller fitting was procured to bevel the ends of the pipe, greatly reducing the risk to the back and shoulders when performing this task (Figure 18). This has reduced the risk of laceration injuries performing this task and improved the consistency and quality of beveling.

Figure 17. Beveling Pipe with a Saw.

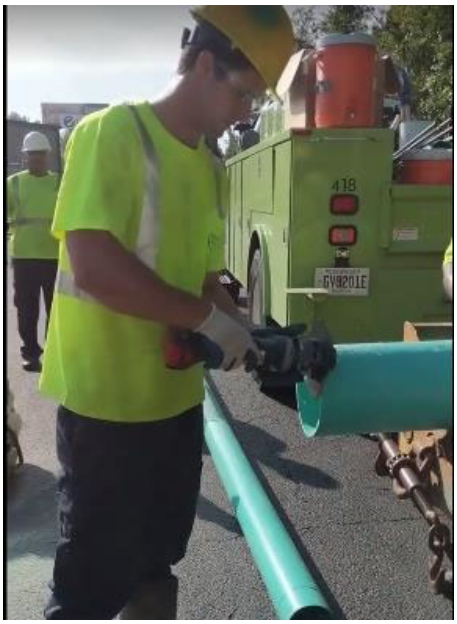


Figure 18. Beveling Pipe with a Hand Tool Intended Specifically for Beveling Pipe.

Improved Hearing Protection

Vacuum truck operations generate noise levels up to 124 dB(A) for a period of six to eight hours of exposure. Hearing protection is subsequently required for these operators. Previously, in-ear foam hearing protection was used, which was uncomfortable to wear and inhibited communication between operators. This would require operators to perform repetitive bouts of walking, over long distances, to communicate with the other operators on the job, otherwise they were not able to hear each other. Over-ear, voice-activated Bluetooth headphones were sourced which are more comfortable, allow operators to speak to each other without having to continually walk over to each other, and work within a 1,000-foot range of the base station inside the vacuum truck (Figure 19).

Figure 19. Improved Hearing Protection.

“Tap” Machine

To install a new customer service on a main, employees need to tap the main using a for purpose device known as a “tap machine.” It drills a hole in the main so an outlet can be fitted to the pipe, and the customer service is attached to this fitting.

The device previously in use (Figure 20) required two operators to hold the machine, while a third employee generated high forces (in excess of 50lbf) to penetrate the main and install the service. A modified tap machine was sourced that requires a single operator and less force to operate than the old machine. The old machine weighed 25 lbs., while the new machine weighs 4 lbs. It previously took three employees 45 minutes to tap a main. With the new machine (Figure 21), one employee can tap a main in five minutes.

Figure 20. Left Shows “Old” Tap Machine, with “New” Machine on the Right.

Figure 21. Using the New Tap Machine.

East Bay Municipal Utilities District (EBMUD)

Greasing Mechanical Equipment

A hand-operated grease gun was used to grease bearings and other moving components of mechanical equipment (Figure 22, left image). This required a high degree of force and repetition, and static, awkward postures while operating the gun. The manual gun was replaced with a battery-operated unit, virtually eliminating the amount of force required to operate it, and lowering the time required to perform the task by 33% (Figure 22, right image).

Figure 22. Manual Grease Gun (Left) and Powered Grease Gun (Right).

Accessing Locks on Service Truck

Locks for the cabinets on service trucks were located in a position that required overhead reaching to access (Figure 23). Shoulder and wrist force was required to operate the locks, which was more difficult to generate while reaching overhead. A step was installed to make the locks accessible without the need for overhead reaching (Figure 24).

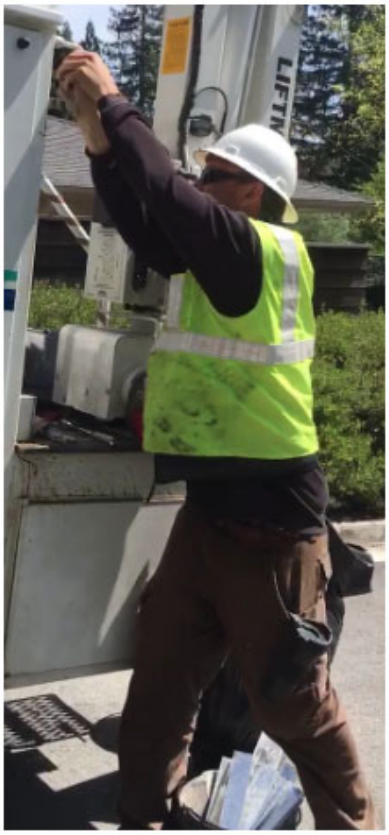


Figure 23. Accessing Locks Overhead.

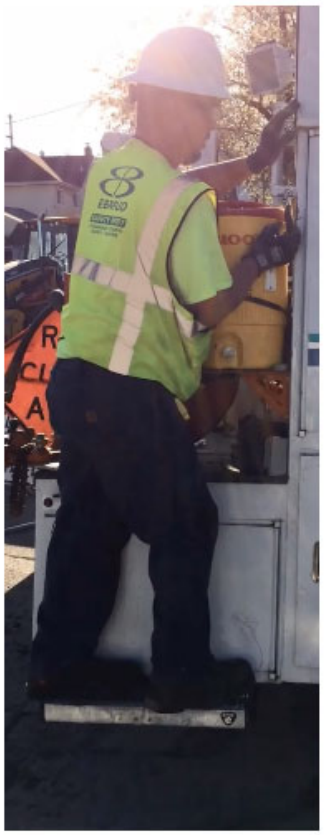


Figure 24. Accessing Locks Using Step.

Potholing Utilities

A shovel was used to dig potholes and other small holes for exposing utilities and other tasks. This required repetitive use of force (more than 75lbf) in awkward postures (Figure 25). A vacuum truck was made available to perform potholing, which reduced the amount of time required to expose utilities, eliminated the risk of utility strikes, and eliminated the task of shoveling (Figure 26).

Figure 25. Digging Holes Using a Shovel.

