

**DEMONSTRATION PROJECT:
SOLID WASTE MANAGEMENT AND
RECYCLING**

November 2004

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INTRODUCTION

The aim of this report is to provide an overview of the solid waste management industry and provide recommendations to address risk factors that might contribute to Work-related Musculoskeletal Disorders (WMSDs). This report will be limited to the processes involved with refuse collection, collection of recyclable material (non-organic), and the sorting of recyclable materials at the material recovery facility (MRF).

In order to be user friendly, the structure of the report is primarily organized by the type of truck used for each operation. The end user can simply go to the section that most applies or may review all sections for a more comprehensive understanding of the processes and suggested options.

Types of Trucks:

[Residential refuse collection trucks](#)

- Automated
- Semi-automated
- Rear loading (traditional)
- Rear loading (retrofitted)

[Commercial refuse collection trucks](#)

- Front loading

[Large commercial](#) (such as at a construction site) or bulk residential recycling

- Roll off compactor

[Residential recycling collection trucks](#)



- Roll up style doors (all manual)
- Semi-automated

[Commercial or residential recycling collection trucks](#)

- Automated

The last section of the report addresses the [sorter job](#) at different types of material recovery facilities.

RESIDENTIAL REFUSE COLLECTION TRUCKS:

Truck Type	Type of Route	Type of Container	Type of Lifting / Work Process	Workers per Truck
<p>1. Automated</p> 	Residential	Standard cart	<p>Mechanical lifting Worker uses a joystick control from within the truck cab. Mechanical arm grabs the cart, lifts, and empties the cart contents into truck.</p>	1
<p>2. Semi-automated</p> 	Residential route also can be used for apartment complexes	Standard cart (**Possibility of some non-standard containers)	<p>Mechanical lifting Worker gets out of truck and rolls cart to the lifting mechanism. Contents of cart are mechanically dumped into truck. (For non-standard carts, see rear-loading traditional section)</p>	1

***NOTE: Some routes may have a mixture of customer types, some use standard carts and some use containers that cannot be used with mechanical devices. This could occur when full conversion to standard carts is still being phased in. There may be other reasons for this scenario as well. There is higher risk of WMSDs when there is manual lifting.*



RESIDENTIAL REFUSE COLLECTION TRUCKS:**Risk Factor(s) and Task(s) of Concern:**

1. Awkward neck postures while looking at mirrors or camera monitors and operating joystick controls
2. If route is not fully mechanized, manual lifting of heavy containers (non-standard)

Recommendations:

- Adjust mirrors and cameras to minimize turning head to either side or peering forward
- Residents all use standard carts while workers use mechanical lift devices.

RESIDENTIAL REFUSE COLLECTION TRUCKS:

Truck Type	Type of Route	Type of Container	Type of Lifting / Work Process	Workers per Truck
<p>3. Rear Loading (traditional)</p> 	Residential	Non-standard container	<p>Manual lifting</p> <p>Worker retrieves container(s) and manually empties its contents at the rear of the truck.</p> <p>Worker might also roll a small commercial “dumpster” container (one without “sleeves”) to the rear of the truck and set it up with the tipping bar. The mechanical bar lifts and tips the contents of the container into the rear of the truck.</p>	1-2
<p>4. Rear Loading (retrofitted)</p> 	Residential	<p>Standard cart</p> <p>(**Possibility of some non-standard containers)</p>	<p>Mechanical lifting</p> <p>Worker rolls cart to the lifting mechanism at the rear of the truck (“flipper”). Contents of cart are mechanically dumped into truck.</p> <p>(For non-standard carts, see rear-loading traditional section above).</p>	1-2

***NOTE: Some routes may have a mixture of customer types, some use standard carts and some use containers that cannot be used with mechanical devices. This could occur when full conversion to standard carts is still being phased in. There may be other reasons for this scenario as well. There is higher risk of WMSDs when there is manual lifting.*


RESIDENTIAL REFUSE COLLECTION TRUCKS:**Risk Factor(s) and Task(s) of Concern:**

1. Manual lifting of heavy containers - containers vary in weight but at times weigh over 60 lbs.
2. Frequent lifting and perhaps twisting, depending on worker's lifting "style" (behavior)

