Workplace Health and Safety Bulletin

WORK SAFE ALBERTA

Musculoskeletal Injuries — Part 5

Assessing Ergonomic Hazards

This is the fifth in a six-part series of Safety Bulletins dealing with musculoskeletal injuries

Musculoskeletal injuries, or MSIs, are referred to by a variety of different names. These include repetitive strain injuries (RSIs), repetitive motion injuries, cumulative trauma disorders (CTDs), work-related upper limb disorders (WRULDs), and others. In each case, the name is used to describe injuries of the bones, joints, ligaments, tendons, muscles, and other soft tissues.

The purpose of performing a workplace hazard assessment is to identify specific workplace hazards that can cause or aggravate work-related MSIs, and to then reduce worker exposure. Many checklists and assessment tools are available from a variety of sources.

The hazard assessment checklist recommended for use by this Safety Bulletin was introduced in May, 2000 by the State of Washington, Department of Labor and Industries, as part of that state's ergonomics legislation (WAC 296-62-051, Ergonomics). It was selected on the basis that

(1) it addresses very specific risk factors identified in the scientific literature as being related to MSIs;
(2) it presents clear, specific exposure limits (time and angles) for worker exposure to the various risk factors, something that few other assessment checklists provide;
(3) it is relatively simple to understand and can be applied by both employers and workers; and
(4) it is based on a comprehensive, multi-year literature review and public consultation process that involved industry, labour, and the public

The approach recommended by this Safety Bulletin does not, and cannot eliminate all MSIs among affected workers. The approach will reduce the incidence and/or severity of MSIs caused in whole or in part by the risk factors listed in the hazard assessment. Non-work exposures and risk factors inherent to the individual worker are not addressed.

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Use of this hazard assessment checklist, as with any of the recommendations or recommended practices contained in the Safety Bulletins prepared by Alberta Human Resources and Employment, Workplace Health and Safety, is voluntary. The use of other similar hazard assessment checklists is acceptable.

Is this a "caution zone job"?

A "caution zone job" is a job where a worker's typical work activities meet one or more of the physical risk factors and levels listed in Table 1. Typical work activities are those that are a regular and forseeable part of the job and occur on more than one day per week, and more frequently than one week per year. Caution zone jobs all have a sufficient degree of risk to require that some modest precautionary steps be taken — ergonomic awareness training and a hazard assessment — but they do not necessarily have risks great enough to require corrective action. Caution zone jobs may not be hazardous. The durations listed in Table 1 — two hours for example — refer to *the total amount of time per day workers are exposed to the risk factor, not how long they spend performing the work activity that includes the risk factor*.

Actions employers should take

If there are no physical risk factors exceeding the levels listed in Table 1, then no actions are required.

If one or more physical risk factors exceed the levels listed in Table 1, then the job is a caution zone job and the employer should provide the worker with ergonomics awareness training and perform a hazard assessment using the checklist presented in Table 2. The ergonomics awareness training is to provide workers with a basic level of understanding and knowledge. The training for workers should include

(a) how to use their workstation, including how to adjust its equipment and furnishings;
(b) how to use or select tools appropriate to the work they are performing;
(c) the safe work practices they are expected to follow; and
(d) information describing the signs, symptoms, and methods of preventing MSIs.

Every worker in a caution zone job, *and the supervisors of these workers,* should receive basic ergonomics awareness training.

A hazard assessment should be performed

(a) when a work process or operation changes;
(b) when a new work process is introduced; and
(c) prior to the design and installation of a new workstation.

Whenever possible, affected workers should be involved in the hazard assessment.

When analyzing caution zone jobs using the checklist presented in Table 2, employers should do so in a thorough and systematic manner. This means paying attention to the physical demands of the job (such as body position, force, and repetition), the layout of the work area (such as reaches and working heights), and the load lifting and handling requirements of the job (such as object size and shape). Workers performing the caution zone jobs should be encouraged to participate in the performance of the hazard assessment and any initiatives undertaken to reduce those hazards.

If the hazard assessment determines that the physical risk factors exceed the levels listed in Table 2, then a hazard is present and the employer needs to take action. Each identified hazard should be reduced below the levels stated or to the degree technologically and economically feasible. The methods used to reduce the hazard(s) should not rely primarily on changes in worker behaviour. Examples of suitable methods for reducing hazards include:

- changes to workstations and tools;
- reducing the size and weights of loads handled;
- process redesign to eliminate unnecessary steps or introduce task variety; and
- job rotation.

