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Implementation of Safety and Health on Construction Sites

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Hazard surveillance in new residential construction

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ABSTRACT: Construction workers suffer elevated disease and death rates. However, with the exception of lead and asbestos, little exposure data among this population have been documented. With this in mind, an observational study aimed at identifying the potential hazards associated with each phase of construction was conducted. Each phase consisted of multiple tasks, each with its own potential for exposure. Observations were made by an industrial hygienist (IH) who visited four different residential construction sites and observed and documented specific work practices and recorded all chemical substances used during each task. The information gathered and examined during this study indicate that a substantial potential for exposure to hazardous agents exists for some workers involved in building a new home. In general, a lack of appropriate/effective personal protective equipment was noted for all trades. Potential ergonomic hazards were noted for 63% of the trades observed. Other hazards associated with different trades are presented in Table 1.

1 INTRODUCTION

Estimates of the number of workers employed in the construction industry range from 6-8 million (BLS 1997). However, these estimates include all workers for many different types of construction. Of particular interest is the new residential construction industry (Standard Industrial Classification (SIC) Code 1521). This interest stems from the fact that virtually no exposure data exists for workers in this sector of the construction industry. According to the Bureau of Labor Statistics (BLS), the construction industry leads all other industries in the number of occupational injuries and illnesses (BLS 1993; Zimmerman, et.al. 1997). The average employment in the residential building construction industry (SIC 1521) in 1995 was 608,600 with an incidence rate of 8.6 total cases of occupational injuries and illnesses (BLS, 1993). These rates were based on logs recorded by employers and are probably influenced by changes in economic activity, working conditions and work practices, worker experience and training, and the number of hours worked. In the past, research to identify occupational hazards associated with construction work has been conducted primarily in the "general" construction sector of this diverse industry. However, workers involved in residential construction have historically been understudied. This may be due, in part, to the fact that most of the residential construction work is often performed by small subcontractors who employ non-union workers. BLS surveillance data suggest that smaller contractors have greater fatal injury rates but lower nonfatal rates when compared to larger contractors (BLS 1993). Since small contractors who often do not have health/safety or monitoring programs comprise a large portion of all contractors engaged in residential construction, the need for

hazard identification and task-based exposure assessment studies specific to this industry becomes very clear.

According to the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA), the number one reason for a citation at a construction site was the failure to have a written hazard communication program (OSHA 1997). Other violations frequently cited by OSHA include; lack of adequate fall protection (45%), electrical (20%), and scaffolding (15%). Overall, OSHA citations are more aligned with safety issues than health issues. To further support this trend, an analysis of the OSHA citation data available for construction indicated that health-related citations account for only 4% of the top 100 citations (OSHA 1997). Recently, a pilot program called HomeSafe was initiated in the Denver, CO area in response to 7 deaths that occurred in residential construction. This program focuses on a 10 point list of potential significant hazards on residential construction sites with the ultimate goal of educating workers and reducing injury rates (Gilkey et.al. 1998; Fowler 1997).

Each phase of construction usually consists of multiple tasks, each with its own potential for exposure. Therefore, adopting a task-based exposure assessment strategy is necessary to properly characterize exposure (Susi and Schneider 1995). The purpose of the preliminary study presented here was to identify potentially hazardous physical and chemical exposures among workers involved in the construction of new residential dwellings. The general phases of residential construction observed and evaluated were: excavation, foundation pouring, framing/carpentry, roofing, plumbing, electrical, drywall, painting, interior finishing, and carpet/flooring.

2 METHODS

This study involved the use of a qualitative exposure assessment method (observational) which consisted of an IH visiting four different home sites during various phases of construction. The construction sites consisted of different types of homes (single level and two story). A field data sheet (survey instrument) was developed for the purpose of recording observations of work practices and other qualitative data during the site visits. The survey instrument allowed the collection of information pertaining to a specific phase of construction, self-reported job description, actual tasks performed, and the potential chemical and physical exposures. Once on site, the IH observed workers engaging in their normal job tasks and recorded all products used during each task. Later, information about the materials used was collected from Material Safety Data Sheets.