Recommendations:

- Retrofit trucks with semi-automated "flippers" or phase in fully automated or semi-automated trucks to replace the rear loading trucks. (Some cities may have areas that can only be accessed and serviced by the smaller rear-load trucks. Use retrofitted rear load trucks with standard carts). With manual lifting essentially eliminated, the maximum weight limit per cart can be much higher than the weight noted in the bullet below.
- Set a maximum weight limit per container, notifying customers that overweight cans or items will be tagged and NOT picked up for garbage collection. Suggested weight limit is 50 lbs. (Having a policy is not the same as adhering to the policy).
- Job task rotation (for trucks staffed with 2 workers)— driver and helper can switch job tasks at set intervals to spread the total amount of lifting between two people. Heavy or unusually bulky loads can be team lifted.
- Avoid twisting the trunk and slinging the load to save time while lifting. Instead, encourage worker to take a few extra steps and seconds to keep load square with the body.
- Consider payment by the hour instead of using a "finish and go home" pay scheme that encourages work at excessively fast rates and increases the potential for injuries

COMMERCIAL REFUSE COLLECTION TRUCKS:

Truck Type	Type of Route	Type of Container	Type of Lifting / Work Process	Workers per Truck
<p>5. Front Loading</p> 	Commercial	"Dumpsters"	<p>Mechanical lifting Driver positions the lifting forks to align with the lifting "sleeves" on the "dumpster". Sometimes the driver must manually push/pull the "dumpster" (2, 3, or 4 cubic yard containers) out from its inaccessible home base location to an acceptable position that matches up with the lifting forks. The worker returns to the truck cab to operate the lifting forks--lifting and emptying the container contents into the collection hopper. The container is then returned to its home base location. Driver may have to get in and out of the truck several times per site.</p>	1
	(residential routes as described)		<p>Modified setup: a short-wall container is used as a temporary collection bin that allows for manual collection of refuse cans. See section for traditional rear loading refuse collection.</p>	1-2

Risk Factor(s) and Task(s) of Concern:

1. Push/Pull force – At times it takes high push/pull forces to move the "dumpsters" into position to use the truck's lifting forks. Sometimes the ground is uneven, on an incline, and/or unpaved – all making it more difficult to push the "dumpster".



COMMERCIAL REFUSE COLLECTION TRUCKS:


Be aware of the push/pull forces that are needed to manually move “dumpsters”, particularly the more difficult ones. It is a good idea to keep these forces within reasonable levels. As a guideline, the Liberty Mutual Push/Pull Tables provide force values (initial and sustained) acceptable to 10%, 25%, 50%, 75%, and 90% of industrial male and female populations. Extrapolating data from those tables, 75% of men should be able to exert 62 lbs of initial push force as a regular part of daily work and 47 lbs of initial pull force. Since men are far more likely to perform these tasks than women, the values for 75th percentile man were used for this report. Liberty Mutual authors indicate, “A worker is three times more susceptible to low back injury if he or she is performing a job which less than 75% of the working population can perform without overexertion.” (Snook, Campanelli, and Hart 1978).*

Recommendations:

- Consider using a motorized tugger device when needed. This would allow the worker to guide, not push/pull the “dumpster” into position. Will need to devise a way to transport the tugger with the truck. Consider this for new truck designs.
- Work with property owners/planners to have areas easily accessible to a front-loading truck. For space limited areas that require rolling the “dumpster” into an acceptable position, the positioning path should be paved and level.
- Consider adding additional casters and/or larger casters to the “dumpster” for the purpose of reducing the push force requirement.
- Maintain casters of “dumpster” on a scheduled basis. Ensure the most appropriate wheel type is used for outdoor use and uneven surfaces.
- For customers using difficult to push wheeled “dumpsters”, discuss and negotiate alternative options—possibly using a smaller container with a more frequent pick-up schedule or perhaps 2 easier to move containers. Use disincentive fees that discourage the use of poorly accessible or difficult to move “dumpsters”.

