The City of New York

DEPARTMENT OF HEALTH AND MENTAL HYGIENE

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Environmental Investigation of Chemical Ingredients of Moisture Cure Urethanes Used as Wood Floor Coatings

Environmental & Occupational Disease Epidemiology Program

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I. Introduction

In September of 2002 the New York City Department of Health and Mental Hygiene (DOHMH), Environmental & Occupational Disease Epidemiology Program (EODE) began receiving reports that moisture cure urethanes (MCUs), which are used to coat wood floors in homes, were generating strong odors and raising health concerns for building residents. In response to these concerns, EODE reviewed material safety data sheets on various MCU products, researched the known health effects associated with chemical ingredients of these products, and consulted with the New York State Department of Health. Additionally, EODE, with assistance from the Office for Environmental Investigations (OEI), conducted an inspection during an MCU application at an apartment building in Brooklyn, New York on March 7, 2003, that included sampling for airborne ingredients of MCUs.

Exposure to the chemicals in MCU products can lead to a variety of health effects depending upon the level and duration of exposure. Brief exposures to elevated levels of these materials can result in headaches, respiratory irritation, and exacerbation of asthma; while very high and/or long-term (e.g. lifetime) exposures can lead to more serious health effects such as organ damage, reproductive effects, chemical allergies, and possibly cancer.

Environmental sampling at the Brooklyn apartment building detected several MCU chemical ingredients in the air. These chemicals produced noticeable odors throughout the building. The presence of the chemicals found in the common hallways of the building may result in irritation of the respiratory system, exacerbation of asthma in some individuals, and headaches. In an occupied residential building these conditions represent a nuisance. Based on the limited sampling, the exposures in the building would not be expected to be associated with more severe health symptoms.

DOHMH recommends that adequate ventilation be used during the application and curing of these products so that airborne levels are minimized in occupied or common areas of residential buildings or that an alternative coating material containing less volatile and/or less hazardous ingredients be used. Exposures to workers should be evaluated and appropriate protection should be provided when these materials are used.

II. Background on Polyurethanes and Health Effects

There are many types of polyurethane products used to coat wood floors. In general, the most commonly used types are water-based polyurethanes, oil-based polyurethanes, and moisture curing polyurethanes (also called moisture cure urethanes). Moisture cure urethanes provide high abrasion resistance and are often used on gymnasium and bowling alley floors. MCUs also have good chemical, corrosion, and weather resistant properties making them ideally suited for industrial equipment and steel structures.

All polyurethanes contain volatile chemical solvents and curing agents, and urethane polymers. The volatile materials evaporate into the air during application and curing of the polyurethane product. Limits have been set for occupational exposures to many of the substances in MCUs and potential health effects associated with these levels have been documented. However, air standards for general environmental exposures have not been determined.

Descriptions of the solvents, curing agents and urethane polymers commonly used in MCUs and known health effects associated with exposures are provided below.

Solvents

Moisture cure urethanes contain a variety of solvents depending upon their formulation, and typically contain xylene, ethylbenzene and acetates. Many solvents, including xylene and ethylbenzene, have strong odors that can be smelled at very low levels.[1] Short-term exposure to elevated levels can cause reversible irritation of the skin, eyes, nose, and throat; exacerbate asthma; and cause health effects such as headaches, nausea, and dizziness.[2] In occupational settings and in animal studies, exposure to very high levels of solvents has been shown to cause neurological, kidney, and liver damage, and can impact developing fetuses.[3,4] The International Agency for Research on Cancer (IARC) lists ethylbenzene as a possible human carcinogen. IARC lists xylene as not classifiable as a human cancer agent. **Overall, an exposure to these solvents that is sporadic, short in duration, and of a low level, has not been linked to birth defects or pregnancy complications. Serious or permanent health effects would also not be expected at low levels.** [2,3,4]

Acetates, in general, evaporate more slowly and make up a smaller percentage of the product than the other solvents. There are many types of acetates. The acetate found in the air at the Brooklyn apartment building (ethyl 3-ethoxypropionate) is of low toxicity, but exposures to elevated levels can be irritating to the respiratory system.[5,6]

