



Allied Building Products

Roofing Materials Distribution

December 2002

Allied Building Products

Ergonomics demonstration project report

Introduction

In July 2002, Allied Building Products and the Washington State Department of Labor and Industries (L&I) began an ergonomics demonstration project. The purpose of the project was to perform an ergonomics review of current warehouse and job site delivery/stocking operations, and to document existing use of risk reduction equipment, methodologies, etc. Any observed hazardous exposures would also be identified.

This report provides examples of ergonomics methods of risk reduction used for building materials distribution and their benefits to employees' health and safety at work. The focus of the ergonomics principles and ideas presented here is the prevention of work-related musculoskeletal disorders (WMSDs).

About Allied Building Products

Allied Building Products is a leading distributor of building materials in Washington State, distributing from warehouses located in Edmonds, Spokane, Woodinville, Tumwater, Tacoma, and Kent.

This report covers the Allied Building Products warehouse in Edmonds, WA, and an example of job site delivery of roofing materials to a residential subdivision in Renton, WA.

Warehouse tasks at Allied's Edmonds warehouse location include receipt of bulk roofing and other building materials from suppliers, order picking / order assembly, loading delivery trucks, loading customer trucks, unloading empty pallets, and miscellaneous activities such as product/order labeling, cleanup, and paperwork.

Job site delivery/stocking tasks include driving the delivery truck to the job site, positioning and setup of boom truck at job site, stocking the roof (loading and unloading the conveyor), departing the job site, and driving to the next site.

Allied Building Products invests significant time, money and effort into training its employees to ensure their safety and well-being.

Allied's corporate safety and health manager trains workers on safe and productive methods for warehouse and job site set up.

The company has experienced limited numbers of ergonomics-related worksite injuries, with more injuries at job sites than in the warehouse.

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Because of the preventive approach to safety and health referred to above, and because of the productivity advantages inherent in the use of warehouse and job site equipment such as forklifts and boom trucks, Allied Building Products has implemented a number of good ergonomics practices. Warehouse-based distribution of building materials, including the roofing materials described in this report, includes a number of product handling jobs required to take pallet loads of product received from individual suppliers, assemble customer orders, and deliver orders to customer job sites. Some of these distribution jobs, if done manually, would likely expose workers to hazardous levels of lifting, bending, repetitive motions, and high hand force that could lead to work-related musculoskeletal disorders (WMSDs).

This report describes ergonomics applications to roofing products distribution operations that reduce the need for lifting, bending, repetitive motions, and high hand force. These include the use of mechanical product handling equipment and work procedures.

Table 1 summarizes the results of the ergonomics evaluation of the warehouse operations.

Table 2 summarizes the results of the ergonomics evaluation of the job site delivery / roof stocking operations.

Table 3 lists the most significant ergonomics accomplishments implemented at the warehouse and job sites to-date.

Table 4 lists possible Ergonomics Rule concerns. Further analysis is suggested in these areas.

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Table 1. Summary of Ergonomics (WMSD) Risk Factors – Warehouse