3 RESULTS

A total of 30 different tasks involving 19 different trades were observed and evaluated for potential exposure to various chemical and physical agents and are briefly outlined here. Table 1 serves as a job-potential exposure matrix according to a given trade. The main potential hazards associated with operators of excavation machinery (e.g. bulldozer, backhoe) for the excavation phase of construction were: vibration, noise and exposure to diesel exhaust. The foundation pouring phase included the pouring of footers, foundation walls, damp proofing the concrete walls, rough plumbing, back fill, and pouring of interior concrete floors. The potential exposures for concrete technicians included ergonomic (awkward bending, pulling concrete), dermal (Portland cement), and respiratory (asphalt emulsion, concrete curing product). The plumbers installing the underground rough plumbing were potentially exposed to the chemicals used to clean and seal the joints of the PVC piping (Methyl ethyl

Table 1: Potential Exposure Hazards Associated with Residential Construction Trades

POTENTIAL	RESIDENTIAL CONSTRUCTION TRADES																		
	EARLY PHASE					MID-PHASE				FINAL PHASE									
	Bulldozer/backhoe	Concrete	Damp-roofing	Plumber	Carpenter (Frame)	Carpenter (Trim)	Roofer	HVAC	Electrician	Drywall Hanger	Drywall Finisher	Insulator	Painter	Siding Applicator	Ceiling Applicator	Mason	Floor Prep Tech	Floor Installer	Carpet Installer
Ergonomic	X	X	X	X	X	X	X	X	X	X	X	X						X	X
Noise	X				X														X
Diesel Exhaust	X																		
Portland Cement		X														X		X	
Petroleum Hydrocarbons			X	X															
Mineral Spirits		X	X																
Asphalt			X																
Methyl Ethyl Ketone				X											X				
Acetone			X	X						X									
Tetrahydrofuran			X																
Cyclohexanone			X																
Aromatic Naphtha		X																	X
Calcium Carbonate					X			X	X		X				X	X			
Silica (crystalline)				X	X			X	X					X	X	X	X	X	
Fibrous Glass				X							X							X	
Hexane			X						X										
Toluene			X																X
Wood Dust			X	X													X		
Falls			X	X							X	X							
Cuts/Abrasions						X							X						
Gypsum								X	X						X	X			
Aliphatic Petrol. Distillates												X		X					
Ethylene Glycol												X						X	
Volatile Organic Compounds												X							

ketone, acetone, tetrahydrofuran, cyclohexanone).

The carpentry phase involved both framers and trim carpenters. The potential exposures observed for the framers were ergonomic (hand tool vibration), respiratory (silica from marking chalk, acetone, hexane, toluene from sub-floor adhesive), and a safety issue (lack of fall protection). The potential exposures for the trim carpenters primarily involved respiratory exposure to wood dust. The roofing phase was observed to have the greatest potential for falls. Most of the workers wore a body harness, but were not tied off to the roof safety hook. The rough mechanics phase included the trades of Heating, Ventilation, and Air Conditioning (HVAC), Plumbing, and Electrical. The potential exposures for the HVAC technician were mainly safety issues. The potential for injury due to cuts resulting from contact with the sharp edges of the sheet metal were observed during the formation and installation of intake plenums and duct work.

The rough plumbing phase involved the installation of PVC piping and copper water supply lines. The potential exposures observed for the plumbers were mainly due to chemicals present in the materials used to connect the piping. Potential exposure to agents in the PVC pipe cleaner and cement were discussed earlier. The paste flux used in the connection of copper pipes for the water supply lines contained zinc chloride, ammonium chloride whereas the solder contained tin/copper/silver alloy.

The potential exposure for the electricians were ergonomic; the fine hand manipulation required may increase the potential for repetitive-motion disorders or cumulative trauma disorders (CTD). Insulation of the exterior walls was accomplished by first caulking all joints. The caulking compound, a siliconized acrylic caulk, contained aliphatic petroleum distillates and ethylene glycol. The fiber glass insulation contained fibrous glass wools and phenol formaldehyde urea polymers.