Curing Agent

MCUs contain isocyanates, typically toluene-diisocyanate (TDI) as a curing agent. This chemical helps create the hardness of the final urethane finish. During application and curing of the liquid MCU, most of the TDI is combined into the polyurethane without becoming airborne. Exposure to elevated levels of TDI in the air can irritate the eyes, nose, throat, and lungs and cause coughing, chest tightness, reactive airways disease, and

shortness of breath. These symptoms can exacerbate asthma. Respiratory sensitization to TDI has been documented to occur in an occupational setting. Once sensitized, subsequent exposures can cause an allergic, asthma-like, response. Skin irritation and, less commonly, skin sensitization can also occur upon direct exposure to TDI.[7] There is no information on the adverse reproductive or developmental effects of TDI in humans or animals (U.S. EPA 1994a). IARC lists TDI as a possible human cancer agent.

Urethane Polymers

The TDI in MCUs reacts with a polyol (urethane polymer or co-polymer) to form the polyurethane finish. Urethane polymers are polyesters and polyethers. The chemical urethane (ethyl carbamate) is not a component of polyurethane products. Like the solvents, there are many kinds of polymers used. The specific polymers used are often trade secrets and may not be listed on product labels or material safety data sheets (MSDS). Urethane polymers are usually viscous and have a low volatility. Since residents do not come into direct contact with the product, exposure to these chemicals is unlikely.

The cured polyurethane product is generally considered to be inert and non-hazardous. In addition to being used in coating surfaces, polyurethane products are commonly used in clothing (e.g., spandex) and foam products (e.g., packing materials, cushions).

III. Inspection at a Brooklyn Apartment Building

EODE was informally notified by a community member that MCU was to be used at an apartment building in Brooklyn in early March. On March 7, 2003, EODE and OEI performed air sampling in the building to determine air levels for the ingredients in Harco Moisture Cure Urethane 3100 (Harco Chemical Coatings, Inc.), the MCU product that was used at the location.

The building is a semi-attached four-story structure and is co-operatively owned. Each floor has one apartment except for the fourth floor, which has two. The basement was unoccupied and is used for storage areas and/or mechanical equipment rooms.

On the day of the inspection, a contractor was applying MCU on the floors of the first floor apartment and one of the fourth floor apartments. DOHMH was denied access to these apartments during the investigation. The contractor reported that approximately 2 gallons of MCU was applied to 600 square feet of flooring in the first floor apartment and approximately a half a gallon of MCU was applied to 150 square feet in the fourth floor apartment.

The contractor began using MCU at approximately 4:15PM and applied the product until approximately 5:45PM. During this period the common hallways and stairwells were heavily ventilated as air moved freely between the open doors on the roof and the main entrance. The contractor left at 6:00PM at which time the doors were closed. It is general practice to close windows and restrict ventilation in the work area during and

after the application of MCU to ensure a proper curing of the product, which takes approximately 24-hours to complete.

Sampling Methods

Area samples were collected for solvents and TDI in four locations: on the first and fourth floors in common hallways/stairwells adjacent to work areas, in a child's bedroom of the third floor apartment, and on the roof to determine outdoor levels.

Solvents

Solvents were sampled using evacuated (Summa®) canisters. Evacuated canisters are metal cans that have been emptied of air to create a vacuum. A valve on the can is opened and the air sample is drawn into the can at a controlled rate. Once the sampling time has elapsed, the valve is closed and the can is sent to the laboratory where the collected air is analyzed. The samples were collected over a one-hour period of time, after the roof and front doors were closed. The solvents in the air samples were analyzed using an Environmental Protection Agency (EPA) standard method (TO-14).

A photo ionization detector (PID) was used to determine total volatile organic compound (VOC) levels, including the MCU solvents, in various locations in the building. The PID can measure the amount of all VOCs combined but cannot distinguish between different chemicals. The instrument is able to provide results instantaneously.

TDI

TDI was sampled and analyzed in accordance with OSHA Method 42 (Occupational Safety and Health Administration). To collect TDI samples, an air pump is used to draw air through a specially treated filter. TDI is collected onto the filters, which are then sent to the laboratory for analysis. Sampling began shortly after MCU application began. Sampling times for the four TDI samples ranged from two to three hours.

Sampling Results

Solvents

Evacuated canister results for xylene and ethyl benzene are shown in Table 1. Levels were much higher in the common hallways outside the work areas than inside the apartment on the third floor.