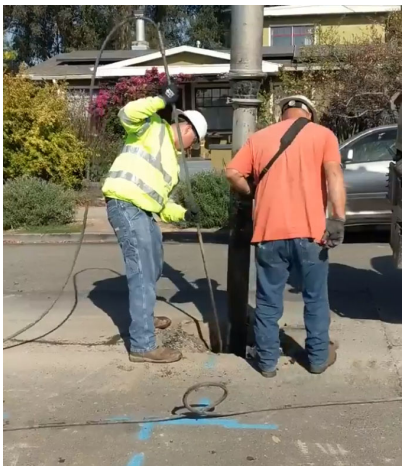


Figure 26. Vacuum Excavation.

San Francisco Public Utilities Commission (SFPUC)

Jackhammer Assist

Jackhammers are used to break up concrete and asphalt to access services. Once the jackhammer blade is worked into the concrete or asphalt, it needs to be pulled from the concrete, requiring a large degree (more than 100lbf) of force (Figure 27). The jackhammer assist is a device which mechanically "lifts" the blade from the asphalt, reducing the amount of force required (Figure 28).

Figure 27. Jackhammer without Assist Device.

Figure 28. Jackhammer with Assistive Device Installed.

Appendix A: Survey Tools

Exertion Survey and Risk Identification Tool

Water/Sewer District Ergonomics Task Survey

NAME: _____ **Date:** _____
mm/dd/yy

LOCATION _____ **Time of day** _____

TASK _____

SHIFT _____

CONDITIONS _____

A. Level of exertion/fatigue

On the scale below, please rate your level of exertion or fatigue after doing the task by circling the number that represents the fatigue/exertion in the body part indicated.

Exertion/Fatigue	Neck	Shoulder	Forearm	Wrist/Hand	Back	Legs
Right/Left/Both		R L B	R L B	R L B		R L B
Nothing at all	0	0	0	0	0	0
Noticeable Fatigue/Exertion	1	1	1	1	1	1
	2	2	2	2	2	2
Moderate Fatigue/Exertion	3	3	3	3	3	3
	4	4	4	4	4	4
Strong/heavy Fatigue/Exertion	5	5	5	5	5	5
	6	6	6	6	6	6
Very strong Fatigue/Exertion	7	7	7	7	7	7
	8	8	8	8	8	8
	9	9	9	9	9	9
Extreme Fatigue/Exertion	10	10	10	10	10	10

B. Ease of each step in the task:

Please describe & rate each step in the task (e.g., taking safety cones off truck):

	Step	<Easy					Difficult>
1.	_____	0	1	2	3	4	5
2.	_____	0	1	2	3	4	5
3.	_____	0	1	2	3	4	5
4.	_____	0	1	2	3	4	5
5.	_____	0	1	2	3	4	5
6.	_____	0	1	2	3	4	5
7.	_____	0	1	2	3	4	5

C. What are 3 good things about the way the task is done, including tools used?

1.

2.

3.

D. What 3 things that could/should be improved, including tools used?

1.

2.

3.

E. Ideas for improvement:

Water Research Foundation Physical Demands Survey

EMPLOYEE NAME: _____Date: _____/____/_____
MM DD YY

LOCATION: _____Time of day: _____

JOB: _____

TASK (e.g., operating valve # 7): _____

_____

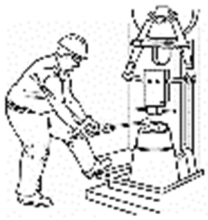
CONDITIONS: _____

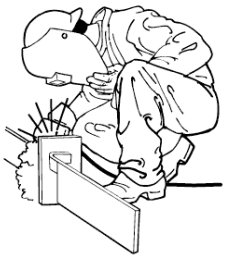
Notes:

The checklist below is designed to help identify work methods, tools, and tasks that can contribute to work-related discomfort or musculoskeletal problems. It's NOT designed to evaluate any employees, only the tasks they perform at work.

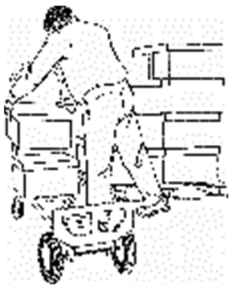
To use the checklist, observe the task and if any of the activities or body positions are present in the work activities. The checklist depends on an estimate, from you or the employees doing the tack, of the length of time they are doing that activity or working in those positions. Please keep in mind that the more difficult parts of the task (e.g., taking a heavy tool or other item on/off a truck) are especially important to observe, so find out about those ahead of time and plan to be there when those will be done. Some tasks may be more difficult under certain conditions (deadlines, bad weather, etc.), place information on that under 'Conditions' above, and use the 'Notes' box to enter more info on the Task or Conditions.

Working positions

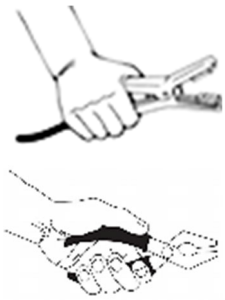
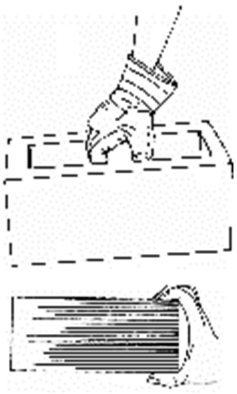
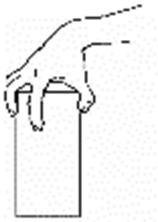
Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Working with the back bent forward more than 30° (without support or the ability to vary posture) More than total of 2hrs/day.			
Working with the back bent forward more than 45° (without supporting the torso or varying posture) More than total of 1hour/day.			
Twisting the back more than 20° More than total of 1hr/day.			
Bending and twisting More than total of 30 min./day.			
Working with the neck bent forward or backward more than 30° (without support and without the ability to vary posture) More than 2 hours total per day.			

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Working with the neck bent more than 45° (without support and without the ability to vary posture) More than 1 hour total/day.			
Working with the hand(s) above the head, or the elbows above the shoulders More than 2hrs./day.			
Squatting More than 2hrs./day.			
Kneeling on one or both knees More than 2/day.			