If an employer cannot reduce the hazard(s) below the hazard level using the controls described above, the employer should supplement those controls with interim measures that primarily rely on individual work practices or personal protective equipment. Examples of such practices include impact gloves, team lifting, and training on work techniques. Since these are interim measures, the employer should continue to look for alternative measures that will address the hazard on a permanent basis.

Table 1 Determining if a job is a caution zone job

	Physical Risk Factor	Duration
Awkward body positions	(1) Working with the hand(s) above the head, or the elbow(s) above the shoulder. (2) Working with the neck or back bent more than 30 degrees (without support and without the ability to change posture). (3) Squatting. (4) Kneeling.	(1) More than 2 hours total per day. (2) More than 2 hours total per day. (3) More than 2 hours total per day. (4) More than 2 hours total per day.
High hand force	(1) Pinching an unsupported object(s) weighing 900 grams or more (2 lbs) per hand, or pinching with a force of 180 Newtons or more (4 lbs) per hand (comparable to pinching half a ream of paper). (2) Gripping an unsupported object(s) weighing 4.5 kg or more (10 lbs) per hand, or gripping with a force of 340 Newtons or more (10 lbs) per hand (comparable to clamping light duty automotive jumper cables onto a battery).	(1) More than 2 hours total per day. (2) More than 2 hours total per day.
Highly repetitive motion	(1) Repeating the same motion with the neck, shoulders, elbows, wrists, or hands (excluding keying activities) with little or no variation every few seconds (2) Performing intensive keying.	(1) More than 2 hours total per day. (2) More than 4 hours total per day.
Repeated impact	(1) Using the hand (heel or base of palm) or knee as a hammer more than 10 times per hour.	(1) More than 2 hours total per day.
Heavy, frequent, or awkward lifting	(1) Lifting objects weighing more than a) 34 kg (75 lbs) once per day; or b) 25 kg (55 lbs) more than 10 times per day. (2) Lifting objects weighing more than 4.5 kg (10 lbs) if done more than twice per minute. (3) Lifting objects weighing more than 11.4 kg (25 lbs) above the shoulders, below the knees, or at arm's length more than 25 times per day.	(2) More than 2 hours total per day.
Moderate to high hand-arm vibration	(1) Using impact wrenches, carpet strippers, chain saws, percussive tools such as jackhammers, scalers, or riveting or chipping hammers, or other hand tools that typically have high vibration levels. (2) Using grinders, sanders, jig saws, or other hand tools that typically have moderate vibration levels. *(Employers may assume that hand tools vibrating less than 2.5 m/s^2, eight-hour equivalent, are not covered.)*	(1) More than 30 minutes total per day. (2) More than 2 hours total per day.

Heavy, frequent, or awkward lifting

The assessment checklist for heavy, frequent, or awkward lifting prepared by the State of Washington, Department of Labor and Industries (L&I) and included in this Safety Bulletin, is based on the Revised NIOSH Lifting Equation [NIOSH-National Institute for Occupational Safety and Health (U.S.)]. The equation was designed to help evaluate lifting tasks and reduce the incidence rate and severity of lower back injuries to workers. Its aim is to protect the industrial working population from lower back pain.

To simplify use of the original equation, to provide employers with the opportunity to achieve practical implementation in the workplace, and to provide workers with an adequate level of safety, L&I made important changes to the original equation's Lifting Index. Readers interested in more information on this issue should refer to page 78 of L&I's *Concise Explanatory Statement*, listed in the references at the end of this Safety Bulletin.

Using the hazard assessment checklist

In many workplaces, more than one worker may do identical or essentially the same jobs. It is not expected that employers will do a separate hazard assessment for every worker on every shift on every day. Representative sampling of very similar jobs may be used. For example, if thirty workers use identical wire strippers for the same repetitive task, the employer may assess how several workers do the job rather than all thirty. While employers may choose to use representative sampling, they should design the sampling strategy carefully and appropriately. For example, a different sampling method might be needed for risk factors influenced by the size of individual workers. A short worker on a particular job may work with his or her hands above the head, while a taller worker might not. Choosing several average size workers for representative sampling would not be sufficient to identify those workers in the caution zone. An alternate, more effective approach might be to evaluate the postures used by the workers at the two extremes of size as well as the average or midrange.

