

**MERCURY CONTAMINATION
OF POLYURETHANE FLOORING**
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EXECUTIVE SUMMARY

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Polyurethane floors (i.e., “Tartan” or “rubber floors”) have been available for installation in athletic and recreational spaces for the past forty-five years. It is now known that some of these floors contain heavy metals in elevated concentrations, especially mercury. Presence of mercury may be problematic for two reasons: first, mercury vapors can be emitted from these floors, and elevated mercury vapor levels can be dangerous to human health; and second, mercury concentrations in these floors may be sufficient to trigger “hazardous waste” requirements for renovation or demolition work which disturbs such flooring.

It is recommended that building owners inspect their facilities for the presence of polyurethane flooring. In Ohio, these floors should be sampled in accordance with Ohio EPA requirements. If floors are determined to be “hazardous waste,” they should be properly removed and disposed prior to renovation and demolition work that would disturb them. Inspection, sampling, and assessment work should be performed by environmental consultants with specific knowledge and previous experience of such flooring systems.

HISTORIC BACKGROUND

3M Corporation claims to have developed the first synthetic rubber athletic surface (polyurethane flooring or running track) in 1962, under the trade name “Tartan Brand Surfacing.” Since then, rubberized sport surfaces have been manufactured by several companies, including, but not limited to, the following: 3M (Tartan Brand Surfacing), Athletic Polymer Systems, Dynamic Sports Construction (Versaturf), Crossfield Products (Dex-O-Text), Mondo Rubber, Pitzer Inc., Robbins Sport Surfaces (Chem Turf & Pulastic Systems), Selby Battersby & Company,

Surfacing Systems, and Whittaker Synthetic Surfaces (Chemothane). Although no manufacturers report the present use of mercury or other heavy metals in synthetic rubber floor products, it appears that mercury may have been utilized in such flooring systems until 2000.

Polyurethane flooring is manufactured by combining two liquid resins to form a durable, resilient surface. This material can be factory produced in sheets and rolls or installed in situ (as a liquid to level and cure in place). Polyurethane surfaces are generally installed over portland cement concrete substrates in gymnasiums and multipurpose rooms, and over asphaltic concrete substrates for exterior tracks. Thickness of polyurethane flooring ranges from 1/4" to 1" with majority of school floors in Ohio installed to a 3/8" specification.

3M Corporation reports that "Tartan Brand" polyurethane flooring contained several heavy metal salts (often containing mercury, lead, or other heavy metals) as catalysts, pigments, and additives. It also appears that other flooring manufacturers may have used heavy metals in their products. US EPA has published guidance documents noting that "rubber" floors may contain mercury. EPA recommends that these surfaces be sampled and, if found to contain mercury, that proper procedures be implemented for disposal of flooring waste. 3M has alerted building owners with "Tartan Brand Surfaces" of similar concerns and requirements.

Due to vapor pressure of elemental mercury and mercury-containing salts, contaminated polyurethane floors emit mercury vapor at room temperature. On warm days, vapor levels in gymnasiums and multipurpose rooms with mercury-containing floors may reach 1.0 to 5.0 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$), 100 - 500 times ambient air levels. Studies have shown that physical education equipment and porous room furnishings can become contaminated from vapor released by these surfaces.

Although federal regulations promulgate maximum allowable concentrations of mercury vapor in occupational settings (see Work Practices Section below), there are no such regulations for residential or institutional exposures. Agency for Toxic Substances and Disease Registry (ATSCR) typically considers indoor mercury vapor concentrations at or below $1.0 \mu\text{g}/\text{m}^3$ an acceptable level of exposure to airborne mercury in a residential scenario, i.e., 24 hours per day, 7 days per week (ATSDR, 2006). ATSDR further states that exposure to elevated mercury vapor levels (e.g., 10 - $100 \mu\text{g}/\text{m}^3$) over a prolonged time period can cause neurobehavioral effects, including mood changes and tremors (Children's Exposure to Elemental Mercury, CDC & ATSDR, 2009).

Long-term exposure to mercury vapor primarily affects the central nervous system. The term "mad as a hatter," is based on a brain disease that commonly afflicted 19th century hat makers who used liquid mercury to treat animal pelts which were in turn used in the construction of some hats. Early nonspecific symptoms of exposure to elevated levels of mercury vapor include insomnia, forgetfulness, loss of appetite, and mild tremor; these symptoms are often misdiagnosed as psychiatric illness. Continued exposure leads to progressive tremor and memory impairment. Mercury also accumulates in kidney tissues, directly causing renal toxicity.

REGULATORY DISCUSSION

Many polyurethane flooring systems have been in use for 35 to 40 years and are ready for replacement. Removal and replacement of these floors raise several regulatory questions:

- Must such flooring be sampled? And if so, how must this flooring be sampled?
- How do owners remove and dispose of polyurethane flooring materials?