| Activities | Possible WMSD Risk Factors* | Risk Reduction Ideas |
|--|--|---|
| Warehouse Receipt of Bulk Roofing Materials Deliveries unloaded at warehouse (at loading dock or doorway) * Loaded pallets placed on floor or on shelf racks (e.g., bundles, rolls, asphalt buckets) * Other materials placed on floor or on shelf racks (e.g., buckets of nails, other miscellaneous materials) * Window assemblies, door frames placed on floor | Lifting (heavy, frequent, awkward) Back bending Highly repetitive motions Forceful gripping | * Forklifts, pallet jacks used to unload bulk roofing materials received from suppliers on pallets * Heavier items (e.g., larger window assemblies) offloaded mechanically, or manually with two or more workers |
| Order Picking / Order Assembly * Full pallets * Partial/mixed pallets * Miscellaneous items * Window assemblies | Lifting (heavy, frequent, awkward) Back bending Highly repetitive motions Forceful gripping | * Forklifts, pallet jacks used (to lift/carry most materials) * Cart or other device used for moving heavier window assemblies – sliding/rolling used where possible instead of lifting |
| Loading delivery trucks Stocking trucks loaded with customer orders | Lifting (heavy, frequent, awkward) Back bending Highly repetitive motions Forceful gripping | * Pallets loaded on truck with forklifts * Boom truck open bed has easy access for forklift loading of pallet loads of roofing materials at warehouse |
| Loading customer trucks (warehouse pickup by customer) | Lifting (heavy, frequent, awkward) Back bending Highly repetitive motions Forceful gripping | * Forklifts (e.g., pallets loaded, or material loaded (slid) off of forks) |
| Unloading empty pallets From returning delivery trucks | Lifting (heavy, frequent, awkward) | * Forklifts, pallet jacks |
| Miscellaneous Product/order labeling Paperwork Clean up | None | N/A |

* See Ergonomics Rule for specific Caution Zone and hazard limits associated with these risk factors

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Table 2. Summary of Ergonomics (WMSD) Risk Factors – Job Site

| Activities | Possible WMSD Risk Factors* | Risk Reduction Ideas |
|---|---|---|
| Driving truck to job site * Typically a boom truck | None | N/A |
| Positioning and setup of boom truck at job site * Position truck adjacent to job site roof to be stocked. * Deploy powered conveyor. | Lifting (heavy, frequent, awkward) High hand force | * Boom truck located adjacent to roof to be stocked – to minimize manual handling requirements * Powered deployment of conveyor |
| Stocking Roof (loading conveyor) (bottom man) * Shingle bundles (shipped on pallets) * Rolls (shipped vertical) | Lifting (heavy, frequent, awkward) Back bending | * Use of boom trucks vs. manual loading of roof * Conveyor load point at about waist height * Tip a lower bundle on the pallet upright first, then roll bundle over knee before lifting (raises the starting height for this lift to above knee level) * Reduce conveyor loading to only about 2 to 3 bundles per minute (every 20 to 30 seconds) (limits the frequency of lifting for the bottom man) * Job rotation (rotate bottom man and top man) |
| Stocking Roof (unloading conveyor) (top man) * Shingle bundles * Individual rolls Materials carried (distributed) across roof | Lifting (heavy, awkward) Back bending | * Conveyor unload point at about waist height (lift from between knee and waist level) |
| Departing job site * Stow powered conveyor. * Depart job site. | Lifting (heavy, frequent, awkward) High hand force | * Powered stowing of conveyor |
| Driving truck to next site * Drive truck to next job site or return to warehouse | None | N/A |

* See Ergonomics Rule for specific Caution Zone and hazard limits associated with these risk factors

Warehouse Operations at Allied Building Products

1. Bulk deliveries of building materials (from suppliers) are unloaded at the warehouse (loading dock or doorway), using forklifts.

Full pallets and other materials are placed in warehouse storage, either at floor level, or on shelf racks.

2. Customer orders are picked from the warehouse and assembled on pallets.

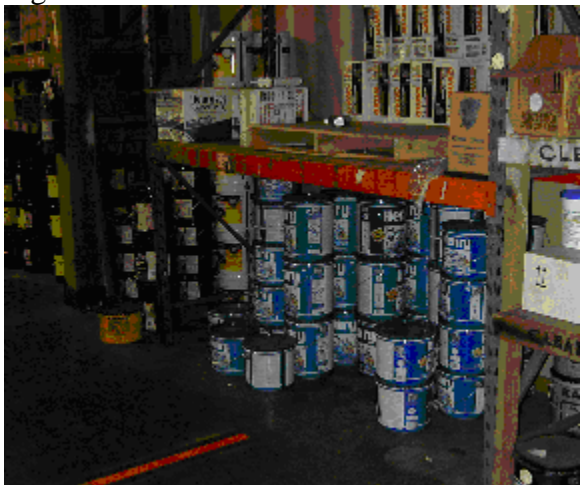
Powered equipment is used to handle the building materials wherever possible, both to maximize productivity and to minimize manual lifting of heavy or awkward materials.