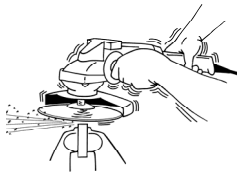
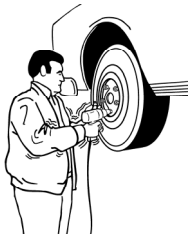
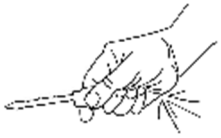
Lifting, pushing, pulling

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Weight or force required Lifting or pulling/pushing object weighing more than 75 pounds One or more times/day			
Lifting object weighing more than 50lbs. More than 10 times/day			
Pushing or pulling with force greater than 50lbs. with back straight More than 10 times/day			
Lifting objects weighing more than 50 pounds above the shoulders, below the knees, or at arm's length More than 10 times/day			
Repetitive (more than twice per minute) lifting of objects weighing more than 10 pounds More than 2hrs/day			

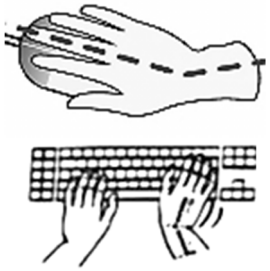
Gripping

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Forceful gripping: Holding tools weighing 10lbs. or more per hand, or gripping with more force than clamping automotive jumper cables. More than 2hrs/day			
Forceful pinching: using a pinch grip to hold an object weighing 2 or more pounds per hand, or pinching an object to squeeze it with weighing more than 4 lbs. of force per hand. More than 2hrs/day			
Using a pinch grip with the wrist bent More than 1hr./day			
Pinching + highly repetitive motion More than 3hrs/day			
Gripping plus wrist deviation More frequently than 1/hour			

Impact & Vibration

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Using sanders, jigsaws or other hand tools that have moderate vibration levels More than 2 hours/day			
Using impact wrenches, chain saws, percussive tools (pneumatic hammers, scalers, riveting or chipping hammers) or other tools that have high vibration levels More than 30 minutes/day			
Pressure applied by tool to part of the body More than 1 hour/day			

Computer use

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Intensive keyboard use (e.g., data entry) or mouse use (e.g., in CAD applications) More than 4 hours/day at a desktop computer OR More than 2 hours/day using a laptop			
Keyboard or mouse use with wrist deviations More than 1 hour/day			

Source: Sketches courtesy of the Washington State Department of Labor & Industries.

Appendix B: Training Materials Provided to Utility Teams

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Water Research Foundation Participatory Ergonomics Training

Elise Condie, M.S., CPE

Principal Consultant

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Objectives

- Understand ergonomics and its benefits
- Understand basic anatomy and WRMSDs
- Learn about participatory ergonomics
- Learn about ergonomic risk factors and using your 'ergo eyes'
- Working as a team, setting and running meetings, recordkeeping using Box
- Use the Ergonomics Screening Tool
  - How to take photos and video
- Next steps, homework assignment & logistics

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2

Introduction to Ergonomics

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3

Ergonomics

- Ergonomics is fitting the task to the individual
  - Good fit: reading a meter at eye height, operating an excavator in a seated posture
  - Poor fit: bending over into a trench, lifting a valve that is too heavy
- Matching the job demands with human capabilities and limitations
- Can improve productivity with new methods to make work easier to perform

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Ergonomics

- Fatigue, discomfort, and injuries occur when the worker and his or her environment are mismatched
- Productivity, work quality, and morale can all be affected

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5

Why is Ergonomics Important?

- With the proper tools and environment, tasks can be made easier to carry out, improving the quality and efficiency of the work.
- Unresolved ergonomic issues can lead significant discomfort and injuries that are difficult to overcome.
- Injuries have the potential to limit one's ability to perform the work and can also affect one outside of the workplace.

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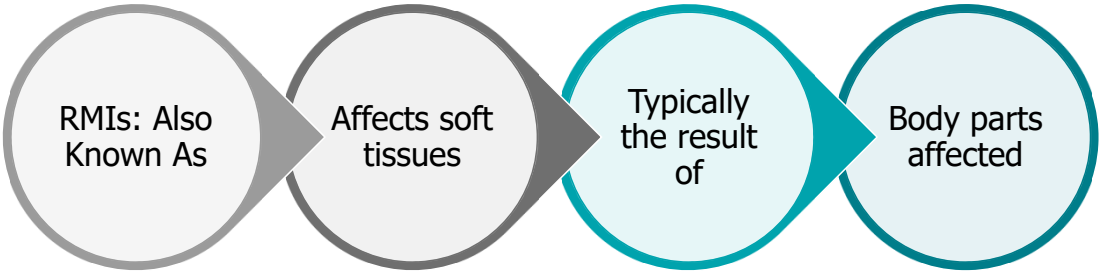
6

Repetitive Motion Injuries (RMIs)



- Work-Related Musculoskeletal Disorders (WMSDs)
- Cumulative Trauma Disorders (CTDs)
- Repetitive Stress Injuries(RSIs)

- Nerves
- Ligaments / Tendons
- Muscles

- Static and awkward postures
- Force
- Repetitive motions

- Neck and shoulders
- Lower to upper back
- Wrists, hands, and arms

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7

Injury Progression and Symptoms

1. Early Stage
   1. Muscle fatigue, swelling, inflammation, minor pain and discomfort, losing grip strength
2. Late Stage
   1. Numbness, loss of feeling, loss of function or range of motion, difficulty working effectively, medical treatment likely needed.
   2. Having a "funny" feeling may be a sign of early nerve damage
3. Severe Stage
   1. Permanent damage occurs to muscles, tendons, ligaments, and/or nerves
   2. Inability to work, lost wages and productivity
   3. Potential to affect long term career depending on the degree of damage

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Impacts of Poor Ergonomics

- Direct Impacts
  - Pain and suffering of employee with injury
  - Higher burden on the non-injured employees to keep up with demand in the absence of injured workers
  - Employees forced to take on more work more likely to develop injuries themselves from the higher workload
  - Diminished engagement from injured and non injured employees owing to discomfort, perceived exertion and workload, and perceived loss of job control
  - Diminished engagement can impact productivity and employee retention

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Why is Ergonomics Important?

- Injuries have significant economic costs as well
  - Lost wages
  - Medical expenses and worker's comp claims
  - Retraining
  - Lost productivity

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What is Participatory Ergonomics?

Definition

- When employees work together under guidance from professionals to review and revise the task and/or tools used to perform the task, and occasionally overall job design, to to achieve maximum productivity and minimize the risk of injury.