Sampling requirements are outlined in Ohio Administrative Code (OAC) 3745-52-11, "Any person who generates a waste, as defined in OAC 3745-51-02, must determine if that waste is a hazardous waste . . ." Since polyurethane flooring is not a listed waste as defined in OAC 3745-51-30 through 3745-51-35, then the waste generator (i.e., Owner) must either properly test the material per OAC 3745-51-24 or apply previously obtained knowledge regarding the characteristics of the material to determine if such waste would be hazardous. **Based on current knowledge of characteristics of polyurethane flooring, this material has potential to be hazardous; therefore, sampling is required for each unique installation.**

Ohio EPA has further clarified their position concerning sampling of polyurethane flooring prior to renovation or demolition work that would remove this material. There are two possible scenarios for disposal of contaminated flooring materials: 1) during renovation work when flooring is removed and replaced; and 2) during demolition when flooring is removed as entire structure is razed. In each scenario, the waste streams (materials being disposed) are different.

During renovation work (scenario 1), materials being disposed are typically the polyurethane flooring surface and a small fraction (finished surface) of the portland cement or asphaltic concrete substrate, which may have been contaminated by mercury. During building demolition (scenario 2), the waste stream is the debris of the entire building, including polyurethane flooring and the entire concrete or asphaltic substrate.

For purposes of renovation, Ohio EPA has defined the waste stream to include polyurethane flooring material only. For demolition work, waste stream is defined as flooring material and associated substrate. Therefore, to establish the chemical characteristics of each floor encountered, representative samples must be procured and analyzed; and since representative samples are determined by the ultimate waste stream, sample procurement methods depend upon whether or not the flooring will be removed for renovation or demolition work. Based on analytical results, flooring materials are then designated as either construction & demolition debris or hazardous waste.

Materials not exhibiting the characteristics of a hazardous waste may be disposed as non-regulated construction and demolition debris.¹ Materials exhibiting the characteristics of a hazardous waste must be disposed in a facility licensed to process such materials.

¹ Ohio EPA recommends that a lined sanitary landfill (in lieu of an unlined construction & demolition debris landfill) should be used for disposal of flooring materials that contain mercury (but whose mercury TCLP result does not trigger hazardous waste requirements).

BULK SAMPLING OF FLOORING MATERIALS

Collection of representative samples of flooring material is essential to establishment of a material's hazard characteristics. Although a sampling protocol for polyurethane flooring has not yet been published, it is recommended that samples be analyzed for the 8 Resource Conservation and Recovery Act (RCRA) regulated metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) by toxicity characteristic leachate potential (TCLP) per EPA Document SW-846.

Upon analyses and evaluation of samples from flooring, results should be compared to Ohio EPA's requirements for a characteristic leachable waste as noted in OAC 3745-51-24 (Table 1, as shown below). If the sum of average TCLP result and confidence interval exceeds the characteristic level for any of the metals, then the flooring material should be considered a hazardous waste.

Ohio EPA Hazard Limits for Characteristic Wastes of the 8 RCRA Regulated Metals as Listed in OAC 3745-51-24, Table 1

Compound	Regulatory Limit (mg/L)	Hazardous Waste ID No.
Arsenic	5.0	D004
Barium	100.0	D005
Cadmium	1.0	D006
Chromium	5.0	D007
Lead	5.0	D008
Mercury	0.2	D009
Selenium	1.0	D010
Silver	5.0	D011

During the past ten years, bulk samples have been procured from dozens of polyurethane floors in Ohio school facilities. These samples were analyzed to determine if concentrations of any of eight heavy metals exceeded RCRA and OAC levels for hazardous waste. Analytical reports found that over 50% of the floors sampled in these facilities exceeded RCRA/OAC levels for mercury; some of these same floors also exceeded RCRA/OAC standards for one or more of these additional heavy metals: arsenic, barium, lead, selenium and silver. All but one of these floors was reportedly installed between 1970 and 1975; the other floor found to have hazardous concentrations of mercury was installed in 1993.

When polyurethane floors test above the EPA TCLP limit, further testing will be necessary prior to disposal. RCRA Land Disposal Restrictions establish a high-mercury treatment subcategory for waste with total mercury content greater than 260 milligrams per kilogram (mg/kg).

WORK PRACTICES FOR POLYURETHANE FLOORING REMOVAL

The following are typical work practices for removal of polyurethane floors. They are intended as examples only and do not represent the full range of removal techniques available.

