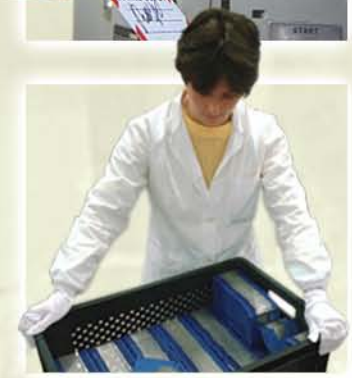

Ergonomic Assessment:
Fibre & Container Sorting lines

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IAPA
It's About Making A Difference.

IAPA's Vision:

A world where risks are controlled because everyone believes suffering and loss are morally, socially and economically unacceptable.

EXECUTIVE SUMMARY

This analysis was done to quantify risk factors associated with the development of musculoskeletal disorders and to determine if these risks could lead to discomfort and/or injury. The report is to provide suggestions to identify solutions to help control and/or eliminate these risks.

Four main risk factors have been shown to increase the risk of developing musculoskeletal disorders. These risk factors include:

- Static or extreme postures or movements
- Extended periods of repetitive movement
- High forces or efforts
- Lack of sufficient recovery time

An analysis of the work demands, the physical and environmental layout of the workstation, and work practices of the fibre and container sorting positions indicate that risk factors are present, which could contribute to the development of low back, wrist, and shoulder discomfort.

For the Fibre and container sorting line these risk factors include:

- ***Awkward shoulder postures***
- ***Awkward postures of the hands, wrists and arms***
- ***Repetitive forearm and wrist movement***
- ***Forward bending at the waist***
- ***Forceful exertions of the arms***

Summary of recommendations

- ***Use of platforms for shorter workers so that they are working at elbow height***
- ***Holster for exacto knife***
- ***Padding the side of the fibre conveyor line***
- ***Foot rail***
- ***Increase opening for fibre line***
- ***Use of deflectors to bring materials closer***
- ***Educate workers on proper body mechanics need to maintain good body postures whenever possible***

Additional potential long term recommendations are also suggested but these are not easy to implement as they require continued ongoing with transport companies that pick up recycling and local residents to reduce the non recycle waste received, poorly sorted materials (fibre in container and vice versa) and eliminate receiving recycling materials in bags that need to be opened.

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1 INTRODUCTION

Dave Bromley, Diversion Supervisor, of the Ottawa Valley Waste Recovery Centre contracted the Industrial Accident Prevention Association (IAPA) to conduct an ergonomics assessment of the task of container and fibre manual sorting lines. This was to identify opportunities to decrease the risk factors associated with MSD development. The findings and recommendations for improvement are presented in this document.

1.1 Objective of the Evaluation

An ergonomics assessment was performed to:

- Identify risk factors that could lead to the development of musculoskeletal disorders.
- Provide recommendations for improvement
- Assist with internal ergonomics team to develop additional ergonomics improvements

1.2 Workplace Contact Person

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1.3 Job Description

The Ottawa Valley Waste Recovery centre is a municipally run recycling centre. Items are shipped to this location via outside transport contractors that would off load items into appropriate piles. One pile would be for fibre products (cardboard, boxboard, mixed office paper and newspaper) and another pile would be for container products (metals, plastics, glass). In addition local newspaper companies may also drop off paper bundles that need recycling. The items are then loaded onto an automated conveyor and brought to a manual sorting line to be separated and placed into the appropriate bins later to be sold. It is important that items are properly sorted as there is only a minimum amount of contamination.

1.4 Background / Injury information

Over the years, OVWRC has had some lost time injuries related to musculoskeletal disorders as a result of risk factors present. In addition there are frequent complaints of discomfort by operators.

2 FIBRE SORTING LINE

2.1 Findings

The fibre line starts with a loader feathering items onto the line (figure 1), an automated conveyor line brings the fibre products up to the elevated enclosure where there is a manual sorting line. The conveyor enters the side of the enclosure. Occasionally large pieces of cardboard will get stuck at the opening requiring one of the cardboard sorters to lean in and pull while outstretched to the side. The conveyor line is 24 inches wide and there is approximately 60 inches between the chutes and where the worker stands to sort items.