*The extrapolated data used in this report came from the Liberty Mutual Push/Pull Tables (1991) and using parameters most closely representing the “dumpster” pushing and pulling tasks. See Appendix 1 for details.

TRUCKS FOR COMMERCIAL OR BULK RESIDENTIAL RECYCLING


Truck Type	Type of Route	Type of Container	Type of Lifting / Work Process	Workers per Truck
<p>6. Roll off Compactor</p> 	<p>Large commercial (example: construction sites)</p> <p>*Can also be used as a shuttle transport container for bulk loads of recyclables to MRF</p>	<p>Large commercial “dumpsters”</p>	<p>Mechanical lifting</p> <p>Worker drives to customer site to mechanically pick up filled containers or drop off empty containers. Worker uses a mechanical winch to pull a container onto the truck bed (via rails). The filled container is delivered to a disposal site. A hydraulic hoist device is used for take the container off the truck bed.</p> <p>Transport shuttle: Method of pulling up and dropping off container is the same as above. Driver picks up full container of same-type (segregated) recyclables from a “collection yard”, drives to MRF to empty the load on the “tipping floor”. Driver returns to “collection yard” to drop off empty roll off container.</p>	<p>1</p>

Risk Factor(s) and Task(s) of Concern: None

Recommendations: N/A

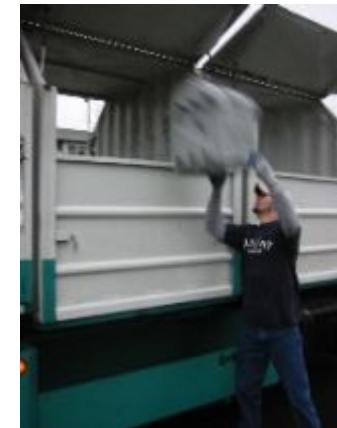
RESIDENTIAL RECYCLE COLLECTION TRUCKS

[Sorting at the Material Recovery Facility (MRF) is addressed separately]

Truck Type	Type of Container	Type of Lifting / Work Process	Workers per Truck
<p>1. Roll-up style doors – all manual operation</p> 	<p>Small plastic bins</p>	<p>Manual lifting</p> <p>Customers sort recyclables into separate recycle bins. Cardboard is piled next to bins at curbside. Worker empties plastic recycle bins into appropriate compartments of truck. Each truck compartment door can be adjusted in height depending on how full the compartment is. For this truck the minimum clearance height for the door usually starts at 66 inches and rises to the maximum height of 90 inches as the compartment fills up. Often times it requires overhead lifting by the worker. Worker may also need to do further hand sorting of glass by color, tossing glass into appropriate truck compartments. Cardboard is placed in low height compartments on the truck.</p>	<p>1</p>

Risk Factor(s) and Task(s) of Concern:

1. Picking up recycle bins from low heights and emptying at high heights. The pace may be frequent and the bins, heavy at times.
2. Twisting while lifting, depending on driver’s lifting “style” (behavior)
3. Frequent use of a hook grip combined with contact stress when using recycle bins without hand cutouts.
4. Open bins are susceptible to rain. Rainwater and rain-soaked newspaper can make the bins much heavier.





RESIDENTIAL RECYCLE COLLECTION TRUCKS

Recommendations:

- Use a fold out step to raise the worker (lowers the ending height for the lift)
- Use bins with hand cut-outs that allow for a power grip rather than a hook grip or pinch
- Use bins with drainage holes
- Avoid twisting the trunk and slinging the load to save time while lifting. Instead, encourage worker to take a few extra steps and seconds to keep load square with the body.
- Provide customer with a newspaper bin with a plastic cover (flip open or otherwise) as a rain protector. Encourage customer to place this newspaper bin at the top of the 3-bin stack to keep the heavier load near waist level for lifting. May need to design a new bin with a cover. —OR—If there is no cover, encourage customers to place the newspaper bin on the bottom of the 3-bin stack in an effort to minimize waterlog effect (higher bins may provide some rain protection for the newspaper).
- When notably heavy, pick up smaller amounts of newspaper by hand instead of lifting the whole bin. Break up newspaper into smaller, lighter piles before transferring newspaper to recycling truck compartment.
- Consider converting from a manual collection operation to an automated or semi-automated collection system with all recyclables commingled in one standard cart. (The appropriate MRF system will need to match this type of collection system).