It is acceptable practice to observe typical periods of work and calculate or estimate what the full day exposure would be as long as there is a reasonable basis for believing that the period of observation is representative. For example, consider a job in which a worker performs the same five-minute sequence of work repetitively for six hours every day and 2 minutes of each five-minute sequence (or 40%) is spent inspecting parts with the neck bent. The employer could observe several work cycles and then calculate that 40% of six hours or 2.4 hours is spent with the neck bent.

It is also permissible to rely on previous knowledge, evidence established for other purposes (e.g. time motion studies or job safety analysis), or job descriptions instead of direct job observation as long as there is a reasonable basis to believe that such information or knowledge is accurate, representative, and sufficiently detailed. Production data could be used to estimate the number of lifts per day for materials handling jobs. If the employer has intimate knowledge of regular work activities, duration of exposures may be estimated with or without direct observation of the work. Where regular work activities are not well known to the employer, worker interviews can be used to identify typical work. The employer could then observe relatively short sample periods of actual work to validate the interview information.

In the case of jobs with intermittent, unpredictable, or highly variable tasks, the following steps should be followed when performing the assessment:

- First, it is necessary to identify or list the different "typical work activities" that are part of the various tasks performed by the worker(s) doing a given job. Where this is not well known to the employer initially, this can be accomplished by observing worker(s) performing the tasks and/or by asking worker(s) to identify the different tasks they perform. It is important in this first step to determine all the major tasks typically performed by the worker(s) as a routine part of their overall job over time, including tasks that vary from day-to-day.

  In workplaces where several different workers perform essentially the same job, a separate hazard analysis does not need to be performed on all workers, on all work shifts, on all days. A representative sample of workers performing the same job should be observed performing the tasks, including workers of different sizes (e.g. short, average, and tall heights) where such individual differences might affect the outcome of the hazard analysis. One or more workers can be interviewed to help identify the range of tasks they perform and to help estimate the approximate percentage of their time spent performing the various tasks (this can be per day, per week, per job, or whatever measure is appropriate for this job).

- Second, determine whether or not the risk factor limits are exceeded. The tasks identified in step one (for this job) are analyzed to determine whether they include one or more of the specific physical risk factors listed in the risk factor table, and whether the risk factor(s) for this job exceeds the limits. Hazard contribution times from the different tasks are "added up" to make this determination. Where this information is not readily available to the employer from past/present knowledge (e.g. from existing job descriptions, time motion studies, job safety analyses, production data, etc.) it must be determined.

One way to determine the hazard contribution from one of several tasks would be to determine the percentage of overall job time spent performing this one task, and then determine the percentage of time during that task that the worker is exposed to the ergonomic risk factor. For example, a task done for four hours that involves working with the hands above the head only ¼ of the time results in an awkward body position risk factor duration (for that one task) of 1 hour per day. Similar calculations are done for all the other task components of the job, and for each risk factor that is present. The calculation can be done for a day, a week, the duration of the job, or whatever interval is appropriate for that particular job. For comparison with the limits specified in the table, the total risk factor exposure numbers should be converted to a daily basis.

Table 2 Hazard assessment checklist

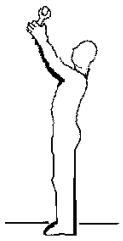
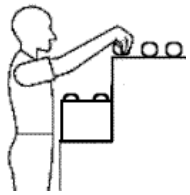
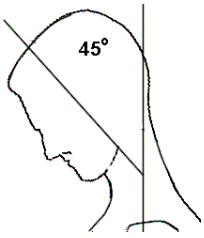
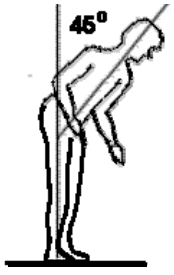
Awkward Body Positions				Check (3) here if this is an MSI hazard
Body Part	**Physical Risk Factor**	**Duration**	**Visual Aid**	
Shoulders	Working with the hand(s) above the head or the elbow(s) above the shoulder(s)	More than 4 hours total per day		θ
	Repetitively raising the hand(s) above the head or the elbow(s) above the shoulder(s) more than once per minute	More than 4 hours total per day		θ
Neck	Working with the neck bent more than 45º (without support or the ability to vary posture)	More than 4 hours total per day		θ
Back	Working with the back bent forward more than 30º (without support or the ability to vary posture)	More than 4 hours total per day		θ
	Working with the back bent forward more than 45º (without support or the ability to vary posture)	More than 2 hours total per day		θ

