



Construction Chemical Exposures on a New Construction Site

John B. Moran Column Editor , Pam Susi & Scott Schneider

To cite this article: John B. Moran Column Editor , Pam Susi & Scott Schneider (1995) Construction Chemical Exposures on a New Construction Site, Applied Occupational and Environmental Hygiene, 10:2, 100-103, DOI: [10.1080/1047322X.1995.10389289](https://doi.org/10.1080/1047322X.1995.10389289)

To link to this article: <https://doi.org/10.1080/1047322X.1995.10389289>



Published online: 24 Feb 2011.



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John B. Moran, Column Editor

Reported by Pam Susi and Scott Schneider

Introduction

The National Institute for Occupational Safety and Health has documented the presence of at least 77 toxic agents on construction sites.⁽¹⁾ It has also found elevated death rates due to cancer and other diseases among construction workers.⁽²⁾ However, little exposure data for construction workers can be found in the literature. The Center to Protect Workers' Rights (CPWR), with the assistance of the Occupational Health Foundation, investigated exposures associated with construction of a four-story steel structure in suburban Maryland. The project began in April 1991 and was completed in July 1992. The project involved one general contractor and 25 subcontractors. No more than 150 workers were working on the site at any one time. The building now serves as headquarters for the International Association of Machinists and Aerospace Workers.

Methods

A considerable number of brief, intermittent chemical exposures occurred during this project. The transience of such exposures makes accurate characterization difficult. To capture these occurrences, chemical lists were generated which documented the date, craft, process, and potential exposure hazards observed during periodic site walk-throughs. These lists were compiled and included in a CPWR report describing this project.⁽³⁾

Integrated sampling methods were used primarily for processes that occurred over multiple days or weeks of the project. A sampling strategy aimed at capturing task-specific exposures was utilized. In many cases, results are believed to be representative of full-shift exposures, since sampled tasks were performed throughout the duration of the day. The primary sampled exposures were asphalt fumes among roofers and paving crew laborers; mineral wool exposures among insulators, plasterers, and electricians; welding fumes among iron-

workers and steamfitters; dust and quartz exposure among laborers, drywall finishers, terrazzo workers, and plasterers; and solvent exposure among painters, terrazzo workers, carpenters, and roofers.

Results

Mineral Wool

Fireproofing composed of a resin-coated slag/rock wool was sprayed on steel beams and columns in the fall of 1991. Workers from multiple crafts were exposed to these fibers during initial application and when working around insulated surfaces. Workers complained about eye and skin irritation from the fibers. Samples were collected to determine worker exposure to both respirable and total fibers. Exposures to respirable fibers ($>3 \mu\text{m}$ in length and $<3.5 \mu\text{m}$ in diameter) ranged from 0.006 to 0.039 fibers/cc (f/cc) with a geometric mean exposure of 0.020 f/cc ($n = 9$). Exposures to total fibers ranged from 0.016 to 0.062 f/cc with a geometric mean exposure of 0.034 f/cc ($n = 10$). A relatively high percentage of collected fibers were in the respirable size range. Results from monitoring are presented in Table 1.

Asphalt Fumes

During the winter of 1991–1992, roofers were engaged in installing a four-ply built-up roof system on the building. This process involved layering insulation and felt paper with several coats of hot asphalt. Cylinders of asphalt were heated on site in a kettle maintained at approximately 500°F. Liquid asphalt was poured from a spigot at the bottom of the kettle into 5-gallon buckets and carried to mobile mop buckets. Roofers spread hot asphalt with cotton mops.

Personal breathing zone (PBZ) exposures to total particulate and the benzene-soluble fraction of asphalt fumes were collected during January and February 1992. The kettle operator had the highest exposures, which ranged from 10.4 to 28.85 mg/m³ total fume particulate and had a benzene-soluble fraction particulate concentration of 21.8 mg/m³. Other

roofing crew members were sampled while carrying asphalt, mopping, rolling out felt paper, and cutting in insulation. Exposures received during these operations were lower than those received by the kettle operator by two to three orders of magnitude.

Laborers and operating engineers working on asphalt paving crews were also monitored for exposure to total particulate and benzene-soluble particulate. Exposures to total asphalt fume particulate ranged from <0.20 to 0.59 mg/m³ with a geometric mean of 0.34 mg/m³ ($n = 3$). Exposures to the benzene-soluble particulate ranged from <0.05 to 0.29 mg/m³ with a geometric mean of 0.08 mg/m³ ($n = 5$). Results from asphalt sampling are presented in Table 2.