Figure 1 start of fibre line

Along the fibre sorting line there are normally 6 sorting positions along both sides of the line (see figure 2). ***Along the sorting line position 1&2 remove cardboard, 3&4 remove boxboard, 5&6 remove garbage and mixed paper***. The items once removed are placed into a chute next to the worker. The chute leads to a very large plastic bin beneath the sorting platform. In addition to removing their main items workers remove other items, garbage, plastics, metals placing them into plastic bins behind them (see figure 4). Frequently workers would need to bend to the side use an exacto knife chained to the side of the conveyor line to open garbage bags and to cut banding strip on newspaper bundles.

Occasionally throughout the day the sorters would carry the bins either down the stairs to a container for garbage or to the container line. The sorter noted that frequently they have items on the line that are not recyclable such as wood, construction materials and items that should have been in the container recycling.

Awkward arm / trunk posture

Figure 2 fibre sorting line

Shoulder posture as worker is too low

Figure 3 Awkward arm/ shoulder postures

Figure 4 emptying garbage bags

Figure 5 sorting bins behind workers

2.2 Recommendations

- It was suggested that a team approach be used in order to develop recommendations. The team consisted of experienced workers from the container & fibre line, maintenance, diversion supervisor and the team leader, Mary Ryan, for both lines. A meeting was held on April 21 where MSD risk factors were reviewed and the results of the RULA assessment. Several immediate recommendations were made and the team met again on April 28th to further brainstorm on recommendations.

- **Initial recommendations included**
  - **Identify ideal work height for workers and make use of appropriate height platforms mandatory. Sorters should have the conveyor line just below elbow height so as to not need to elevate shoulders or hold arms out to the sides. Ensure that adequate toe clearance if stored under the conveyor so as to not increase the reach distance for taller workers**
  - **Toe plate to help relieve the effects of prolonged standing providing a change in position.**
  - **Continue rotation considering the body postures and movement required and reach distances so as to allow for a rotation cycle that allows some variety in muscle groups**
  - **Place knives on a shorter cord so sorters not required to bend to reach it**
  - **Replace padding on side of conveyor to allow sorter to lean on it to reduce trunk bending**
  - **Increasing the wall opening for the conveyor so larger items do not get blocked requiring sorter to pull them while in a side bent position**
  - **Reduce effects of prolonged standing by adding a foot rail. This must not impede access to worker platform**
  - **Identify best practices for sorting various materials to reduce effort and awkward body postures. For example using a sweeping motion for Styrofoam rather than a wrist flicking motion which increases the risk of injury to the wrist.**
  - **Training to employees on use of proper body mechanics, the need for micro breaks such as bring arms into the side rather than holding up and out at all times.**
  - **Other potential changes,**

- **Investigating backing boards of the main bins to allow for less precise movements and dropping of materials on the floor**
- **Investigate placement, size of the storage bins behind the workers**
- **Consider deflectors to reduce the reach distances required by bring the materials closer to the sorter**

- **Initial long term recommendations**
  - **Working with recycling transport companies and communities to reduce the amount of non recycling material, improper material (ie fibre in container and vice versa) and eliminate garbage bags filled with recycling or bottles filled with liquids.**
  - **Identify a system that may open garbage bags prior to manual sorting line or that can empty contents without need of over shoulder postures**

It was also noted that a roller drum system had been approved and was going to be installed in June. This will allow to better tether amount of recycling material on the line. This should allow for better and more consistent levels of sorting materials than with the use of the loader only.

3 CONTAINER SORTING LINE

3.1 Findings

The container sorting line starts with a backhoe loading materials onto the line and then this passes through a chain system which helps to tether the quantity of materials as it goes up to the sorting line.

The automated conveyer goes up to an enclosure similar to the fibre line. At the beginning of the container sorting line there are three pre sort positions;

-Pre-sort B sorter primarily removes garbage and plastic bags placing them into bins beside them.
-Pre-sort A sorter primarily removes metal and plastic bags placing them.

Pre-sort A & B placed on opposite sides of the conveyor. On the day of this assessment the additional pre-sort position was on the same side as pre-sort B.