Table 2 Hazard assessment checklist (continued)

Awkward Body Positions (continued)				Check (3) here if this is an MSI hazard
Body Part	**Physical Risk Factor**	**Duration**	**Visual Aid**	
Knees	Squatting	More than 4 hours total per day		θ
	Kneeling	More than 4 hours total per day		θ

Table 2 Hazard assessment checklist (continued)

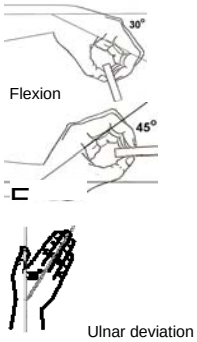
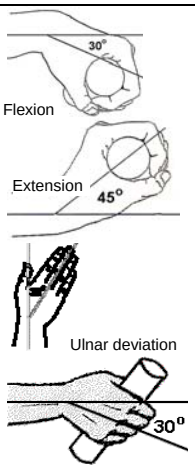
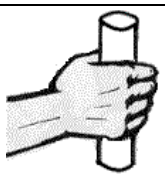
High Hand Force					
Body Part	**Physical Risk Factor**	**Combined with**	**Duration**	**Visual Aid**	Check (3) here if this is an MSI hazard
Arms, wrists, hands	Pinching an unsupported object(s) weighing 900 grams or more (2 lbs) per hand, or pinching with a force of 180 Newtons or more (4 lbs) per hand (comparable to pinching half a ream of paper)	Highly repetitive motion	More than 3 hours total per day		θ
		Wrists bent in flexion 30° or more, or in extension 45° or more, or in ulnar deviation 30° or more	More than 3 hours total per day		θ
		No other risk factors	More than 4 hours total per day		θ
Arms, wrists, hands	Gripping an unsupported object(s) weighing 4.5 kg or more (10 lbs) per hand, or gripping with a force of 340 Newtons or more (10 lbs) per hand (comparable to clamping light duty automotive jumper cables onto a battery)	Highly repetitive motion	More than 3 hours total per day		θ
		Wrists bent in flexion 30° or more, or in extension 45° or more, or in ulnar deviation 30° or more	More than 3 hours total per day		θ
		No other risk factors	More than 4 hours total per day		θ

Table 2 Hazard assessment checklist (continued)

Highly Repetitive Motion				
Body Part	**Physical Risk Factor**	**Combined with**	**Duration**	Check (3) here if this is an MSI hazard
Neck, shoulders, elbows, Wrists, hands	Using the same motion with little or no variation every few seconds (excluding keying activities)	No other risk factors	More than 6 hours total per day	θ
	Using the same motion with little or no variation every few seconds (excluding keying activities)	Wrists bent in flexion 30° or more, or in extension 45° or more, or in ulnar deviation 30° or more **AND** High, forceful exertions with the hand(s)	More than 2 hours total per day	θ
	Intensive keying	Awkward posture, including wrists bent in flexion 30° or more, or in extension 45° or more, or in ulnar deviation 30° or more	More than 4 hours total per day	θ
		No other risk factors	More than 7 hours total per day	θ

Repeated Impact				
Body Part	**Physical Risk Factor**	**Duration**	**Visual Aid**	Check (3) here if this is an MSI hazard
Hands	Using the hand (heel/base of palm) as a hammer more than once per minute	More than 2 hours total per day		θ
Knees	Using the knee as a hammer more than once per minute	More than 2 hours total per day		θ

Table 2 Hazard assessment checklist (continued)

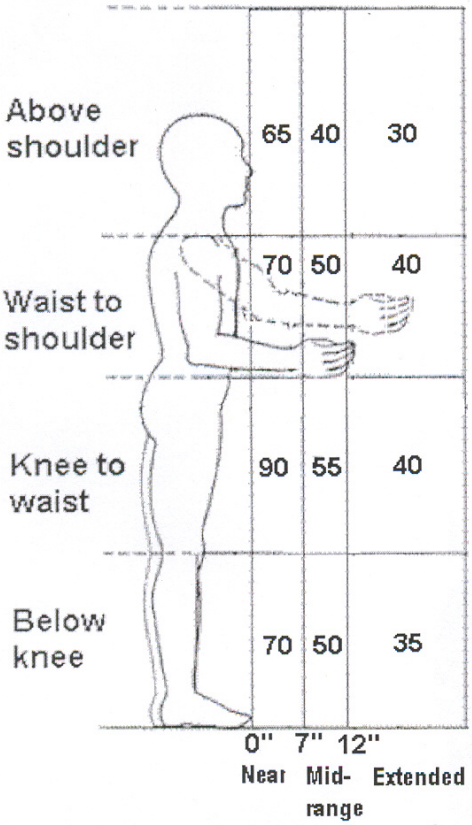
Heavy, Frequent or Awkward Lifting

This analysis only applies to "caution zone jobs" where workers lift 4.5 kg or more (10 lbs), use both hands, and are not seated or kneeling while lifting. For lifting with one hand or while seated or kneeling, use the "High Hand Force" section of this checklist.