RESIDENTIAL RECYCLE COLLECTION TRUCKS
 (Sorting at the Material Recovery Facility (MRF) is addressed separately)

Truck Type	Type of Container	Type of Lifting / Work Process	Workers per Truck
<p>2a. Semi-automated Holding bins mounted on sides of truck—with or without clamps for standardized carts.</p> 	<p>Small plastic bins</p>	<p>Mechanical lifting Customers sort recyclables into 3 separate plastic bins. Worker often lifts bins 2 at a time, one in each hand. The bin for newspaper is generally the heaviest of the 3 bins and is picked up last. Cardboard is also picked up at curbside but is not placed in a plastic bin. Worker operates a control that automatically lifts and empties the holding bin contents into the appropriate truck compartment.</p>	<p>1</p>
<p>2b. A standard cart clamping mechanism can be attached to the holding bin allowing for some versatility in collection containers.</p> 	<p>Standard carts</p>	<p>Mechanical lifting The worker rolls the cart to the clamping device. The attached cart is mechanically lifted with the holding bin and emptied into the appropriate truck compartment. This system is often used at apartment complexes.</p>	

RESIDENTIAL RECYCLE COLLECTION TRUCKS


Risk Factor(s) and Task(s) of Concern:

1. Awkward lifting to pick up recycle bins from low heights. The pace may be frequent and the bins may be heavy at times.
2. Depending on driver's behavior for lifting "style", twisting while lifting
3. Frequent use of a hook grip combined with contact stress when using recycle bins without hand cutouts.
4. Open bins are susceptible to rain. Rainwater and rain-soaked newspaper can make the bins much heavier.

Recommendations:

- Maximize customer use of standard carts and use the clamping device attachment on the side holding bin of the truck (see example 2b on previous page).
- Use recycle bins with hand cut-outs that allow for a power grip rather than a hook grip or pinch
- Use recycle bins with drainage holes
- Avoid twisting the trunk and slinging the load to save time while lifting. Instead, encourage worker to take a few extra steps and seconds to keep load square with the body.
- Encourage customers to place the newspaper bin on the bottom of the 3-bin stack in an effort to minimize waterlog effect (higher bins may provide some rain protection for the newspaper).
- When notably heavy, pick up smaller amounts of newspaper by hand instead of lifting the whole bin. Break up newspaper into smaller, lighter piles before transferring newspaper to the holding bin.

COMMERCIAL OR RESIDENTIAL RECYCLE COLLECTION TRUCKS
 (Sorting at the Material Recovery Facility is addressed separately)

Truck Type	Type of Container	Type of Lifting / Work Process	Workers per Truck
<p>3. Automated – single stream system with commingled recyclables</p> 	<p>Standard cart</p>	<p>Mechanical lifting</p> <p>Customers place all recyclables into one standard cart. All recyclable items are commingled with one another, not sorted by type. Worker (driver) does not sort items. Sorting is done at the MRF. Worker uses automated or semi-automated truck devices to mechanically pick up standard carts. When truck is full, worker drives to the MRF to empty the contents onto the “tipping” floor.</p>	<p>1</p>

Single stream system benefit: Greater recycling participation by customers due to the “easier to do” commingled system. It involves less handling by the customer and the driver. Paper and cardboard quality may be reduced for recycled products due to a higher degree of contamination, but the total volume of recycled material increases overall.

Risk Factor(s) and Task(s) of Concern:

1. Awkward neck postures while looking at mirrors or camera monitors and operating joystick controls
2. If route is not fully mechanized, manual lifting of heavy containers (non-standard)

Recommendations:

- Adjust mirrors and cameras to minimize turning head to either side or peering forward
- Residents all use standard carts while workers use mechanical lift devices.