The container conveyor line then goes down and there is another sorting platform where workers are placed only on one side of the conveyor line and the sorting bins are placed across the conveyor line (see figure 6-9). The items to be removed by each position are identified on a poster board above the bin area as noted in figure 8-9. The sorters remove the items then throw them across the line into the appropriate bin. The sorting positions are as follows

-PET plastics which are primarily water bottles; pop bottles etc
-Additional sorting position to remove PET and occasionally HDPE plastics and will go along the line to retrieve and empty bins behind the workers
-HDPE, heavy plastics
-Mixed plastics
-Milk carton and Styrofoam throwing
-Glass (figure 10)

In addition to removing the required items the sorters would also remove other items such as garbage, plastic bags and hazardous waste such as batteries/ aerosol cans. There are several bins placed behind the

worker where they throw various other sorted material and there is a chute beside them for plastic bags (see fig 11-13).

At the end of the conveyor line, there is an eddy current to separate aluminum cans so they fall into a bin, the rest of the items fall off the line into a bin for garbage

Figure 6- container line

Figure 7- PET plastics, bottles

Figure 8- HDPE plastics to the left and Mixed plastics to the right

Figure 9- Styrofoam

Glass bin

Sorting bins for items other than glass

Figure 10- Glass

Fig 11, 12 & 13 Additional sorting bins placed behind and to the side of the sorters.

3.2 Recommendations

- **Identify ideal work height for workers and making the use of appropriate height platforms mandatory. Sorters should have the conveyor line just below elbow height so as to not need to elevate shoulders or hold arms out to the sides. Ensure that adequate toe clearance if stored under the conveyor so as to not increase the reach distance for taller workers**
- **Toe plate to help relieve the effects of prolonged standing providing a change in position.**
- **Continue rotation considering the body postures and movement required and reach distances so as to allow for a rotation cycle that allows some variety in muscle groups**
- **Reduce effects of prolonged standing by adding a foot rail. This must not impede access to worker platform**
- **Identify best practices for sorting various materials to reduce effort and awkward body postures.**
- **Training to employees on use of proper body mechanics, the need for micro breaks such as bring arms into the side rather than holding up and out at all times.**

Other potential changes,

- **Investigating backing boards of the main bins to allow for less precise movements and dropping of materials on the floor**
- **Investigate placement, size of the storage bins behind the workers**
- **Consider deflectors to reduce the reach distances required by bring the materials closer to the sorter**

Initial long term recommendations

- **Working with recycling transport companies and communities to reduce the amount of non recycling material, improper material (ie fibre in container and vice versa) and eliminate**

garbage bags filled with recycling or bottles filled with liquids.

4 CONCLUSION

An analysis of the work demands, the physical and environmental layout of the workstation, and work practices of the fibre and container sorting positions indicate that risk factors are present, which could contribute to the development of low back, wrist and neck discomfort.

These risk factors include:

- ***Awkward shoulder postures***
- ***Awkward postures of the hands, wrists and arms***
- ***Repetitive forearm and wrist movement***
- ***Forward bending at the waist***
- ***Forceful exertions of the arms***

5 RECOMMENDATION ACTION PLAN

A summary of the recommendations are presented in an action plan format to facilitate implementation, along with the associated hazards. Priorities are listed as High (H) Medium (M) and Low (L).

Often, more than one recommendation is made. Generally, engineering controls (physical changes to the environment, tools and equipment) are more effective than administrative controls (procedures, training, work organization, etc.), but the most effective solutions usually involve a combination of controls.

Ref. No.	Hazard	Recommended Corrective Action	Priority	Key Person	Target Date	Compete Date
5.1						
2.2/ 3.2	Awkward upper arm postures at fibre line	Use of appropriate sized platform so worker is picking below elbow height. Need to investigate easier way to pull in and out platform so that worker are able to use it without straining themselves	H	Team	June 2010	
2.2	Bending forward to retrieve exacto knife	Internal team investigating using a holster so the chain does not dangle and bending forward is not required.	M	Mary	Immed	
2.2	Contact force on side of conveyor line when leaning in	Place padding on the side of the conveyor when it has come off. This will allow workers to lean in and reduce the trunk bending and reaching required	M	Maintenance	Immed	
2.2/ 3.2	Variations in body movements when performing tasks leading to some sorter using more awkward body postures then others	Identify best ways to do task such as keeping wrists straight, arms in close to the body and then training workers on proper body mechanics and body postures to avoid as will increase risk of MSDs	M	Team with assistance from myself	Summer 2010	