Full and partial pallet loads of bulk materials (e.g., shingle bundles) are forklifted from their warehouse storage rack locations to the delivery truck.

Small quantities of miscellaneous materials, such as the types of materials shown below, are manually loaded onto a forklift-mounted pallet, or hooked onto the forklift tongs (using the bucket handles) for transfer to a centrally located pallet. The loaded pallet(s) are then forklifted to the delivery truck.

Light to medium weight items are lifted by hand.

Figure 1. Individual materials.



a) Cans of cement wet patch (on floor)



b) Buckets of standard screws (on shelf)

Typically, customer orders include only small quantities of these miscellaneous materials. Any miscellaneous materials that are commonly picked in large quantities should be stored on pallets, to enable picking of a pallet using a forklift or pallet jack, rather than manual picking/lifting of individual items.

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Heavier items are lifted with the forklift, using forklift attachments where appropriate, as shown below.



Figure 2. Forklift tong for rolls (on top of pile).

3. Delivery trucks are loaded at the warehouse.

Forklifts are used to load full and partial pallet loads of materials as well as un-palletized materials. Limited amounts of materials may be loaded by hand.

Awkward/heavy window assemblies (shown below), door frames, etc. are unloaded from delivery trucks at the warehouse, stored, and later lifted for loading onto delivery trucks.



Figure 3. Lifting window assemblies.

Larger window assemblies, door frames, and other similar items, weigh over 90 lbs and should be lifted mechanically (using forklifts, carts, rails for unloading from a truck, etc.), or manually lifted with two or more workers. (See further discussion after Table 4.)

4. Customer trucks are loaded at the warehouse.

Forklifts are used to minimize lifting during customer loading, such as holding material at a good height for sliding instead of lifting (Figure 4 a) and for placing pallet loads of material directly onto a truck bed (Figure 4 b).

Figure 4. Customer loading.



a) Sliding materials off forklift forks



b) Loading a pallet with a forklift

5. Empty pallets are unloaded from returning delivery trucks.

Forklifts are used to unload empty pallets.

(Mechanical offloading eliminates the need for heavy, awkward lifting.)

6. Miscellaneous tasks, such as product/order labeling, cleanup, and paperwork are performed.

(There are no known potential WMSD hazards associated with these tasks.)

Job Site (Stocking) Operations at Allied Building Products

1. Delivery trucks are driven to the job site.
(There are no known potential WMSD hazards associated with this task.)
2. Boom trucks are positioned and set up at the job site. Trucks are positioned adjacent to the roof to be stocked, and the truck's powered conveyor is deployed. The conveyor deploys mechanically, with no heavy lifting or push/pulling required by the worker.



Figure 5. Conveyor positioning.

3. Roofing materials are loaded onto the powered conveyor by the “bottom man”.

Shingle bundles or rolls are placed onto the conveyor one at a time.

(Lifting more than one at a time would be too much weight:

$2 \times 72 \text{ lbs (typical bundle weight)} = 144 \text{ lbs}$. This greatly exceeds Ergonomics Rule lifting limits)

Lifting individual bundles from a pallet involves a wide range of lifting heights, from above the waist for the top rows, to below the knees for the lowest rows.

(Lifting from between knee and waist levels is preferred – workers' lifting strength is the greatest in that range)

Bundles on upper rows are first pulled towards the worker, then lifted off the top of the pallet (this counts as one lift of the bundle) (Note: Sliding of a bundle is not lifting).

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Bundles on lower rows are first tipped upright, then lifted off the pallet (this counts as two lifts of the bundle – tipping upright counts as one lift (1/2 the bundle weight) and the subsequent lift off the pallet counts as a second lift (the full weight of the bundle)).