Step 1 **Find out the actual weight of objects that the worker lifts.**

Actual Weight = _____ lbs.

Step 2 **Determine the Unadjusted Weight Limit.** Where are the employee's hands when they begin to lift or lower the object? Mark that spot on the diagram below. The number in that box is the Unadjusted Weight Limit in pounds.



Unadjusted Weight Limit: _____ lbs.

Step 3 **Find the Limit Reduction Modifier.** Find out how many times the worker lifts per minute and the total number of hours per day spent lifting. Use this information to look up the Limit Reduction Modifier in the table below.

How many lifts per minute?	For how many hours per day?		
	1 hr or less	1 hr to 2 hrs	2 hrs or more
1 lift every 2-5 mins.	1.0	0.95	0.85
1 lift every min	0.95	0.9	0.75
2-3 lifts every min	0.9	0.85	0.65
4-5 lifts every min	0.85	0.7	0.45
6-7 lifts every min	0.75	0.5	0.25
8-9 lifts every min	0.6	0.35	0.15
10+ lifts every min	0.3	0.2	0.0

Note: For lifting done less than once every five minutes, use 1.0

Limit Reduction Modifier: ____._____

Step 4 **Calculate the Weight Limit.** Start by copying the Unadjusted Weight Limit from Step 2.

Unadjusted Weight Limit: = _____ lbs.

If the worker twists sideways more than 45 degrees while lifting, reduce the Unadjusted Weight Limit by multiplying by 0.85. Otherwise, use the Unadjusted Weight Limit

Twisting Adjustment: = _____._____

Adjusted Weight Limit: = _____ lbs.

Multiply the Adjusted Weight Limit by the Limit Reduction Modifier from Step 3 to get the Weight Limit. **X**

Limit Reduction Modifier: _____.___

Weight Limit: = _____ lbs.

Step 5 **Is this a hazard?** Compare the Weight Limit calculated in Step 4 with the Actual Weight lifted from Step 1. If the Actual Weight lifted is greater than the Weight Limit calculated, then the lifting is an MSI hazard and should be reduced below the hazard level or to the degree technologically and economically feasible.

Note: If the job involves lifts of objects with a number of different weights and/or from a number of different locations, use Steps 1 through 5 above to:
1. Analyze the two worst case lifts -- the heaviest object lifted and the lift done in the most awkward posture.
2. Analyze the most commonly performed lift. In Step 3, use the frequency and duration for all of the lifting done in a typical workday.

Table 2 Hazard assessment checklist (continued)

Hand-Arm Vibration

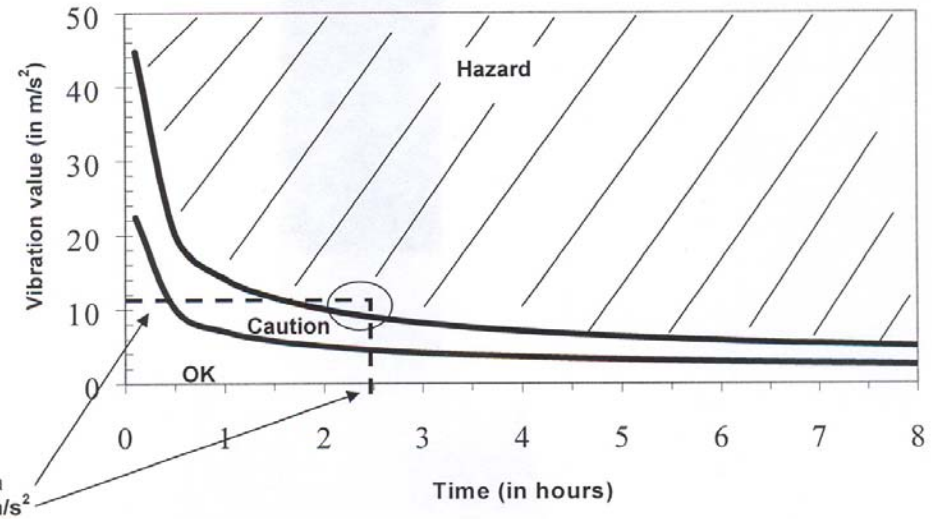
Use the instructions below to determine if a hand-arm vibration hazard exists.