Removal of Hazardous Polyurethane Flooring for Renovation

When renovation work involves removal of a polyurethane floor that has been identified as “hazardous waste” by TCLP analyses, flooring removal is accomplished within negative pressure enclosures. Floor finish is scraped from concrete substrate by machine and hand tools, and residual mastics and primers are removed by blasting or grinding techniques acceptable for replacement materials. Substrate is cleaned of all visible debris, and all removed materials, cleaning supplies, and enclosure barriers are placed in an appropriate container (e.g., hazardous materials dumpster) for transportation to a licensed waste processing facility (permitted to accept this type of waste) for disposal.

Removal of Hazardous Polyurethane Flooring for Demolition

When demolition involves removal of a polyurethane floor system that has been identified as “hazardous waste” by TCLP analyses, flooring removal is accomplished within negative pressure enclosures, as noted above for renovation work, and all removed materials, cleaning supplies and enclosure barriers are placed in an appropriate container for transportation to a licensed waste processing facility for disposal. Concrete subfloor and remaining building components are then razed and disposed using typical demolition means and methods.

General Considerations

Unless polyurethane floors are found to not contain mercury, it is recommended that design and administration of renovation and demolition work (which will remove these floors) be performed by firms with environmental engineering experience. Contractors with training and experience in mercury remediation work should perform polyurethane flooring removal.

During the removal of mercury-containing flooring, dusts and vapors will be generated. Exposure of workers, building occupants, and the general public to these dusts and vapors may represent a violation of Occupational Safety and Health Administration (OSHA) regulations if exposure levels exceed permissible exposure limits (PELs) published in 29 CFR 1910.1000 Tables Z-1 and Z-2. The PEL is the maximum allowable concentration at which an unprotected worker may be exposed based on an 8-hour time-weighted average. PELs for substances likely to be encountered in dust and vapor form during flooring removal work are summarized in the Table below.

**OSHA PELs for the 8 RCRA Regulated Materials
as Listed in 20 CFR 1910.1000 Tables Z-1 and Z-2**

Compound	OSHA PEL ($\mu\text{g}/\text{m}^3$)	Exposure
Arsenic	10	Dust
Barium	500	Dust
Cadmium	5	Vapor/Dust
Chromium	500	Dust
Lead	50	Dust
Mercury	100	Vapor/Dust
Selenium	200	Dust
Silver	0.01	Dust

If laboratory sampling indicates the presence of any of these 8 compounds, air sampling must be performed for that compound during removal of the flooring to assure that OSHA PELs are not being exceeded and that workers and the general public are not being exposed. The specific sampling methods and locations should be established and performed by environmental professionals based on the unique qualities of the flooring removal project.

Exposure monitoring (air sampling) can be performed in a variety of ways: stationary or personal sampling pumps which require laboratory analyses of sample media; mercury vapor analyzers which instantaneously measure vapor concentrations; and personal dosimeters which passively collect longer duration mercury vapor samples for laboratory analyses.

Typically, in buildings with mercury contaminated flooring, maximum exposure levels are established for specific building occupancies. The following concentrations are recommended maximum levels for various mercury vapor exposures in school settings.

- ❖ *Polyurethane Flooring Source (Gymnasium, Multipurpose Room or other location)*
 - For remediation work (removal of flooring) **10.0 $\mu\text{g}/\text{m}^3$**
 - For other occupational/commercial work (transient contractors) **3.0 $\mu\text{g}/\text{m}^3$**
 - For all other uses of the space (scholastic, public, etc.) **1.0 $\mu\text{g}/\text{m}^3$**
 - Clearance standard (post-removal testing) **1.0 $\mu\text{g}/\text{m}^3$**
- ❖ *Remainder of facility (without the mercury source)* **1.0 $\mu\text{g}/\text{m}^3$**

COST ESTIMATE FOR POLYURETHANE FLOORING REMOVAL

Costs for removal of mercury-containing polyurethane flooring materials are dependant on the methods used for removal and the resulting disposal fees (hazardous vs. non-hazardous). The cost estimate presented below is based on recent remediation projects in Ohio school facilities.

Renovation Scenario

Cost estimates for removal of mercury-containing flooring prior to renovation work are:

Cost for Flooring Removal	\$10 psf
Disposal Fees (Hazardous Waste)	\$2 psf
Decontamination of Equipment & Furnishings	\$3 psf
Costs for Design, Administration & Testing	<u>\$5 psf</u>

Total Estimated Cost for Polyurethane Flooring Removal \$20 psf

END OF MEMORANDUM

Note that this document has been prepared for guidance purposes only. Although Gandee & Associates, Inc. strives to provide accurate, complete and useful information, this document is not intended to cover all regulatory issues, interpretations or requirements applicable to the subject. Neither Gandee & Associates, Inc. nor any person contributing to the preparation of this document make any warranties, guarantees, or representations (express or implied) with respect to usefulness or effectiveness of information disclosed in this document or assume any liability for the use of or for any damages arising from the use of information disclosed in this document. User should review applicable regulations prior to starting any work which will disturb polyurethane flooring.