A worker who has lifted a bundle from the pallet must turn around and walk several steps from the pallet to the conveyor, repositioning the feet while turning/carrying. (Thus the bundles cannot simply be “slid” from the pallet to the conveyor, but must be lifted and carried to the conveyor.)

Note that although carrying of bundles over distances is not encouraged, one positive result in this case is that the distance to the conveyor requires turning of the feet while carrying, as opposed to having the feet “planted” in place and twisting sideways at the waist while lifting). This turning of the feet reduces the need to “twist” at the waist while lifting the bundle.

Figure 6. Loading the conveyor (with a shingle bundle).



a) Lifted off pallet (top of pallet)
(bundle slid off top of pallet)



b) Lifted off pallet (bottom of pallet)
(bundle tipped upright before lifted)



c) Carried to conveyor



d) Placed on conveyor

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4. Roofing materials are taken off the conveyor by the top man, and distributed across the roof. The conveyor is positioned at about waist level, which provides a good working height for lifting/carrying material off the conveyor.

Shingle bundles or rolls are taken off of the conveyor one at a time.

(Lifting more than one at a time would be too much weight)

2 x 72 lbs (typical bundle weight) = 144 lbs. This greatly exceeds Ergonomics Rule lifting limits)

5. The powered conveyor is stowed and the truck departs the job site.

The conveyor stows mechanically, with no heavy lifting or pushing/pulling required by the worker.

6. The truck is driven to the next job site, or back to the warehouse.

(There are no known potential WMSD hazards associated with this task.)

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Table 3. Existing Ergonomics Risk-Reduction-Related Accomplishments (Summary)

| In-Place Accomplishment | WMSD Risk Factors Reduced or Eliminated* |
|---|--|
| Fork lifts, pallet jacks (receiving and storing materials, picking/assembling orders, delivery truck loading) | Lifting (heavy, frequent, awkward) Back bending Highly repetitive motions Forceful gripping |
| Boom trucks with powered conveyors (vs. manual rooftop stocking) | Lifting (heavy, awkward) Forceful gripping |
| <p>Work procedures</p> <ul style="list-style-type: none"> • Mechanical equipment used for lifting heavy materials wherever possible • Two or more workers used to lift heavier/bulkier materials • Materials lifted close to the body wherever possible (e.g., pull product across pallet, close to the body, before lifting) • Good housekeeping (maintaining unobstructed work areas that enable easy access to warehouse materials) • Job rotation (where possible) (Consider alternating between forklift driving and material picking in the warehouse, when two worker teams are used for order picking) (Rotate between bottom man and top man, when stocking roofs at job sites) | Lifting (heavy, awkward) Back bending Highly repetitive motions Forceful gripping |

* See Ergonomics Rule for specific Caution Zone and hazard limits associated with these risk factors

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**Table 4. Ergonomics Rule possible hazards.
(Special focus on these areas is suggested)**

| Operation/Task (Warehouse) | WMSD Risk Factors Of Possible Concern* | Possible Risk Reduction Ideas |
|---|---|---|
| <p><u>Manual</u> unloading/loading/moving of window assemblies, door frames, or other heavy/large items</p> <p>(All objects > 90 lbs.)</p> <p>(Heavy objects < 90 lbs. may be included here, if lifted frequently, from awkward positions, or with twisting) (See Ergo Rule, Appx B: Heavy, Frequent or Awkward Lifting)</p> | <p>Lifting (heavy, frequent, awkward), with or without twisting</p> | <ul style="list-style-type: none"> * Use mechanically lifts to move heavy items (forklifts, other lifts) * Slide heavy items, rather than lift (use carts) (consider using rails to unload items from truck) * Use two or more workers to lift heavier items (when manual lifting required) * Use good lifting practices (e.g., lift close to body, start lift at knee to waist height wherever possible, slide rather than lift wherever possible) |
| <p>Order Picking / Order Assembly</p> <p>Hand picking items (e.g., 5-gal buckets, nail/screw containers)</p> | <p>Lifting (heavy, awkward), with twisting</p> | <ul style="list-style-type: none"> * Mechanical lifting of heavy or awkward items wherever possible * Store heavy items on pallets to facilitate mechanical lifting * Lift heavy items mechanically by their handle where applicable (e.g. loop handle on 5-gal bucket) * Store heavier manually- handled materials between knee and waist levels * Lift heavy items with two or more workers (when manual lifting required) * Job rotation (other tasks) |