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Participatory Ergonomics

Benefits

- Gets everyone involved
- Creates a mechanism for swift change
- Creates accountability for issues and greater commitment to resolving them
- Develops more effective solutions
- Improves safety and productivity
- Improves morale, overall worker performance and satisfaction with work
- Employee driven and focused

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12

What to Look For

Identifying Risk Factors

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13

Ergonomic Risk Factors

- Repetitive Motion
- Force
- Awkward Postures
- Static Postures
- Contact Stress
- Vibration

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Repetitive Motion

Typical Examples:

- Lifting
- Repeatedly twisting, bending
- Gripping (i.e. trigger finger)
- Shoveling

Use your ergo eyes! What specific examples can you identify in your workplace?

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Force

Typical Examples:

- Pushing
- Pulling
- Lifting
- Carrying
- Gripping (overexposure to vibration)
- Heavy objects

Use your ergo eyes! What specific examples can you identify in your workplace?

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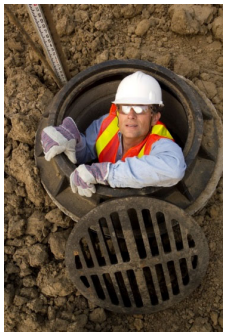
Awkward Postures

Typical Examples:

- Bending at the back
- Twisting and lifting an objects
- Reaching overhead

Use your ergo eyes! What specific examples can you identify in your workplace?



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Static Postures

Typical Examples:

- Standing
- Bending

Use your ergo eyes! What specific examples can you identify in your workplace?

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Contact Stress

Typical Examples:

- Prolonged sitting in earthmoving equipment
- Gripping hand tools

Use your ergo eyes! What specific examples can you identify in your workplace?

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Vibration

Typical Examples:

- Sustained grip on a tool
- Using tools without a vibration dampener
- Poorly maintained equipment

Use your ergo eyes! What specific examples can you identify in your workplace?

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Combined Risk Factors

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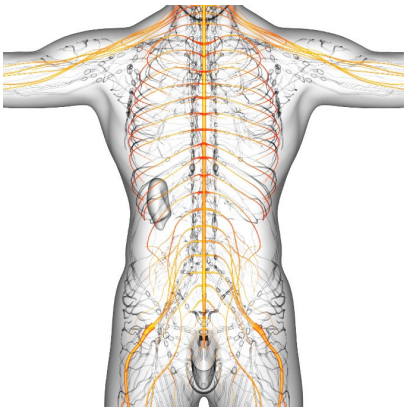
21

Anatomy Review

- In order to understand injuries and reasons behind workplace improvements we need to review some basic anatomy in the following areas:
  - Wrist and hands
  - Arms and shoulders
  - Neck and back



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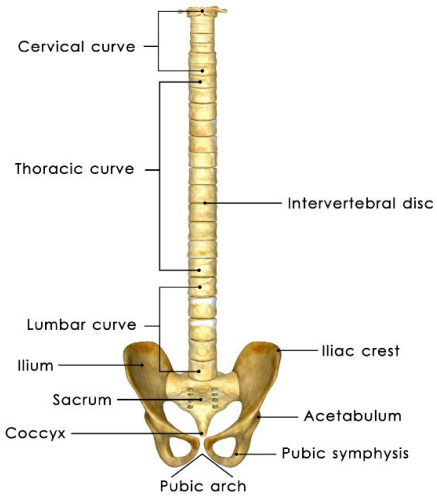
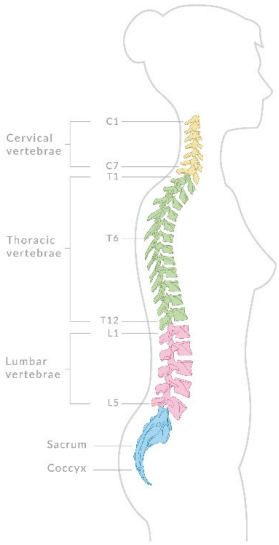
Anatomy of the Back

- Vertebrae
- Spinal Curves





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Back Risk Factors

Sustained or repeated bent over posture

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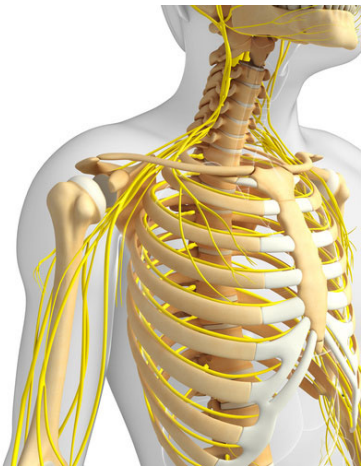
Anatomy of the Shoulder

- Nerves start at neck and run to the fingers
- These nerves travel under soft tissues like muscle, ligament, tendon, and synovial sheaths
- Impingement may occur anywhere along this pathway



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Shoulder Risk Factors

Reaching overhead

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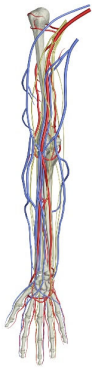
26

Anatomy of the Forearm

- Forearm muscles control hand
- Elbow
  - Ulnar nerve/Median nerve
    - Runs shoulder-hand
    - Possible issues with contact stress



Ulnar Nerve • Median Nerve

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Forearm Risk Factors

Over-gripping and vibration

Sustained or repetitive wrist extension

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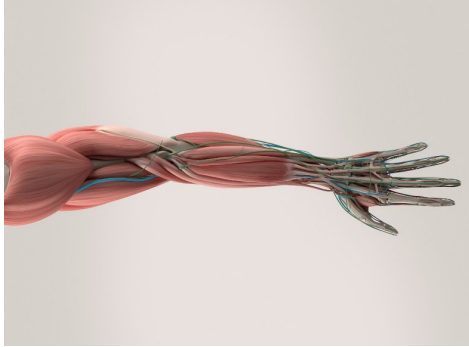
28

Anatomy of Wrists and Hands

- Nerves
- Ligaments
- Tendons
- Blood vessels



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Hand/Wrist Risk Factors

Awkward position of wrist or hand

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30

Getting Started

Let's get to work!

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31

Participatory Ergonomics Teams

Who should be on the team?