Table 1: Solvent Levels at an Apartment Building During MCU Application*

	1st Floor Hall	4th Floor Hall	3rd Floor Bedroom
Xylene	44 ppm	53 ppm	2.6 ppm
Ethyl Benzene	30 ppm	35 ppm	1.8 ppm

* All results in parts per million (ppm)

The acetate, ethyl 3-ethoxypropionate was detected in all of the indoor canister samples. The laboratory was unable to determine a numeric level for this chemical, but was able to determine that higher levels were detected in the common areas as compared to the 3rd floor bedroom. Based on the use of acetates in MCU products and the vapor pressure (a

measure of how volatile a chemical is) for this acetate, it is expected that the levels found in each location would be lower than those of the other solvents found.

PID readings for total VOCs in the common areas (after the doors were closed) were approximately 70 parts per million (ppm). Rooftop values were less than 30 parts per *billion* (ppb).

TDI

The levels of TDI in common areas were 0.87 parts per billion (ppb) in the 1st floor hallway and 0.26 ppb in the 4th floor hallway. TDI was not detected in the 3rd floor bedroom or rooftop sample.

IV. Discussion and Conclusions

The odors associated with MCU use at the Brooklyn apartment building were immediately apparent in the common areas of the building and inside the 3rd floor apartment. Air sampling results showed higher levels of xylene and ethyl benzene in the common areas of the building than in the 3rd floor apartment. Additionally, the acetate, ethyl 3-ethoxypropionate, was detected in all three indoor air samples.

No environmental air quality standards exist for the chemicals analyzed in this assessment- xylene, ethylbenzene, acetates and TDI. However, as described above, information from occupational and animal studies does exist on the health effects of these substances.

The airborne solvent levels found in the common hallways of the building may cause irritation of the respiratory system, exacerbation of asthma in some individuals, and headaches. These exposure conditions represent a nuisance in occupied residential buildings. Considering the airborne levels and types of exposures that could occur in the building, more severe health symptoms associated with the chemicals identified in this survey would not be expected.

TDI was detected at low levels in the common areas of the building but not at levels reported to pose health concerns.

It is important to note that these results reflect the relatively short time periods during which sampling occurred and do not provide us with information as to how long or at what levels these chemicals would continue to be present. Moreover, this sampling occurred in only one building. Air levels at different locations where these products are used will vary based on site-specific conditions such as the amount of product used, surface area treated and ventilation.

V. Recommendations

Based on the findings of this investigation, which included review of scientific information on MCU ingredients and the inspection at the Brooklyn apartment building, DOHMH recommends the following:

1. If MCU products are used, ensure increased ventilation and exhaust of solvent vapors and odors during the application and curing processes. If this is not feasible, it is recommended that the use of MCUs be avoided and an alternative product that contains less volatile and/or less hazardous ingredients be used. Safer alternatives should always be considered.

2. Inform residents prior to using MCU products in an occupied building. Information regarding the product to be used, its potential health effects, and the date and times of application should be posted in the building common areas or distributed to residents.

3. Protect workers applying moisture cure urethane coatings. Employers should train workers using MCUs and other chemical materials on health effects and safe work procedures for these materials. It is also recommended that employers conduct exposure assessments for workers applying MCUs, and that workers be properly equipped and trained to use any necessary personal protective equipment.

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[1] American Industrial Hygiene Association, Odor Thresholds for Chemicals with Established Occupational Health Standards. Fairfax, Virginia, 1997.
[2] US Environmental Protection Agency, Integrated Risk Information System, Xylenes. February 2003.
[3] US Department of Health & Human Services, Agency for Toxic Substances and Disease Registry, Toxicological Profile for Xylenes. Atlanta, Georgia, August 1995.
[4] US Department of Health & Human Services, Agency for Toxic Substances and Disease Registry, Toxicological Profile for Ethylbenzene. Atlanta, Georgia, July 1999.
[5] Bisesi, M. "Esters of Mono-and Alkenyl Carboxylic Acids," Patty's Toxicology Volume 6, Bingham E., Editor, John Wiley & Sons, Inc., New York, 2001.
[6] Lewis R., Editor, Sax's Dangerous Properties of Industrial Materials, 10th Edition, John Wiley & Sons, Inc., New York, 2000.
[7] Cohrssen B. "Cyanides and Nitriles," Patty's Toxicology Volume 4, Bingham E., Editor, John Wiley & Sons, Inc., New York, 2001.