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| Operation/Task (Job Site) | WMSD Risk Factors Of Possible Concern* | Possible Risk Reduction Ideas |
|--|---|--|
| Loading Conveyor (bottom man) Shingle bundles Rolls | Lifting (heavy, frequent, awkward) | <ul style="list-style-type: none"> * Lift one bundle at a time * Lift one roll at a time * Where possible, start a lift close to the body, from between knee and waist height, without twisting * Tip a lower bundle on the pallet upright first, then roll bundle over knee before lifting (raises the starting height for this lift to above knee level) * Reduce conveyor loading to only about 2 to 3 bundles per minute (every 20 to 30 seconds) (limits the frequency of lifting for the bottom man) * Job rotation (rotate bottom man and top man) * Lighter weight shingle bundles (less shingles per bundle) (not currently available – see Appendix 3 of this report) |
| Unloading Conveyor (top man) Shingle bundles Rolls | Lifting (heavy, frequent, awkward) | <ul style="list-style-type: none"> * Lift one bundle at a time * Lift one roll at a time * Start a lift close to the body, from between knee and waist height, without twisting * Lighter weight shingle bundles (less shingles per bundle) (not currently available – see Appendix 3 of this report) |

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| | | |
|--|---|---|
| <p>Job site <u>manual</u> unloading/moving of window assemblies, or other heavy/large items Manual handling of heavy/awkward materials (e.g., windows, door frames)</p> <p>(All objects > 90 lbs.)</p> <p>(Heavy objects < 90 lbs. may be included here, if lifted frequently, from awkward positions, or with twisting)</p> <p>(See Ergo Rule, Appx B: Heavy, Frequent or Awkward Lifting)</p> | <p>Lifting (heavy, frequent, awkward), with or without twisting</p> | <ul style="list-style-type: none"> * Use mechanical lifts to move heavy items, where available (truck-mounted lifts, forklifts) * Slide heavy items off delivery truck, rather than lift. Consider using rails. * Use two or more workers to lift heavier items (when manual lifting required) * Use good lifting practices (e.g., lift close to body, start lift at knee to waist height wherever possible, slide rather than lift wherever possible) * Use carts, to reduce lifting and carrying (where appropriate) |
|--|---|---|

* See Ergonomics Rule for specific Caution Zone and hazard limits associated with these risk factors

Lifting of heavy window assemblies, door frames, and other similar items

Window assemblies (and other larger/heavier items) that are lifted off of supplier trucks at the warehouse, stored/moved within the warehouse, loaded onto delivery trucks at the warehouse, and unloaded at job sites are a potential lifting hazard, due to the size and weight of the windows (larger window assemblies weigh over 90 lbs.)

Lifting of heavier window assemblies should be performed in ways that do not exceed the lifting limits specified in the Ergonomics Rule:

* Caution Zone lifting limits (per worker): 75 lbs once per day a day, or 55 lbs more than 10 times per day

* Hazard level lifting limits (per worker): 90 lbs under ideal conditions (lifting infrequently, hand position at the start of the lift is close to the body between knee and waist height). Less ideal lifting (higher frequency, hand positions at the start of the lift below the knees or above the waist, or twisting while lifting, reduces the lifting limit (per worker) to less than 90 lbs. (See the one page: “Heavy, Frequent or Awkward Lifting” criteria in Appendix B of the Ergonomics Rule, for specific lifting limits.)