- Mix of management and people who perform the tasks (preferably equal mix but management should not outweigh employees)
- One person who can make operational and budget decisions
- Good to have someone from Health & Safety on the team

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Participatory Ergonomics Teams

Participation Expectations

- Ensure your management knows you will be spending time on this project and have agreement on the amount of time dedicated to this project
- Join all meetings
- Actively participate and provide feedback and input

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33

Working As A Team

Holding Meetings and Meeting Frequency

1. Once per week or bi-weekly as a group
2. Work to a set agenda and keep minutes of each meeting
3. Assign meeting lead, scribe, and timekeeper
4. Assign responsibility and due dates for action items and track to completion

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Example agenda

- Confirm attendance
- Review actions from last meeting
- Task 1 review progress
  - Update on control implementation
  - Training/retraining
- Task 2 review progress
  - Update on control implementation
  - Training/retraining
- Other new business
- Set next meeting date and close

Action item	Notes and action required	Responsibility	Due date
Engineering approval of jig design	Still outstanding; needs follow up with J. Jones	T. Thompson	4/20/17
Develop SOP for use of jig for machining task	In draft; needs review by team	S. Sampson to distribute for comment; comments due 4/31/17	4/16/17

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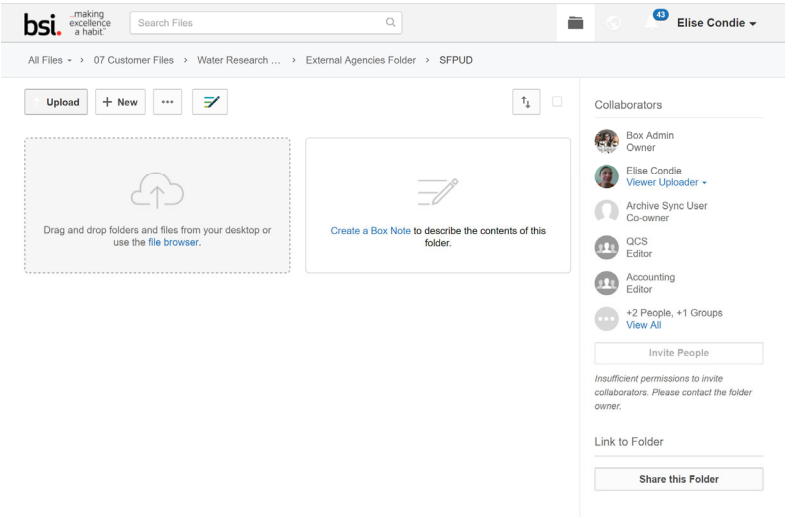
Using Box to upload and share information



- Completed screening tool/risk assessments
- Photos and videos
- Risk assessments
- Vendor and product information
- Meeting minutes
- Anything else relevant

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By the next training session (starting 4/10/17)

- Identify tasks to 'screen'
- Complete the screening tool for each task and decide which tasks to complete risk assessments on
- Take photos and videos of each task you will be risk assessing
- Upload your completed screening tools, photos and videos to Box
- Come prepared to examine each task in more detail using a risk assessment tool

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Collecting Information

Using the Screening tool

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Working As A Team

Picking Where to Start

1. Look for the most pertinent issues
    1. Which tasks are most difficult?
    2. What other jobs do you know people don't like to do?
    3. Which tasks involve the most repetition? Least amount of recovery time?
    4. If the solution seems too obvious, it may not be the best task to consider
2. Share information (via Box)
    1. Even unrelated tasks can be resolved with similar solutions
    2. Review problems identified with other teams
    3. It is cost effective and saves time if two teams encounter similar issues

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Water/Sewer District Ergonomics Task Survey - DRAFT

NAME: _____ Date: ____/____/____ (mm dd yy)

LOCATION: _____ Time of day: _____

TASK: _____

SHIFT: _____

CONDITIONS: _____

A. Level of Exertion/Fatigue

On the scale below, please rate your level of exertion or fatigue after doing the task by circling the number that represents the fatigue/exertion in the body part indicated.

Exertion/Fatigue	Neck	Shoulder	Forearm	Wrist/ Hand	Back	Legs
Right/Left/Both		R L B	R L B	R L B		R L B
Nothing at all	0	0	0	0	0	0
	0.3	0.3	0.3	0.3	0.3	0.3
Barely noticeable Fatigue/Exertion	0.5	0.5	0.5	0.5	0.5	0.5
Noticeable Fatigue/Exertion	1	1	1	1	1	1
	1.5	1.5	1.5	1.5	1.5	1.5
	2	2	2	2	2	2
	2.5	2.5	2.5	2.5	2.5	2.5
Moderate Fatigue/Exertion	3	3	3	3	3	3
	4	4	4	4	4	4
Strong/heavy Fatigue/Exertion	5	5	5	5	5	5
	6	6	6	6	6	6
Very strong Fatigue/Exertion	7	7	7	7	7	7
	8	8	8	8	8	8
	9	9	9	9	9	9
Extreme Fatigue/Exertion	10	10	10	10	10	10

Ergo Task Survey, v.1 (3-18-17) 1

B. Ease of each step in the task:

Please describe & rate each step in the task (e.g., taking safety cones off truck):

Step	<Easy Difficult>
1. _____	0 1 2 3 4 5
2. _____	0 1 2 3 4 5
3. _____	0 1 2 3 4 5
4. _____	0 1 2 3 4 5
5. _____	0 1 2 3 4 5
6. _____	0 1 2 3 4 5
7. _____	0 1 2 3 4 5

C. What are 3 good things about the way the task is done, including tools used?

1.

2.

3.

D. What 3 things that could/should be improved, including tools used?

1.

2.

3.

E. Ideas for improvement: _____

_____

_____

Ergo Task Survey, v.1 (3-18-17) 2

40

How to Use the Screening Tool

Overview

- Think about whether or not you want to capture the WHOLE task or process or just certain parts of a task/procedure
- Remember the Ergo Eyes concepts

Using the tool

1. Consult with the employees who perform the task
2. Ask them to rate the effort involved for each body part (1-10)
3. Rate the difficulty in performing each step of the task
4. Note ideas for improvement- ask the employees you are surveying

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Other tips for using the screening tool

Discussion Focus

1. During this part of the process, pick the top 3-5 jobs that are most difficult.
2. Take photos and videos to use when we meet again to perform an in depth risk assessment of the task.
3. Job Hazard Analyses (JHAs) may be useful as sources of information to help with collecting photos and videos for each step of the task.
4. Make sure to have photos or videos for each step of a process even if no JHAs are available.
5. Be able to show each step accurately to someone who has never seen it before.

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Practice time: using the screening tool

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Questions?