Welding Fumes

Two different crafts were engaged in welding on site over the course of the project: ironworkers and steamfitters. Sheet metal workers also welded duct work in the shop and brought out fabricated modules to the site, but these exposures were not sampled.

Ironworkers who were on the structural steel erection crew were engaged in three different general welding activities:

1. arc welding structural steel columns and beams,
2. arc welding galvanized decking to structural steel, and
3. resistance welding metal studs to galvanized decking.

Exposures were sampled outside the welding hood during each of these processes. Exposures to total welding fume during flux core welding structural steel were 3.78 and 2.63 mg/m³. An exposure to total metal fumes measured during low hydrogen stick welding of structural steel was 6.43 mg/m³. Exposures to metal fumes measured during stick welding galvanized decking to structural steel were 1.59 and 0.807 mg/m³. Zinc exposures associated with these samples were 0.347 and 0.0722 mg/m³, respectively. Resistance welding metal studs to galvanized decking produced a total fume exposure

TABLE 1. PBZ Exposures to Slag/Rock Wool from Thermal Insulation

Task	Craft	Sample Duration	Total f/cc*	Respirable f/cc*	% Respirable
Load hoppers	Plasterer assistant	235	0.049	—	—
Spraying	Plasterer	233	0.062	—	—
Spraying	Plasterer	355	0.039	0.033	84.6
Spraying	Plasterer	250	0.041	0.036	87.8
Spraying	Plasterer	166	0.023	0.017	73.9
Spraying	Plasterer	155	0.034	0.020	82.4
Spraying	Plasterer	150	0.041	0.022	53.7
Spraying	Plasterer	136	0.016	0.006	37.5
Spraying	Plasterer	225	0.034	0.019	55.9
Pushing scaffold	Plasterer assistant	242	0.025	0.011	44.0
Pulling cable	Electrician	240	—	0.039	—

*Time weighted over sample duration.

of 1.97 mg/m³, with a zinc exposure of 0.542 mg/m³.

In November 1991, steamfitters began arc welding carbon steel pipe used to construct the chiller system. Iron and manganese were the principal components of welding fume samples collected during this type of welding. Steamfitters remained on the site throughout the duration of the project, with the bulk of work being completed in April 1992. Exposure monitoring continued throughout this period. The principal metal fume exposures associated with welding carbon steel were iron oxide and manganese fumes. Exposures to iron oxide fumes ranged from 0.52 to 5.29 mg/m³ with a geometric mean of 2.33 mg/m³ and a geometric standard deviation of 2.11 (n

= 9). Exposures to manganese ranged from 0.05 to 0.71 mg/m³ with a geometric mean exposure of 0.14 mg/m³ and a geometric standard deviation of 2.99 (n = 9). Exposures to total fume ranged from 2.52 to 9.18 mg/m³ (n = 2).

Ironworkers returned in the final months of the job to install steel, circular stairs, and hand rails. This involved welding newly painted steel. Low level exposure to lead (<0.019 and 37 µg/m³), in addition to iron (0.108 and 0.535 mg/m³) and manganese (0.011 and 0.027 mg/m³), was measured during this process.

Dusts and Quartz

In April and May 1992, a two-person crew sandblasted low, exterior, concrete

walls of the building. This was done to pit the concrete surfaces to create an appearance similar to the granite sheathing on the exterior panels of the building. We also collected one personal sample from a plasterer working approximately 20 to 30 ft from the blasting operation. There were a number of other dust-generating activities that were sampled during the course of the project, including drywall sanding, cutting concrete paving blocks, jackhammering, chipping concrete, and dry sweeping. Personal exposures during these activities were collected and analyzed for total and respirable dust concentrations. Samples were further analyzed for quartz content. The results of dust sampling are presented in Table 3.

Epoxy Resin

A large quantity (several 55-gallon drums) of epoxy resin was used for terrazzo floors. Smaller amounts were also used in paint systems. The basic steps involved (1) application of a two-part epoxy resin primer, (2) spreading of the terrazzo mixture (marble chips/dust/epoxy resins), and (3) grinding and buffing.