Thus even under the most ideal lifting conditions described above (which may not be present for a given lifting scenario), window assemblies weighing over 90 lbs should be lifted mechanically, lifted with two or more persons, or slid rather than lifted. Window assemblies weighing 90 lbs or less, should be reviewed to see if the lifting limits are being exceeded.

Other Significant Activities

Design of the warehouse layout

The design of warehouse layout is important for reducing potential exposures to WMSD hazards, as well as for enhancing overall productivity. A storage layout that includes ready access to palletized product by both workers and mechanized equipment can reduce redundant or awkward worker handling of product, including a reduction in the need for lifting and carrying.

Good housekeeping

Good housekeeping in the warehouse environment reduces potential for injury from ergonomics and safety-related hazards such as trips and falls, redundant motions and awkward postures while lifting. Keeping warehouse work areas such as aisleways, storage areas, picking areas and shipping docks free of obstacles reduces hazards and increases productivity.

Conclusions

Distribution of roofing materials is performed using forklifts and pallet jacks for moving bulk quantities of materials, with limited amounts of manual material handling required. Worker manual handling of materials occurs primarily during warehouse order picking, where customer orders are assembled on pallets for subsequent shipping, and during job site roof stocking.

Potentially hazardous exposures encountered during warehouse order picking are significantly reduced by such means as:

- a) Use of mechanical material handling equipment such as forklifts, pallet jack, and boom trucks, wherever feasible
- b) Training on low risk means of equipment operation and product handling
- c) Warehouse layout and good housekeeping that provides ready access to materials
- d) Starting manual lifting close to the body, from between knee and waist height, without twisting, wherever possible
- e) Lifting heavier window assemblies, sliding doors, or other large, heavy materials, mechanically, or with two or more workers, or by sliding where possible
- f) Task rotation (e.g., rotate forklift driver and order picker when two-worker teams are used for picking materials in a warehouse, or if a picker works alone then rotate tasks between picking and other tasks such as labeling materials, completing paperwork, performing other tasks) (e.g., rotate bottom man and top man while stocking shingle bundles on a roof top)

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Potentially hazardous exposures encountered during roof stocking (as well as other work site activities) are significantly reduced by such means as:

- a) Use of mechanical material handling equipment such as boom trucks, to reduce or eliminate manual stocking of roofs
- b) Training on low risk means of equipment operation and product handling
- c) Lifting one bundle or roll at a time on and off the conveyor
- d) Starting manual lifting close to the body, from between knee and waist height, without twisting, wherever possible
- e) Lifting heavier window assemblies, sliding doors, or other large, heavy materials, with two or more workers
- f) Job rotation (rotate bottom man and top man)

The company plans to continue training and enforcement of equipment use and work procedures that reduce exposures to possible WMSD hazards.

Appendix 1

Shingle Bundle Lifting Limits – Conveyor Stocking

(calculated using the Washington State Ergonomics Rule, Appendix B)

Roofing shingle bundles stocked by Allied Roofing range from 65-80 lbs., with most products in the 68-73 lb range.

75% of the shingle bundles stocked are 30-year shingles, weighing approximately 72 lbs per bundle.

Using the Washington State Ergonomics Rule, Appendix B one page lifting limit calculator to identify the lifting limit for stocking shingle bundles, the following lifting limits were calculated, based on the following site observations and conditions:

Bottom Man

Lifting Conditions:

1. Total time per day a worker is actively lifting bundles while stocking: 1-2 hrs (total) per workday
2. Starting position of hands when lifting bundles: Between knee and waist height
3. Bundles lifted per minute: 2-3 lifts/min (every 20 to 30 seconds), or 4-5 lifts/minute (every 12-15 seconds)
4. Worker does not “twist more than 45 degrees” while lifting

Lifting Limit Calculated (2-3 lifts per minute) (a lift every 20 to 30 seconds): **76.5 lbs**
(Not a hazard, since most shingle bundles weigh approximately **72 lbs.**)

Lifting Limit Calculated (4-5 lifts per minute) (a lift every 12 to 15 seconds): **63 lbs**
(Hazard, since most shingle bundles weigh approximately **72 lbs.**)

Bottom Man lifting methods

The above calculation describes lifting of shingle bundles by the **bottom man**.