Ref. No.	Hazard	Recommended Corrective Action	Priority	Key Person	Target Date	Compete Date
2.2/3.2	Prolonged standing	Install foot railing that could be used to allow for change in body posture when standing for long periods.	M			
2.2	Awkward side trunk bend and arm postures and excessive force to remove large cardboard stuck in opening	Increase opening at fibre line	M			
3.2	Trunk bending and reaching to pick items on conveyor line	Look at the use of deflectors to bring materials closer to the sorter reducing reach distance and forward bend positions required	M			

6 GENERAL RECOMMENDATIONS

6.1 Micro-breaks

Sufficient rest is an essential component in preventing musculoskeletal injuries. It would be more effective to take shorter breaks throughout the day rather than taking longer breaks less often. Besides the standard lunch and coffee breaks, employees should take regular micro-breaks throughout the day. A micro-break is a short duration break (30 – 60 seconds) during which the high-use muscles of the neck, shoulders, arms, and hands are stretched or allowed to rest completely to reduce muscle tension and fatigue.

6.2 MSD prevention program

Every day we use our muscles, tendons, ligaments and joints to lift, carry, sit, stand, walk, move and work in a variety of ways. However, sometimes these tasks or the way we do them can put too much demand on our bodies, causing pain and discomfort. In addition, it may lead to a more serious injury called a musculoskeletal disorder (MSD). MSD's are the number one type of work-related lost-time injury reported to the Workplace Safety and Insurance Board (WSIB) in Ontario. They:

- cause pain and suffering for thousands of workers every year, and
- cost Ontario's workplaces hundreds of millions of dollars due to worker absence and lost productivity.

(Statistics from other jurisdictions are comparable and can be provided as requested).

MSD's are strongly linked to known risk factors or hazards in the workplace as discussed in this report.

Ottawa Valley Waste Recovery currently has an MSD prevention program in which workers have been trained to report any signs and symptoms immediately to the supervisor to ensure that they do not progress. To date they have not done specific detailed assessments in the sorting area and once assessment will be working on developing control to minimize risks factors to developing MSDs. Often the team Leader would then move workers to attempt to reduce strain on the area of discomfort.

6.3 Healthy Workplace

MSD's are often attributed to the physical conditions of the workplace however studies show that an unhealthy workplace can lead to MSD's.[1] A healthy workplace means more than just a safe and healthy physical workspace. Ensuring healthy and productive workers requires addressing your organizational culture and the health practices of your employees. Unhealthy, unsafe and stressful workplaces cost Canadian employers billions of dollars annually in workers compensation, absenteeism, presenteeism, turnover, short- and long-term disability, mental illness and lost productivity.

IAPA has the tools and expertise – training, products, and consulting services – to help organizations like yours foster a healthy workplace culture. IAPA is the exclusive provider of the **NQI PEP® Healthy Workplace Program** for IAPA member firms and can also provide these services to other Canadian organizations.

[1] The following important "non-physical" factors influencing clinical presentations and illness related behaviour have been identified: monotonous work, perception of intensified workloads, limited job control and job satisfaction, low job clarity and low social support (concerning low back injuries) (Johanning, 2000).

7 RELEVANT TERMINOLOGY

7.1 Ergonomics

Ergonomics is a method of fitting a work area to the worker. Its purpose is to reduce the amount of strain put on a body to maximize productive work while reducing injury. This is done by first analyzing the work process then adjusting the work area, process and essential job tasks to the proper heights or angles to accomplish the necessary tasks. The physical demands are analyzed and potential risk factors are identified that are associated with the potential development of musculoskeletal disorders (MSD's).