The material safety data sheets (MSDS) for the epoxy resins did not identify the specific hazardous ingredient by chemical name. The manufacturer's initial resistance to releasing this delayed us in identifying an agent-specific sampling method. Only a small number of personal air monitoring samples were collected and analyzed for solvents, epichlorohydrin, and respirable dust. A bulk sample of terrazzo dust captured by the vacuum trap of the buffing machine was analyzed. The bulk analysis indicated that the dust

TABLE 2. PBZ Exposures to Asphalt Fume

Process/Task	Total Fume in mg/m ³ * (Number of Samples)	Benzene Soluble Fraction in mg/m ³ * (Number of Samples)
Roofing/kettle operation	10.4–28.9 (3)	21.8 (1)
Roofing/carrying buckets	—	0.51–1.89 (2)
Roofing/mopping	0.03–3.66 (4)	0.08–0.35 (4)
Roofing/fitting insulation	0.52–0.97 (2)	0.33–0.92 (2)
Paving/adjusting screen elevation	0.20–0.59 (3)	0.04–0.29 (4)
Paving/signaling dump truck	0.16 (1)	—
Paving/spreading	—	0.05 (1)

*Time-weighted average over sample/task duration.

TABLE 3. PBZ Exposures to Dust and Quartz

Task	Exposure	Results in mg/m ³ * (Number of Samples)
Cutting/laying/chipping concrete	Respirable concrete dust	0.86–1.07 (2)
Cutting/laying/tamping concrete	Total concrete dust	1.98–4.89 (5)
Dry sweeping	Total dust	9.35–15.00 (1)
Dry sweeping	Respirable dust	0.89 (1)
Sanding drywall	Respirable gypsum dust	1.77–4.20 (3)
Sanding drywall	Total gypsum dust	25.30–59.74 (2)
Sandblasting	Respirable quartz inside helmet	<0.14–0.20 (4)
Sandblasting	Total quartz inside helmet	<0.05–0.06 (4)
Plastering near sandblasting	Respirable quartz	0.21 (1)
Cutting/chipping concrete	Respirable quartz	0.07–0.34 (2)
Grinding terrazzo	Respirable quartz	0.08 (1)
Cutting/laying/tamping concrete	Total quartz	0.16–0.62 (3)
Sanding drywall	Total quartz	0.23 (1)
Grinding terrazzo	Total quartz	0.07 (1)

*Results represent time-weighted exposures over task/sample duration.

was by percent weight 59.2 percent calcium rich, 1.5 percent quartz [1.0% was <10 μm aerodynamic diameter (AD) and 0.27% was <5 μm AD], 35.1 percent dolomite, 1.1 percent calcium silicates, 0.5 percent feldspar, 0.7 percent muscovite, and 1.9 percent miscellaneous. Personal sampling results indicated relatively low level inhalation exposure to solvents. Arithmetic mean time-weighted average (TWA) exposures were 2.25 ppm for hexane ($n = 3$), 0.18 ppm for heptane ($n = 3$), and <0.039 for epichlorohydrin ($n = 2$).

Discussion

Exposure monitoring is particularly challenging in the construction environment. Being on site at the right time and in the right place can be difficult given the kinetic nature of the construction process and the mobility of work crews. Although there is a planned work schedule, the actual work schedule is driven by weather, materials, and the sequential process of multiple subcontractors and crafts involved in each phase of the job.

Once work crews have been located and the occupational hygienist is prepared to sample, the question of sampling duration must be dealt with. Because of the nonroutine nature of construction work, task duration and frequency may

vary from day to day for many crafts. Full-shift sampling will measure the exposure of a particular worker on a particular day. However, if multiple tasks are performed throughout the shift, or if the task of interest is not performed throughout the work shift, the results may be of limited use in estimating the exposures encountered by the sampled worker on another day. In addition, information on tasks and work practices that are associated with the highest exposures is lost. Such information is essential for maximizing the benefits of control interventions. Sampling over task duration can also be difficult since the task of interest may be punctuated by frequent periods involved in other activities.

Our experience on this site underscores the difficulty in tracking the use of chemicals on a work site. Although multiple crafts worked side by side, there was little coordination among the subcontractors for whom they worked regarding chemical use and exposures. A better system for coordinating and controlling chemical use and exposures on the site is needed. Maintaining a complete and product-specific collection of MSDS is also difficult in construction as products are continuously being delivered or brought on site by multiple contractors who come and go over the project life-

time. On this job, a binder of MSDSs was available, but the MSDSs were not specific to the products used on site.

The principle chemical hazards observed during the course of the year were mineral wool, asphalt fumes, welding fumes, solvents, epoxy resins and dusts, including silica, concrete, and gypsum dust. The highest exposures were asphalt fumes among roofers, with extremely high exposure to kettle operators; total and respirable quartz exposure to laborers, plasterers, cement masons, and terrazzo workers; and total gypsum dust exposures among drywall finishers.