The lifting limit is calculated for the “most commonly performed lift”. It appears reasonable to assume that the most common lift for the bottom man starts at a location between knee and waist height, as described by the following:

Bundles are lifted from the top, middle, and bottom locations of the pallet.

- Top of Pallet: (bundles at waist-to-shoulder height on the pallet) – bundle are slid towards the worker over the edge of the stack and then fully supported around waist height as it drops down and is “lifted” (the bundle angling downward over the edge of the stack and the average location of the two hands when the bundle is finally supported make it even more so)

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- Middle of Pallet – Bundles are slid towards worker to the edge of the stack and then lifted at approximately knee to waist height, with the bundle approximately horizontal at the start of the lift
- Bottom of Pallet (bundles below knee height) – worker tips a bundle up and then lifts it from about knee height

Counts as two lifts:

1st lift: Bundle tipped upright ($\frac{1}{2}$ weight of bundle) – from below the knee level

2nd lift: Bundle lifted off ground (full weight of bundle) – from foot level (below knee level) if lifted vertically, or from knee to waist level if bundle is tipped over the knee before it is lifted

Top Man

For the **top man** lifting a bundle off the top end of the conveyor, it appears that most lifting is done close to the body, at about waist height (calculated as lifting starting from knee to waist height). The calculated bundle weight lifting limits are thus the same as for the bottom man.

Appendix 2

Stocking Bundles using an Articulated Boom Crane

(preliminary analysis – not observed on-site)

(This information was derived from analysis of rooftop stocking done with a boom crane shown on the L&I instructional videotape: “Moving Rooftop Materials Safely”, developed by L&I and Allied Roofing.)

Stocking bundles with an **articulated boom crane** (as opposed to using a powered conveyor), where a pallet of shingle bundles is suspended above the roof and unloaded by the roof top worker, was not formally evaluated as part of this demonstration project report. It is suggested that the shingle bundle lifting associated with use of this equipment should be viewed on-site and analyzed in a manner similar to the analysis performed for the powered conveyor. *Preliminary analysis* of the use of an articulated boom crane (as compared to use of a powered conveyor) for roof top stocking indicates the following:

- Bottom man lifting is eliminated (the bottom man operates the boom crane – transferring pallet loads of shingle bundles mechanically to the the roof top, rather than manually loaded individual bundles onto a conveyor)
- Top man lifting occurs over less total time per day, since the complete pallet load of bundles is lifted to the roof top and is continuously available for unloading. The roof top pallet location may also be moved occasionally during the unloading process to “follow” the top man – this would also increase the top man’s lifting rate as less carrying would be required.
- Top man lifting occurs at a higher frequency rate (# lifts/min) compared to conveyor unloading – due to the continuous availability of bundles to the top man

Lifting Conditions (estimated):

1. Total time per day a worker is actively lifting bundles while stocking: 1-2 hrs (total) per workday
(the time for unloading is less than for conveyor use, but appears likely to be approximately 1-2 hrs/day)
2. Starting position of hands when lifting bundles: Between knee and waist height
3. Bundles lifted per minute: 4-5 lifts/minute (every 12-15 seconds), or 6-7 seconds (every 8 to 10 seconds)
Videotape observation of lifting rate: as frequently as every 5 sec during times the worker is squatting next to a pallet and unloading bundles at the bottom of the pallet load, and every 10 seconds where standing up and walking back and forth to the pallet to unload it. This was observed when the fork tips under the pallet were positioned to be lightly touching the roof and thus the pallet load is not freely rotating. Additional time was observed in cases where the pallet was suspended completely off the roof (freely rotating) and thus needed to be aligned before removing each bundle.
4. Workers in general do not appear to “twist more than 45 degrees” while lifting when the suspended pallet is positioned so that they are walking back and forth to

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the pallet load. The worker may be twisting, however, while squatting down next to a pallet removing lower level bundles from the pallet.