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Water Research Foundation Participatory Ergonomics Training

Elise Condie, M.S., CPE

Principal Consultant

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Objectives

- Review Last Training
- Homework Review and Questions on Box
- Review of Risks and Examples of Each
- Using the Screening Tool
  - Identify Risk Factors in Each Task
- Homework/What to Work On

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Review of Last Training

- What is ergonomics?
- What are the ergonomic risk factors?
- Participatory Ergonomics Team
  - Do you have the right team?
  - Anyone else needed?

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Review of Last Training

- What risk factors do you see here?

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4

Review of Last Training

- What risk factors do you see here?

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Shifting to Box

- Was everyone able to access Box?
- New Questions?
- Any remaining challenges?
- Start keeping all information in your Box folder.
- Ensures everyone can access everything in one location

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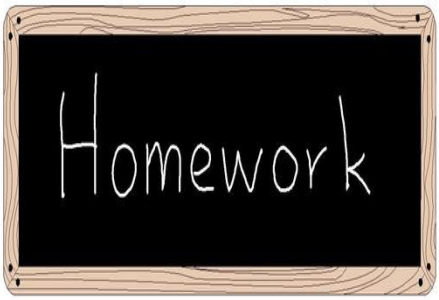
Homework Review

- What challenges did you encounter?
- What went well?
- Did you complete surveys on the tasks we identified? Or other tasks?
- What questions do you have?
- What did you learn through completing these surveys?



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Let's look at your surveys

- Which tasks scored the highest overall?
- Which tasks generated the best/ most interesting comments?
- Did employees have ideas for solutions for any tasks? What are they?
- Are there any solutions that are just obvious that you can go ahead and implement?

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Next Steps

Looking at chosen tasks in more detail using more detailed form

1. Work out what the problems really are from an ergonomic standpoint:
    1. Repetitive Motion
    2. Force
    3. Awkward Postures
    4. Static Postures
    5. Contact Stress
    6. Vibration
2. Determine which steps of the task are most risky
3. Start thinking about solutions

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How to Identify the Risks

1. Document ALL risk factors seen in the photos and videos
2. May have to watch a video multiple times before spotting a risk factor
3. For the videos, make a note if you see the same risk at 2 different points
    1. Ex: Sustained grip on various tools, like an impact gun or jackhammer
4. Power tools are an example of where multiple risk factors occur at once, including gripping, vibration, awkward postures, and force.

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Watching videos for each task

- Before you start to analyze, watch the video from start to finish
- What do you notice about the way the task is done? What seems difficult or awkward?
- Now watch the video again (multiple times if needed) to start completing the risk assessment checklist so you can identify the issues
- May need to start out slow and watch the video once for each risk factor
- Look at what is happening with the major joints: shoulder, elbow, wrist, back, hips, knees

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Using the Risk Assessment Tool

- 'Job' refers to the larger job that is happening, e.g. water main replacement
- 'Task' refers to the specific task we are looking at, e.g. removing a manhole cover
- 'Conditions' is where you note particular conditions that may exist, e.g. dark, emergency work, work in the rain or heat, confined spaces, dangerous atmosphere, etc.

1

Water Research Foundation Physical Demands Survey

EMPLOYEE NAME: _____ Date: ____/____/____ (MM DD YY)

LOCATION: _____ Time of day: _____

JOB: _____

TASK (e.g., operating valve # 7): _____

_____

CONDITIONS: _____

Notes:

The checklist below is designed to help identify work methods, tools, and tasks that can contribute to work-related discomfort or musculoskeletal problems. It's NOT designed to evaluate any employees, only the tasks they perform at work.

To use the checklist, observe the task and if any of the activities or body positions are present in the work activities. The checklist depends on an estimate, from you or the employees doing the tack, of the length of time they are doing that activity or working in those positions. Please keep in mind that the more difficult parts of the task (e.g., taking a heavy tool or other item on/off a truck) are especially important to observe, so find out about those ahead of time and plan to be there when those will be done. Some tasks may be more difficult under certain conditions (deadlines, bad weather, etc.), place information on that under 'Conditions' above, and use the 'Notes' box to enter more info on the Task or Conditions.

Based on the work of the Washington State Department of Labor & Industries, and Prof. Thomas E. Bernard

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Using the Risk Assessment Tool

Bending and twisting:

- Note if you see extremes in posture with or without support (e.g. leaning on equipment versus reaching down to the ground)
- Estimate the duration based on how long the task takes, and how many times a day the task is completed.

2

Working positions

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Working with the back bent forward more than 30° (without support or the ability to vary posture) More than total of 2hrs/day.			
Working with the back bent forward more than 45° (without supporting the torso or varying posture) More than total of 1hour/day.			
Twisting the back more than 20° More than total of 1hr/day.			
Bending and twisting More than total of 30 min./day.			
Working with the neck bent forward or backward more than 30° (without support and without the ability to vary posture) More than 2 hours total per day.			

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Using the Risk Assessment Tool

Which Risk Factors Would you Select from the First Page?

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Using the Risk Assessment Tool

Which Risk Factors Would you Select from the first page?

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15

Using the Risk Assessment Tool

-Observe the neck: do you see the worker looking down for extended periods/ repetitively?

-Do you see repeated or sustained overhead reaching?

-Do you see repeated or sustained squatting or kneeling?

3

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Working with the neck bent more than 45° (without support and without the ability to vary posture) More than 1 hour total/day.			
Working with the hand(s) above the head, or the elbows above the shoulders More than 2hrs./day.			
Squatting More than 2hrs./day.			
Kneeling on one or both knees More than 2/day.			

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Using the Risk Assessment Tool

Which Risk Factors Would you Select from the Second Page?

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17

Using the Risk Assessment Tool

Lifting, Pushing, and Pulling

- These techniques require observation for a full day, but videos are only 5-10 minutes.
- Estimate the number of times the activity is performed per day.
- Use a crane scale or similar if you don't know the weight of the item.
- Ex: Worker lifts 50 lb. object every 45 minutes. That's 9 times for an 8 hour day which is below the threshold of 10.

4

Lifting, pushing, pulling

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Weight or force required Lifting or pulling/pushing object weighing more than 75 pounds One or more times/day			
Lifting object weighing more than 50lbs. More than 10 times/day			
Pushing or pulling with force greater than 50lbs. with back straight More than 10 times/day			
Lifting objects weighing more than 50 pounds above the shoulders, below the knees, or at arm's length More than 10 times/day			
Repetitive (more than twice per minute) lifting of objects weighing more than 10 pounds More than 2hrs/day			

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Using the Risk Assessment Tool

Which Risk Factors Would you Select from the Third Page?

