

ERGONOMICS DEMONSTRATION PROJECT

Update

# Residential Construction

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## Musculoskeletal Injury Risks and Mitigation in Residential Construction: Ergonomics Demonstration Project Preliminary Results

### Introduction and Background

This ergonomics demonstration project in residential construction, was conducted by the Field Research and Consultation Group of the Department of Environmental Health at the University of Washington. This summary details specific findings from the project. A subsequent final report will provide additional details and clarification.

Exposure assessments were performed by ergonomist observation in the field for house framers, carpet installers and hardwood floor installers. A total of six framing crews, one carpet-laying crew, and one hardwood floor installer were observed as part of the project. The contractors participating generally build different styles of two-story wood frame house construction. Possible solutions to mitigate Hazard Zone risk factors based on the Ergonomic Rule were developed by informal discussion with workers and contractors as well as research into tool options and alternative construction methods.

Evaluation of risk factors was conducted by using a work sampling method called PATH (Posture, Activity, Tools and Handling) developed by Buchholz et al. (1996). Using this method, postures and activities were recorded once a minute during observations of the different crews. Eleven observation sessions of two to three hours were conducted at random times. More than 3300 observations of 23 residential framers on three different sites were taken to arrive at estimates of exposure. One crew of three carpet installers was observed for a total of 480 samples. Exposure for one hardwood floor installer was assessed by 254 observations. The resulting estimated error due to work sampling was less than 3% for flooring installation and less than 1% for framing. This level of analysis was conducted for the purposes of the demonstration project and would not be expected of employers wanting to conduct their own hazard analysis.

Exposure assessment confirmed that workers in each of the three trades -- residential framing, carpet installation and hardwood floor installation -- would be in the Caution Zone, as defined by the Ergonomics Rule. Caution Zone levels of 2 hours per day for bent back postures of 30 degrees or greater, and for repetitive hand motions were exceeded by each of the trades. Heavy, frequent or awkward lifting was also a likely Caution Zone risk factor, either by lifting materials weighing 75 lbs or more once per day or material weighing 55 lbs or more 10 times per day. These results were expected and would require employers to provide ergonomics awareness education for workers in these trades. However, caution zone jobs are not prohibited and no changes need to be made to the jobs unless further analysis reveals that they include WMSD hazards as defined by the Ergonomics Rule.

Work sampling during different activities evaluated the presence or absence of Hazard Zone risk factors -- those exposures that would require employers to modify the job, work organization or tools. Any Hazard Zone risk factor must be reduced to below the Hazard Zone level or to the degree technologically or economically feasible. Hazard reduction may be done first through either administrative controls such as rotating workers between tasks or by engineering modifications such as new tools. If neither of these options proves feasible, then work methods training and/or personal protective equipment must be given to reduce risk factor levels.

## Residential Framing Hazard Zone Risk Factors and Solutions

The findings of this project documented two possible Hazard Zone risk factors to which residential framers may be exposed during regular work. Three possible Hazard Zone risk factors were found in carpet installation and one Hazard Zone risk factor in hardwood floor installation. Residential framers were exposed to back bending greater than 45 degrees for more than 2 hours during wall building and floor deck installation. However, floor deck installation was not observed being performed more than once per week by the crews, and thus did not qualify as a Hazard Zone task under the Ergonomics Rule. Framers were exposed to heavy lifting greater than 90 lbs when lifting header beams, trusses, and wall sections. Lifting of heavy material may also present an exposure above Hazard Zone levels if workers attempt to lift too much material at a time and in an awkward manner.

Solution options of very low cost were found that would address each of these risk factors for residential framers. Use of fastener tools with handle extensions costing \$100 or less was identified along with job rotation as possible easy solutions for reducing back bending during floor deck installation. Figure 1 shows the use of a glue gun extension handle compared to the current task. Wall building likely presents a longer exposure and fewer options for risk factor reduction were identified. Raising the working height by using sawhorses and job rotation are possible options, though other construction methods should be investigated. Heavy lifting can be reduced relatively easily by using boom trucks, powered lifts, hand-crank lifts, jacks, pneumatic lifters, and team lifting. An example of using crank lifts to place a beam is shown in figure 2. The Hazard Zone risk factors and possible solutions identified in the project are summarized in table 1. Estimated costs for equipment refers to a one day rental rate.

Table 1. Potential Hazard Zone Risk Factors and Preliminary Mitigating Solutions for Residential Framing