7.2 Musculoskeletal Disorders

Musculoskeletal Disorders (MSD's) are injuries and disorders of the musculoskeletal system where exposure to various risk factors are present in the workplace may have either contributed to the disorders' development, or aggravated a pre-existing condition.
MSD is an umbrella term for a number of injuries and disorders of the muscles, tendons, nerves, etc. Other terms that mean the same as MSD include:

- repetitive strain injury (RSI)
- cumulative trauma disorder (CTD)
- work-related musculoskeletal disorder (WMSD)
- musculoskeletal injury (MSI, MSK)
- occupational overuse syndrome (OOS)
- sprain and strain

Injuries / disorders that are a direct result of a sudden, single event involving an external source (e.g. a fall, vehicle accident, violence, etc.) are not considered to be MSD. (MSD Strategy Development Committee, Feb 2005)

According to scientific literature, three main MSD risk factors are present when some developed an MSD; these include awkward or static postures, forceful exertions, and time factors (frequency, duration, rest) of postures and motions. Other risk factors include vibration, cold temperatures, unfamiliar or unaccustomed work, and psychosocial factors such as paced work, tight deadlines, or difficult relationships with co-workers or supervisors. The risk of an MSD is magnified when risk factors exist in combination.

7.3 Risk Factors

7.3.1 Force

Force is the amount of effort exerted by your muscles. All work tasks require the worker to exert some force. However, when a task requires a level of force that is too high for any particular muscle, it can damage the muscle or the related tendons, joints and other soft tissues. In dealing with force, think not only about how much force is being exerted / how much weight is being handled, but also:

- How long you need to keep exerting it.
- How many times you need to exert it in a given period, and

- The posture you are in when exerting the force.

7.3.2 Posture

Posture is another term for the position of your various body parts during any activity. Good posture is near the middle of the full range of motion for most joints. This is called the “neutral” posture. The farther a joint moves towards either end of its range of motion (i.e., the farther away from neutral), the more awkward the posture becomes. This puts more strain on the muscles, tendons and ligaments around the joint.

7.3.3 Repetition

The risk of developing an MSD increases when you use the same muscles, tendons, joints, etc. repeatedly, with few breaks or chances for rest. Highly repetitive tasks can cause muscle fatigue, damage to other tissues, and, eventually, pain and discomfort. This can occur even if the level of force exerted is low and the work postures are okay.

8 METHODOLOGY

8.1 Systems Approach to Ergonomics

IAPA uses a systematic process of problem solving that defines problems and opportunities in a systems context. Data is collected using various measuring tools and devices describing the problem and solutions are identified and evaluated. This approach allows IAPA to consider all elements of a system, resulting in the best solution being selected and implemented, and its success evaluated. The advantage of a systematic analysis is that it looks beyond workstation components and considers all aspects of the environment including job characteristics, organizational context, technology, and psychosocial variables. Integration of the entire work environment can promote a safer and more efficient workplace.

The following data collection methods were used:

- Informal interviews
- Physical measurements
- Direct observation

Off-site, the data was analysed qualitatively and quantitatively, using guidelines and methods such as:

- Anthropometrics Tables (measurement of the population)

8.2 Physical Measures

Physical measurements including heights, distances, dimensions, weights, forces, duration, and repetition were taken during this analysis. Measurement equipment included:

- Standard tape measure (heights, dimensions, distances)
- Force gauge dynamometer (weights and forces)
- Wristwatch (duration)

All measurements were recorded and reported as listed below:

- Distance, height and dimensions recorded in **centimetres** (cm)
- Force and weight recorded in **kilograms** (kg)
- Times recorded in **seconds** (sec), **minutes** (min), and **hours** (hr)

8.3 Analysis tools

8.3.1 Rapid Upper Limb Assessment (RULA)

Rapid Upper Limb Assessment is a survey method developed for use in ergonomic investigations of workplaces where work related upper limb disorders are reported. RULA is a screening tool that assesses biomechanical and postural loading on the whole body with particular attention to the neck, trunk and upper limbs. A RULA assessment scoring generates an action list which indicated the level of intervention required to reduce the risks of injury due to physical loading on the operator. See table below.