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Using the Risk Assessment Tool

-Forceful gripping is hard to measure on a video: think about lifting or squeezing heavy or stiff objects

-Closely observe the wrist for awkward postures: forward and backward bending and side to side

5

Gripping

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Forceful gripping: Holding tools weighing 10lbs. or more per hand, or gripping with more force than clamping automotive jumper cables. More than 2hrs/day			
Forceful pinching: using a pinch grip to hold an object weighing 2 or more pounds per hand, or pinching an object to squeeze it with weighing more than 4 lbs. of force per hand. More than 2hrs/day			
Using a pinch grip with the wrist bent More than 1hr./day			
Pinching + highly repetitive motion More than 3hrs/day			
Gripping plus wrist deviation More frequently than 1/hour			

Based on the work of the Washington State Department of Labor & Industries, and Prof. Thomas E. Bernard

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Using the Risk Assessment Tool

Which Risk Factors Would you Select from the Fourth Page?

240_F_118328172_5Wq9DJ6Wh8G2H30oV7k3k0qJF3GUq6Gm_ST.mp4

https://v.ftcdn.net/01/18/32/81/240_F_118328172_5Wq9DJ6Wh8G2H30oV7k3k0qJF3GUq6Gm_ST.mp4

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Using the Risk Assessment Tool

Looking for vibration and contact stress

-Using hand tools

-Handles and other objects pressing on the wrist or palm

Impact & Vibration

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Using sanders, jigsaws or other hand tools that have moderate vibration levels More than 2 hours/day			
Using impact wrenches, chain saws, percussive tools (pneumatic hammers, scalers, riveting or chipping hammers) or other tools that have high vibration levels More than 30 minutes/day			
Pressure applied by tool to part of the body More than 1 hour/day			

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Using the Risk Assessment Tool

Which Risk Factors Would you Select from the Fifth Page?

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Using the Risk Assessment Tool

Think about laptop use, tablet or mobile phone use

Computer use

Description of Risk	Picture	Is the risk present? (Yes/No)	Description of activity which requires this risk
Intensive keyboard use (e.g., data entry) or mouse use (e.g., in CAD applications) More than 4 hours/day at a desktop computer OR More than 2 hours/day using a laptop			
Keyboard or mouse use with wrist deviations More than 1 hour/day	 		

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Using the Risk Assessment Tool

Which Risk Factors Would you Select from the Sixth Page?

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25

Practice time….

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26

Thinking about solutions

Hierarchy of controls

Elimination- do not perform the task or use the equipment

Substitution- exchange the tool for one with less ergonomic risk

Engineering- use a crane, forklift, lift assist, cart, or other equipment

Administrative- extra breaks, job rotation, materials handling training

PPE- anti fatigue insoles, knee pads

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Vendor Products/Equipment

Vendor	Website
1. Southworth	1. http://www.southworthproducts.com/
2. Vestil Manufacturing	2. http://www.vestilmfg.com/
3. Lift Products Inc.	3. https://www.liftproducts.com/workpositioners/hydraulic.html/
4. Carts on the Go	4. http://www.cartsonthego.com/dollee-folding-utility-cart
5. Anver Vacuum Lifts	5. http://anver.com/
6. Global Industrial	6. http://www.globalindustrial.com/
7. Grainger	7. https://grainger.com
8. Contractor's Solutions	8. http://www.altec.com/altec-cranes/
9. Altec Cranes	9. http://alum-a-lift.com/
10. Alum-A-Lift	10. http://megacomfort.com/
11. MEGA Comfort Shoe Inserts	

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Next Homework Assignment

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29

Homework

1. (If we have more to complete), finish the rest of your risk assessments
2. Start thinking about solutions:

- Think conceptually: what could address the risk factors we identified?
  - Remove the step from the task; eliminate unnecessary work
  - Use tools or equipment
  - Use additional labor
- Talk to employees who do the job about what you learned from the risk assessment
  - What ideas do they have to address the risk factors you identified?
- Start doing some research on potential solutions
  - Get Elise and Scott to help get you started

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Next session

- We will look at solutions in more detail
- Come with ideas you gathered from your homework
- We will start talking about how you work as a committee to get them implemented

- Between now and then:
  - Collect your ideas in your Box folder
  - Talk to Elise and Scott to get help with vendors, etc.
  - Pick the date for your next session (2-3 hours)

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Questions?

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32

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Water Research Foundation
Participatory Ergonomics Training

Elise Condie, M.S., CPE

Principal Consultant

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Welcome Back!

Training #2 Summary and Homework Review

- What solutions did you come up with?
- What tasks need more research or more time for solutions?
- What was challenging or didn't go so well?
- Questions?

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2

Force Gauges

1. Demonstration Video
2. How did it go?
3. Were you able to use it for the tasks?
4. Why did you decide to use the Force Gauge for some of the work?
5. What was surprising about some of the measurements?
    i. Has your opinion changed about the task?

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3

Thinking About Solutions

Hierarchy of controls

- Elimination - do not perform the task or use the equipment
- Substitution - exchange the tool for one with less ergonomic risk
- Engineering - use a crane, forklift, lift assist, cart, or other equipment
- Administrative - extra breaks, job rotation, materials handling training
- PPE - anti fatigue insoles, knee pads

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4

Weed Control

Elimination: control weeds by stopping them growing in the first place (ex: herbicide, balls on the water)

Engineering: a mechanized pontoon (or similar) that harvests the weeds

1. Screenings conveyor system (see right)
2. Increase the rate of water flow to discourage growth

Administrative: job rotation, movement awareness training

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Throwing Sandbags

Substitution:

- Installation of 'mesh'

Engineering:

- Mini-veyor (small portable telescoping conveyor)
- 'Sled' and winch
- Continuous sandbag system

Administrative:

- Smaller sandbags—BUT more of them
- Job rotation

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Lid Pulling

Engineering:

- Magnetic lid lifter (truck mounted and dolly types)
- Manual lever style lid lifter

Administrative:

- Movement awareness training

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7

Using Principles of Change Management

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8

Principles of Change Management

Why it's important to understand change management

- Plan for change, understand the impact that it's going to have
- Following these principles will make it easier to implement an effective and sustainable change
- Support of leadership is important, and these principles serve as a guiding mechanism

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9

Principles of Change Management

Thinking of Change as a Process

Change is a Process, NOT an Event.