SORTER JOB AT MATERIAL RECOVERY FACILITIES (MRFs)

Sorter

Multi-stream MRF:

Customers sort recyclables into bins (source separated). Collection takes place at curbside and materials are put into compartmentalized trucks. These segregated recyclables are delivered to the MRF and are stockpiled before being placed on a conveyor. Workers pull out selected items from the conveyor depending on the type of recycle batch (tin, aluminum, plastic, or various glass types from one batch; cardboard, white paper, newspaper, from a different batch. Mixed paper is left on the conveyor and collected at the end of the line.)

Single stream MRF:

Commingled recyclables are delivered to the MRF. Commingled recyclables are placed on the conveyor line. Various screen systems, vibrators, magnets, and eddy currents automatically take out desired materials from the conveyor line. Some manual sorting of remaining material takes place at sorting stations along the conveyor line. In general, far less material is sorted by hand at a single stream MRF as compared to the multi-stream MRF, although the degree of automation varies from facility to facility. As the total volume of material processed at the MRF increases, the amount of manual sorting also increases. The pace of hand intensive work appears less intense at highly automated MRFs compared to the less automated MRFs.

JOB DUTIES:

- Worker stands at station along conveyor line to remove undesired items that need to be excluded from the line (negative sorting) or take out desired items that are recyclable (positive sorting). Tosses items into chutes by their individual category type.
- Keeps work areas clear of mounting debris.



Risk Factor(s) and Task(s) of Concern:

1. Long reaching
2. Bent back (for taller workers)
3. Repetitive motions of arms/hands
4. Neck bending

SORTER JOB AT MATERIAL RECOVERY FACILITIES (MRFs)**Recommendations:**

- Maximize use of automated sorting
- Consider using platforms for shorter workers to stand on with conveyor set at height most appropriate for the taller workers. The goal is for all workers to be able to stand upright while working. A simple or more complex platform design can be used. (An adjustable lift work platform for scrap metal recycling is described at <http://www.cbs.state.or.us/external/osha/grants/schnitzsteel/schnitzoverview.html>).
- Rotate worker to different stations along the conveyor and across the conveyor. Benefits: 1) the frequency of reach may vary at different stations along the line so that some stations require less frequent reaching than others, 2) the reach distance can be reduced if workers on opposite sides of the conveyor sort for the same item types, and 3) working from opposite sides of the conveyor may help to reduce overuse of one arm or turning to only one side.
- Use deflectors on conveyors to direct items closer to workers or use shorter width conveyors--reducing the reach distance
- Ensure adequate toe clearance to minimize reach distance to items on the conveyor. This may require modification to the toe boards.
- Consider sit/stand supports to lean on during micro pause breaks to reduce fatigue from prolonged standing when the pace of sorting permits-
- Consider padded bars or supports to lean on to offset forces on the back while leaning forward.
- Provide anti-fatigue mats to reduce fatigue

Attachment 1

Push/Pull Analysis—Adapted from Liberty Mutual Tables

Parameter Options from the Tables:					
Effort type:	Vertical Zone:	Distance of Travel:		Frequency: once every...	
Push	Shoulder	7 ft	100 ft	8 hrs	30 s
Pull	Hip	25 ft	150 ft	30 min	15 s
	Mid-thigh	50 ft	200 ft	5 min	12 s
				1 min	6 s

From Push/Pull Analysis worksheet v2.1 9/24/02 © 2002 Thomas E. Bernard

[NOTE: the closest conditions using the parameter options from the tables were selected to represent these tasks.

For scenario representing a person pushing a 2, 3, or 4 cubic yard “dumpster” with casters

Parameters used:

PUSHING

Distance: 25 ft

Vertical Zone: shoulder level

Frequency: once every 30 min

		Percent Acceptable				
		10	25	50	75	90
Initial	Men	107	93	77	62	48
	Women	79	70	60	50	41
Sustained	Men	85	73	60	47	35
	Women	57	48	38	28	19

For scenario representing a person pulling a 2, 3, or 4 cubic yard “dumpster” with casters

Parameters used:

PULLING

Distance: 25 ft

Vertical Zone: shoulder level

Frequency: once every 30 min

		Percent Acceptable				
		10	25	50	75	90
Initial	Men	74	66	56	47	39
	Women	74	66	58	49	41
Sustained	Men	60	52	44	35	27
	Women	57	49	40	31	23