Lifting Limit Calculated (estimated)

*(4-5 lifts per minute) (a lift every 12 to 15 seconds): **63 lbs***

*(Hazard, since most shingle bundles are approximately **72 lbs.**)*

Lifting Limit Calculated (estimated)

*(6-7 lifts per minute) (a lift every 8 to 10 seconds): **45 lbs***

*(Hazard, since most shingle bundles are approximately **72 lbs.**)*

From the preliminary analysis, it appears that when using an articulated boom crane, the roof top worker typically lifts bundles off the suspended pallet at a higher rate than when unloading from a powered conveyor. This higher lifting rate significantly exceeds the 2-3 bundles per minute (calculated maximum lifting rate for 72 lb bundles) that would be compliant with the Ergonomics Rule as shown below:

Lifting Limit Calculated (estimated)

*(2-3 lifts per minute) (a lift every 20 to 30 seconds): **76.5 lbs***

*(Not a hazard, since most shingle bundles are approximately **72 lbs.**)*

Further analysis is suggested. Rooftop stocking of bundles using an articulated boom crane only exposes one worker (the top man) to lifting – lifting for the bottom man is eliminated. The lifting rate for the top man, however, appears to be somewhat increased.

Appendix 3

Lighter Weight Shingle Bundles

(possible future risk reduction idea)

L&I is currently working with a roofing materials manufacturer and roofing materials distributor to test out roof top stocking of lighter weight shingle bundles (wrapping twelve 30-yr composition shingles in a bundle weighing 54 pounds instead of the traditional sixteen shingle bundles, which weigh 72 pounds).

The test will analyze lifting and handling of the bundles, as well as overall roof top stocking time. Worker stocking of the two different types of bundles will be compared. A small number of pallet loads of the lighter weight shingle bundles have been custom wrapped for the purposes of this project – scheduled to take place in early 2003. Worker opinions on any perceived advantages or disadvantages of the lighter weight bundles will be collected. The Ergonomics Rule lifting limits calculator will be used to evaluate lifting of the lighter weight bundles. It is possible that the lighter weight bundles may be a useful risk reduction option for future roof top stocking applications.

Calculations in the main body of this report showed that for (typical) 72 lb weight shingle bundles, the compliance with the Ergonomics Rule depended on the frequency (rate) of lifting when loading/unloading the conveyor:

Lifting Limit Calculated (estimated)

(4-5 lifts per minute) (a lift every 12 to 15 seconds): 63 lbs

(Not a Hazard, since most 12-shingle bundles would weigh approximately 54 lbs.)

Lifting Limit Calculated (estimated)

(6-7 lifts per minute) (a lift every 8 to 10 seconds): 45 lbs

(Hazard, since most 12-shingle bundles would weigh approximately 54 lbs.)

It is seen from these results that reducing the weight of the bundles from approximately 72 lbs to something less (for example: $12/16 \times 72 \text{ lbs} = 54 \text{ lbs}$), then 4-5 lifts per minute is compliant, and 6-7 lifts/min is close to compliant, but not compliant.

(Note: With the traditional weight bundles, 2-3 lifts/min was compliant, and 4-5 lifts/min was not).

The lighter weight bundle test may find that the lighter weight bundles may be lifted more quickly (more lifts/min) – any such changes will be factored into the lifting limit calculations.

The results of the lighter weight bundle test will be used to evaluate their possible feasibility for roof top stocking.