RULA Action Level Interpretation		
Action Level	**Score**	
1	1-2	The posture is acceptable if it is not maintained or repeated for long periods
2	3-4	Further investigation needed, changes may be required
3	**5-6**	**Investigation and changes are required soon**
4	7	Investigation and changes are required immediately
McAtamney, L. and Corlett, E.N. (1993). RULA: A survey method for the investigation of work related upper limb disorders. *Applied Ergonomics.* 24(2), pp. 91-99		

The action limit for the various line positions are detailed in Appendix A attached. Most of the positions along both sorting lines the RULA calculations were **calculated as an Action level 3, a few positions were noted to be an Action level 4. They were positions 7&8 along the fiber line for office mixed and the additional pre-sort on the container line.** Please refer to the rula summary calculation sheet in the appendix. This was based on the observations of the line on the day of the assessment.

Based on the assessment, significant areas for improvement for all workstation were the upper and lower arm and wrist. Several of the workstations the sorter needed to reach across the conveyor line contributing to significant awkward postures of the back. Please see the RULA Employee Assessment Worksheets attached for more information.

Kilbom Guidelines

Further investigation included evaluation of movement frequency using the Kilbom Guidelines (see table below). The Kilbom guidelines identify risk factors in relation to repetition. The risk of developing an MSD increases when you use the same muscles, tendons, joints, etc. repeatedly, with few breaks or chances for rest. Highly repetitive tasks can cause muscle fatigue, damage to other tissues, and, eventually, pain and discomfort.

Recommended for Risk Assessment in Repetitive Work				
Body Region	**Type of exercise**	**Frequency of movement or contraction**	**Risk assessment**	**Risk modification- VERY HIGH risk**
Shoulder	**Dynamic or Interm. Static**	>2.5/min	High	**One of the following** o High external force o High speed o High static load o Extreme posture o Lack of training o High demands on output o Monotony o Lack of control o Long duration of repetitive work
Upper arm, elbow	**Dynamic or Interm. Static**	>10/min	High	
Forearm, wrist	**Dynamic or Interm. Static**	>10/min	High	
Finger	**Dynamic or Interm. Static**	>200/min	High	
From: Kilbom, A. (1994). Repetive work of the upper extremity: Part 1-Guidelines for the Practitioner. *International Journal of Industrial Ergonomics*, Vol. 14, pp. 51-57				

When observing the sorting task positions and reviewing the information provided as to the process it appears that these tasks would have an elevated risk due to repetition to the shoulder or upper arm, and wrist. For shorter employees not using the platform there would be at greater risk due to more extreme postures of the shoulder. In addition, the high demands for output, the lack of control and the long duration of repetitive work would place these sorters at high risk of injury based on the Kilbom frequency guidelines. Currently workers are rotated to various positions in order to provide slight changes to muscle groups used. Rotation occurs at each break and a schedule is drawn up daily by the team leader Ms. Ryan. Ms. Ryan will also alter the schedule if workers are reporting discomfort in various joints providing them less strenuous tasks.

Most of the work for taller workers was done below elbow height or below. Shorter workers were required to raise their arms and shoulders.

The sorting tasks are machine paced and frequently the workers would feel rushed in order to adequately remove all the items from the sorting line. At the time of this assessment the sorters would stop the line when not able to remove items.

9 REFERENCE DOCUMENTS

In Ontario, no legislated standards exist that specifically address the ergonomics of workstations in the workplace. The following reference texts, standards and drafts of standards were used as guidelines in the preparation of this report:

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Industrial Ergonomics 10, pps. 85-104.

10 CONTACT INFORMATION

Reducing or eliminating physical discomfort or injury risk among employees requires a combination of improved work area design layout, equipment/machinery/tools as well as adjustments to work organization and work practices. When employees already experience discomfort due to injury, reducing and/or eliminating the discomfort is a 24-hour job that requires adjustments at work and at home.

The focus of this report is to address as many areas as possible in an effort to provide recommendations to reduce and hopefully eliminate the discomfort that is experienced by some employees and eliminate or minimize the risk of future musculoskeletal discomfort or injury for all employees. Changes to personal lifestyles and work practices at home and at work are the responsibility of the individual employee; however, hopefully these changes will be supported by a corporate culture that encourages healthy lifestyles overall, and healthy work practices in the workplace.

If you have any questions feel free to contact me directly at 613-925-1016 or jolicoeur@iapa.ca.

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