Task	Possible Hazard Zone Risk Factor	Mitigation Options	Estimated Cost
Floor Deck Installation (likely not more than once per week)	Back Bent > 45 Deg. More Than 2 hrs	Use of a screwgun or nailgun with handle extension	\$100
		Use of a glue gun with handle extension	\$60
		Rotate to different tasks during the day if possible	N/A
Wall Building	Back Bent > 45 Deg. More Than 2 hrs	Use sawhorses for cutting material	N/A
		Training to alternate body postures and activities	N/A
		Rotate to different tasks during the day if possible	N/A
<u>Specific Lifting Tasks:</u>			
Lifting/Placing Header Beams	Heavy Lifting (> 90 lbs)	Use a boom truck to lift and position beam	\$150
		Deliver beam near final location and use a crank/power lift	\$20-\$50
		Deliver beam into sawhorses, lift with 3-4 workers in contact with beam at all times	N/A
Lifting Trusses and Sheeted End Gables	Heavy Lifting (> 90 lbs)	Use a boom truck to lift and position truss	\$150
		Use a powered lift or jack past shoulders, then walk up	\$50
Lifting Wall Sections	Heavy Lifting (> 90 lbs)	Use wall jacks or pneumatic lifter	\$50
		Use a boom truck for wall sections > 10 ft tall	\$150
		Team lift interior (non-sheeted) walls	N/A
Lifting Material	Heavy Lifting (> 70 lbs from ground or > 90 lbs knee to waist level)	Limit lifting of material (one plywood sheet, 2 10' 4x4s, 3 10' 2x6s etc.)	N/A
		Train on proper lifting (walk-up loads from ground, keep close to body, avoid twisting)	N/A



**Figure 1.** Gluing joists during deck installation (left) can contribute to the amount of back bending. The modification (right) uses commercially available extended gun (\$50 retail). A handle was added to the gun to reduce hand/wrist fatigue (<\$10 for parts). Job times were the same between two methods. Handle extensions are also widely available for nail gun and screw guns with auto-feed.



**Figure 2.** The traditional method for lifting beams weighing 500-800 lbs is shown on the left. Using crane lifts to lift and position beam, eliminating the Hazard Zone lifting risk factor, is shown on the right. Equipment rental cost was \$88 for two lifts.

## Carpet Installation Hazard Zone Risk Factors and Solutions

Carpet Installation had three probable Hazard Zone risk factors. Kneeling more than 4 hours was observed while installing task strips and carpet padding if done all day, which was not normal for the observed installation crew. Knee impact more than once/minute for more than 2 hours per day was observed while installing carpet using a knee kicker. Heavy lifting greater than 90 lbs is possible when moving rolls of carpet. Back bending greater than 30 degrees for more than 4 hours would also be present if tack strip installation was performed regularly all day, though this is not likely the case. Workers should be provided with appropriate training to alternate body postures, and rotate tasks to reduce exposure to kneeling risks. Knee pads should also be provided, though this does not reduce exposure to kneeling. Knee impact may be easily reduced by using a carpet stretcher and only using a kicker when necessary at walls or other areas. Heavy lifting of the carpet rolls can be eliminated by attaching the roll to a fixed point and then moving the truck. The carpet can then be pushed to a location where it can be cut into room-size pieces for installation. Other heavy items such as tools and equipment can be moved either with a handtruck or by team lifting.

## Hardwood Floor Installation Hazard Zone Risk Factors and Solutions

Hardwood floor installation had back bending greater than 30 degrees more than 4 hours and bending greater than 45 degrees more than 2 hours as a Hazard Zone risk factor. As a single person frequently does this activity, job rotation options may often be limited. Workers can be trained to alternate body postures, plan work to break up back bending, and take frequent mini-breaks to reduce exposure to this risk factor. Table 2 summarizes the Hazard Zone risk factors and identified solutions documented in the demonstration project.

**Table 2.** Potential Hazard Zone Risk Factors and Preliminary Mitigating Solutions for Carpet and Hardwood Floor Installation

Task	Possible Hazard Zone Risk Factor	Mitigation Options	Estimated Cost
Installing Tack Strips	Back Bent > 30 Deg. More Than 4 hrs	Rotate workers/tasks if performed for entire day	N/A
	Kneeling More Than 4 hrs	Training to alternate body postures and activities	N/A
		Rotate workers/tasks if performed more than half the day Provide and enforce use of knee pads	N/A \$30
Installing Carpet Padding	Kneeling More Than 4 hrs	Training to alternate body postures and activities	N/A
		Rotate workers/tasks if performed for entire day	N/A
		Provide and enforce use of knee pads	\$30
Installing Carpet	Knee Impact > Once/min More Than 2 hrs	Use a carpet stretcher, only use kicker when necessary	N/A
	Heavy Lifting (> 90 lbs)	Attach a sling to carpet roll, secure to point near drive or garage, and drive van away to pull out	N/A
		Push carpet roll, cut carpeting to room size in garage or driveway Use two people or handtruck if equipment is too heavy	N/A N/A
Hardwood Floor Installation	Back Bent > 45 Deg. More Than 2 hrs and	Training to alternate body postures and activities	N/A
	Back Bent > 30 Deg. More Than 4 hrs	Training to take frequent mini-breaks to stretch muscles	N/A

## Conclusion

Residential construction provides challenges in injury reduction due to the small size of crews, smaller amount of resources compared to commercial construction, and sometimes less frequent supervision of activities. However, low-cost solutions of less than \$200 do exist that can help reduce the Hazard Zone risk factors. Several jobs, such as wall building and hardwood floor installation, may have Hazard Zone risk factors that still exist after solution implementation. These tasks may need to be evaluated further for solution development and feasibility determination. Further work in this area should lead to additional improvements and a reduction in exposures to risk factors of injury.

## Reference

Buchholz B, Paquet V, Punnett L, Lee D and Moir S, (1996), "PATH: A Work Sampling-Based Approach to Ergonomic Job Analysis for Construction and Other Non-repetitive Work", *Applied Ergonomics*, 27(3), p 177.