Step 1. Find the vibration value for the tool. (Get it from the manufacturer, look it up at this web site: http://umetech.niwl.se/vibration/HAVHome.html, or you may measure the vibration yourself). The vibration value will be in units of meters per second squared (m/s^2). On the graph below find the point on the left side that is equal to the vibration value.

Step 2. Find out how many total hours per day the employee is using the tool and find that point on the bottom of the graph.

Step 3. Trace a line in from each of these two points until they cross.

Step 4. If that point lies in the crosshatched "Hazard" area above the upper curve, then the vibration hazard must be reduced below the hazard level or to the degree technologically and economically feasible. If the point lies between the two curves in the "Caution" area, then the job remains a "caution zone job" workers should be trained to understand how to use their workstation (including how to adjust its equipment and furnishings), how to use or select tools appropriate to the work they are performing, the safe work practices that they are expected to follow, and an understanding of the signs, symptoms, and methods of preventing MSIs. If it falls in the "OK" area below the bottom curve, then no further steps are required.



Example:
An impact wrench with a **vibration value of 12 m/s^2** is used for **2½ hours** total per day. The exposure level is in the Hazard area. The vibration must be reduced below the hazard level or to the degree technologically and economically feasible.

Note: The caution limit curve (bottom) is based on an 8-hour energy-equivalent frequency-weighted acceleration value of 2.5 m/s^2. The hazard limit curve (top) is based on an 8-hour energy-equivalent frequency-weighted acceleration value of 5 m/s^2.

Other Safety Bulletins in this series

This six-part series of Safety Bulletins consists of the following titles:

http://employment.alberta.ca/documents/WHS/WHS-PUB_erg017.pdf
MSI – Part 1 – Alberta Injury Statistics and Costs – ERG017

http://employment.alberta.ca/documents/WHS/WHS-PUB_erg018.pdf
MSI – Part 2 – Symptoms and Types of Injuries – ERG018

http://employment.alberta.ca/documents/WHS/WHS-PUB_erg019.pdf
MSI – Part 3 – Biomechanical Risk Factors – ERG019

http://employment.alberta.ca/documents/WHS/WHS-PUB_erg020.pdf
MSI – Part 4 – Workplace Risk Factors – ERG020

http://employment.alberta.ca/documents/WHS/WHS-PUB_erg021.pdf
MSI – Part 5 – Assessing Ergonomic Hazards – ERG021

http://employment.alberta.ca/documents/WHS/WHS-PUB_erg022.pdf
MSI – Part 6 – Reducing Ergonomic Hazards – ERG022

A companion series specific to the lifting and handling of loads is also available. It consists of the following titles.

http://employment.alberta.ca/documents/WHS/WHS-PUB_bcl001.pdf
Lifting and Handling Loads – Part 1 – Reviewing Issues – BCL001

http://employment.alberta.ca/documents/WHS/WHS-PUB_bcl002.pdf
Part 2 – Assessing Ergonomic Hazards – BCL002

http://employment.alberta.ca/documents/WHS/WHS-PUB_bcl003.pdf
Part 3 – Reducing Ergonomic Hazards - BCL003

Each of these Bulletins is available through Workplace Health and Safety regional offices or the Department's Internet web site. Refer to the final page of this Safety Bulletin for specific details.

References

Note: Each of the Department of Labor and Industries references are available at the following Internet web address:
www.Ini.wa.gov/wisha/regs/ergo2000

Department of Labor and Industries, State of Washington. *WAC 296-62-051, Ergonomics*. May 5, 2000.

Department of Labor and Industries, State of Washington. *Concise Explanatory Statement* (RCW 34.05.325.6a) WAG 296-62-051, Ergonomics. May 5, 2000.

Department of Labor and Industries, State of Washington. *WAC 296-62-05174, Appendix B: Criteria for analyzing and reducing WMSD hazards for employers who choose the Specific Performance Approach*. May 5, 2000.

Waters TR et al. Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics* 36(7): 749-776; 1993.

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