- The path to change is not always a straight line.

The **progress** towards the goal may have setbacks and detours before reaching the final solution

- Keeping track of meeting minutes is important to ensure accountability during the process

Change Happens With the Individual

Change occurs in individuals first, then organizations

- The people implementing the change need to be ready and willing to make it a success
- Work with individuals to address their concerns to make your change a success.

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10

Principles of Change Management

Managing Resistance

Fear of change is a common aspect of resistance.

Change is often perceived negatively because of the ways in which it can affect everyone at work:

- Personal factors like a employee's perceived value to the company
- Cultural shift
- Worries of mishandling the change

How to be Prepared

Expect the unexpected!

- Try not to enter this stage with an idea of how things are going to go.

Patience is key!

- Use multiple perspectives: employee, manager, team, and organization
- Try to get everyone on board, but don't dwell on detractors, or become too involved in minor details.

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11

Five Different 'Adopter Types'

Innovators:

- eager to try new ideas, cope well with uncertainty

Early adopters:

- respected leaders, not as far ahead as innovators, most people trust them

Early majority:

- Ahead of the average individual but not opinion leaders.
- Deliberate for a while before adopting a change

Late majority:

- Take longer to adopt a change, usually wait until they have to give in to peer pressure

Resistors:

- Last to adopt a change, or may never adopt it.
- May even block change so you need to work hard to address their concerns

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Concerns Based Adoption Model

Stage	Expressions of Typical Concerns
0: Awareness	"I am not concerned about this initiative." "I don't really know what this initiative involves."
1: Informational	"I would like to know more about it." "There is a lot I don't know about this, but I am reading and asking questions."
2: Personal	"How will using it affect me?" "I'm concerned whether I will be able to do this well." "How much control will I have over the way I use this."
3: Management	"I seem to be spending all my time getting materials ready." "I'm concerned that we will need to spend more time in meetings."
4: Consequence	"How is this going to affect my students?" "How can I adapt this to have more impact?"
5: Collaboration	"How can I relate what I'm doing to what others are doing?"
6: Refocusing	"I have some ideas that could work even better than this."

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Principles of Change Management

Gathering Resources & Support

- Everyone needs to understand ***WHY*** the change is being made.
- Gather evidence to support it
  - Think force gauges, ROI calculations, your job task risk assessments
- ***Every*** group needs to be on board.
- People who object need to make those reasons known—in order to find the best solution.
- It is ***better*** for groups to openly object so you can explore and discuss their objections, instead of having silent dissenters

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Principles of Change Management

Communicating Value

- Calculating an ROI will be important for assessing the financial impact—AND demonstrating the value that the change can bring.
- The value of the change needs to be communicated at ALL levels.
- Create rewards for getting involved in the change.
- Reiterate the core message during each team meeting.
  - What is it?

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15

Principles of Change Management

Type of Change: Fast or Slow?

Fast change typically has **more** resistance while *slow* change has **less**.

- The change should be specific to the group
- Example: Faster for a worker using a new tool with little to no change for the manager

Question to Ask:

- What impact will the change have on daily activities?

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Principles of Change Management

Fast Change

May be met with ***more*** resistance, but a change is implemented ***right away***.

- So, the effects will be felt right away as well
- Ex: Buying a new tool for all affected work crews to use.

Fast change ***ensures*** that the change is carried out.

- More thought needs to go into how fast change ***affects*** day-to-day processes because the impact will be more apparent ***immediately***.

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Principles of Change Management

Slow Change

Met with ***less*** resistance, and usually happens with ***small***, incremental changes

- Problems that arise may be easier to deal with in slow change.

However, slow changes can happen too slow, or have the potential to ***stop*** in the middle of the process due to lack of commitment.

- Ex: Testing a new tool with one crew at a time to determine its effectiveness.

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Using the ROI Tool

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Significance of Calculating ROI

Why would we choose to do an ROI calculation?

- What are we attempting to learn from it?
  - Learn the cost of implementing a change, and how much money it can save
- What are we going to do with it when the ROI is completed?
  - Form the basis for the change; show why it is worth implementing

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The ROI Tool

How To Use It

- Currently available in your Box folder
- Step-by-step walkthrough using the Washington State Ergonomics ROI Tool

Worksheet

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The ROI Tool

What to do with a completed ROI

- How do you present this information to a manager?
- How do you properly describe the benefits?
    1. Injury reduction
    2. Increased productivity
    3. How quickly the investment will pay for itself

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22

Planning for Change: Developing a Project Plan

1. Assign a project owner and sponsor: your sponsor should be able to help with budget and operational issues
2. Determine what actions need to be performed to execute your project
   - Collect information, design equipment, new standard work, etc.
3. Assign an owner and due date to each action
4. Review your project plan at each team meeting with the attached template below

Microsoft Excel Worksheet

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Review of Team Meetings

Questions to Ask

1. What progress have you made?
2. Where have you gotten stuck?
3. What have you discussed?
4. Who's been attending?
5. Have you been progressing action items?
6. Have you been sharing information within your group and outside the group about what you've been working on?

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24

Running Team Meetings

Important for Accountability

1. Keep the process moving by meeting frequently ***and*** consistently (bi-weekly)
2. Keep track of the meeting minutes on Box
   - Good record keeping will help illustrate the successes and challenges to WRF
3. Reach out to leadership if you're having trouble
4. Make sure the right people are attending, especially for decision making
   - Note: Always bring up meeting minutes agenda

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Running Team Meetings

Progression Your Action Items

1. Check in on each item every meeting
2. Make sure it is assigned to the right person
   1. If that person is getting stuck, the action may need to be reassigned to someone else
3. Transparency is important!
4. If you're stuck, reach out to the team for help as soon as possible

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Next Homework Assignment

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Homework

Next Steps

1. Start the process of creating solutions for each of the tasks you surveyed
2. Remember to take the process slowly
3. Utilize regular meetings (bi-weekly) to assign and progress action items.
4. Working with vendors to secure product demos
5. If you get stuck, we are here to help! Please get in touch with us.
    - Elise Condie, elise.condie@bsigroup.com
    - Scott Dillon, scott.dillon@bsigroup.com

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Questions?

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