The drywall phase involved the installation of gypsum drywall panels by drywall hangers and the subsequent "finish" process performed by drywall finishers. The drywall hangers' potential exposures were respiratory (gypsum dust, silica) and ergonomic (lifting panels). The drywall finishers applied different joint compounds to achieve a smooth finish on the walls. These workers' potential exposures were dermal (vinyl acetate monomer), respiratory (dust), and ergonomic (overhead sanding).

The painting phase involved potential exposure during the application of caulking compound and paint. The caulking compound, a siliconized acrylic caulk, was discussed earlier. The painters were observed to use their bare fingers to smooth the caulk. Painting in an enclosed room with little or no ventilation could result in exposure to Volatile Organic Compounds (VOC's).

The "finish mechanics" phase included the final stages of electrical and plumbing installations. The potential exposures for the electrician were similar to those identified for the "rough mechanics" electrical phase. The plumbers potential exposures were similar to those identified during the rough plumbing phase except for the connection of the PVC pipes underneath cabinetry, which may increase respiratory exposure to the PVC pipe cleaner and cement. The application of siding, gutters, and brick decor were performed during the exterior finish phase. The siding applicators were exposed to fall hazards (no body harness) and other hazards like cuts to the hands and arms from handling vinyl siding. The gutter applicators were observed to sustain injuries (cuts and abrasions) to the hands and arms while handling the aluminum coil stock used to form the gutters. Also, applicators applied a seam sealer to the joints of the gutter using a caulking gun and smoothed the elastomeric aluminum compound into place with their bare fingers.

The potential dermal and respiratory exposures for the mason laying brick occurred primarily during the preparation and application of the mortar mixture. The mason was observed to dump the powdered masonry cement into a portable mixer where a noticeable cloud of cement dust (silica) was released into his breathing zone.

The flooring/carpeting phase included the preparation of the sub-floor and the installation of resilient flooring, ceramic tile, and carpet. The potential exposure for the worker preparing the sub floor was observed to be respiratory (dust) that was re-suspended during sweeping. The potential exposure for the resilient floor applicator involved dermal and respiratory exposure (toluene, ethanol). The worker installing ceramic tile in the bath and shower area used a "wall base" adhesive containing naphtha and ethylene glycol. The grout used by tile installers contained crystalline silica, Portland cement, and titanium dioxide. Potential respiratory exposure to the dry mix was observed when bags of grout powder was dumped into a mixing vessel. The carpet installer was exposed to primarily ergonomic hazards; most of the tasks were performed while working on the hands and knees. The worker wore knees pads while kneeling to installing carpet. During this task, the knee area was subjected to acute impact force while using a "kicker" to stretch and secure the carpet.

4 SUMMARY AND CONCLUSIONS

There were several advantages and limitations of this observational study. The most important advantage of this study was the opportunity to observe residential construction workers performing their jobs. By observing work practices, valuable information was gathered about specific trades and their potential exposure to various chemical and physical agents. This information will be useful in guiding subsequent exposure assessments. Probably the greatest limitation of this study was the lack of participation by more than one homebuilder. Ideally, observations of construction processes would have been more objective if the study included the participation of more than one homebuilder.

Aside from one worker observed to wear safety glasses, leather gloves and a dust mask, virtually no personal protective equipment (PPE) was observed on-site. Often small contractors do not have the financial resources necessary to procure the appropriate PPE and issue these items to the workers. Based on hazard prevalence, professional judgement and the degree of hazardous product use, potential exposures that warrant quantitative sampling efforts are:

Bulldozer/Backhoe Operators - Noise, Vibration, Diesel exhaust.
Concrete Workers - Naphtha, Mineral spirits, Portland cement.
Asphalt Workers - Petroleum hydrocarbons, Asphalt, Mineral spirits.
Plumbers - Methyl ethyl ketone, Acetone, Tetrahydrofuran, Cyclohexanone.
Drywall Finishers - Total and respirable dust, Hexane, Acetone.
Painters - Ethylene glycol, Volatile Organic Compounds (VOC).
Masons - Dust (during the preparation of Mortar).
Floor Preparation Technicians - Total and respirable dust.
Ceramic Tile Installers - Toluene, Naphtha, Silica (from grout powder).

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