This project provided a glimpse into the complexities of exposure assessment in construction. Each trade has its own characteristic tools and materials which serve as convenient starting points for partitioning potential exposure hazards (e.g., painter/solvent vapors, pipe-fitter/welding fumes). However, on actual sites these divisions are complicated by exposure to in-place materials and exposures to materials used by other crafts.

On this job, the single highest measured exposure to slag/rock wool was received by an electrician pulling cable above the ceiling level approximately 3 months after the insulation had been sprayed on. Similarly, the highest exposure to respirable quartz generated from sandblasting was received by a plasterer working near a sandblasting operation. While the sandblasting crew was equipped with personal protective equipment, the plasterer worked totally unprotected. This exposure is an example of the importance of bystander exposures among construction workers. Job site planning which takes into account downstream exposure hazards and the use of regulated areas would prevent such unnecessary risks to workers.

The episodic nature of exposures in construction causes practical difficulties as well. Exposures may be brief, but very high. Such exposures may be difficult to capture at all. If they are measured, and the usual 8-hour sampling time is used, dangerously high exposure levels can be missed. For example, on this job roofers were responsible for applying a solvent-thinned asphalt waterproofing material to subgrade concrete walls. The configuration of the work space was essentially a narrow concrete trench. Although the roofer spent only a small part of his day performing this work, solvent vapor con-

centrations were high enough to cause dizziness, which he addressed with periodic fresh air breaks. In this case, 8-hour TWA exposure results would be of little help in recognizing a very serious hazard.

Conclusions

Our investigation indicates that there are a number of chemical exposures on new construction sites for which few if any controls are used. Exposure to hazardous particulate such as asphalt fumes, welding fumes, and quartz-bearing dust was observed most often. However, solvent vapors from paints, waterproofing agents, glues, and epoxy resins were also present. There appears to be a general lack of awareness of the health risks associated with these hazards. This is especially true since many of the chemical hazards are "hidden" in dusts, such as concrete and sand, which are not perceived by many workers and contractors to be hazardous.

The study helped identify several recommendations for action:

- Hazard identification should be incorporated into the project design phase.
- Site safety and health committees which involve the participation of the general site superintendent, foreman, stewards, and worker representatives from each craft on site should be established.
- Safety and health committee representatives should actively participate in weekly project planning meetings.
- Regulated areas should be utilized to minimize bystander exposure hazards.
- Substantive training on general concepts associated with chemical hazards as well as regular site-specific training should be provided. (Many joint labor/management training programs have found that being able to interpret even a well-written MSDS requires at least 4 hours of quality training.)
- A checkpoint system that requires contractors to register chemicals and an accompanying MSDS sheet as materials come onto the site should be established. This will ensure that each chemical product in use has an MSDS and that the MSDSs on site are specific to the current job.
- Hazard prevention measures should be incorporated into contract specification language.
- Exposure assessment activities should include task-based exposure monitoring for strategic implementation and

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evaluation of engineering and work practice controls.

- Site personnel and job duty time for the coordination and execution of safety and health programs should be included in bid estimates. Safety and health performance should be included as a measurable element of a contractor's job performance.

There are also areas that warrant future research. Because every job in construction is unique, other projects in other geographic regions of the country should be investigated. Exposure assessment activities should occur in a wide variety of construction sectors, including renovation and maintenance projects which involve exposure to hazardous chemicals in use by host facilities or exposure to in-place materials such as lead and asbestos. Applied research aimed at the development, implementation, and evaluation of engineering and work practice control technology should be conducted. Re-

search documenting the economic benefits of investment in safety and health hazard prevention measures is needed as well.

References

1. National Institute for Occupational Safety and Health: The Assessment of Hazards in the Construction Industry—A DSHEFS Project (Preliminary Report). NIOSH, Cincinnati, OH (1990).
2. National Institute for Occupational Safety and Health: Assessment of Excess Mortality in the Construction Industry in the United States, 1984-1986. NIOSH, Cincinnati, OH (1993).
3. Center to Protect Workers' Rights: Final Report: An Investigation of Health Hazards on a New Construction Project. Report No. OSHI-93. CPWR, Washington, DC (April, 1993).

EDITORIAL NOTE: Pam Susi and Scott Schneider are with the Center to Protect Workers' Rights, 111 Massachusetts Avenue, NW, Washington, DC 20001. A copy of the complete report upon which this article is based, Reference 3, may be obtained from the Center at this address.