Health Consultation

Evaluation of Health Concerns Associated with
Mercury-Containing Polyurethane Gymnasium Floor
in a Milwaukee Public School

Prepared by:
The Wisconsin Department of Health

DECEMBER 16, 2010

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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HEALTH CONSULTATION

Evaluation of Health Concerns Associated with Mercury-Containing Polyurethane Gymnasium Floor in a Milwaukee Public School

Prepared By:

Wisconsin Department of Health Services
Division of Public Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)

Summary and Statement of Issues

Introduction	In November 2009, Milwaukee Public Schools (MPS) requested assistance from the Wisconsin Department of Health Services, Division of Public Health (WDPH), to evaluate potential health concerns associated with mercury-catalyzed polyurethane flooring in the gymnasium (gym) of South Division High School (SDHS), 1515 West Lapham Avenue, City of Milwaukee, Wisconsin. The intent of this health consultation is to characterize and assess the human health implications of elemental mercury vapor levels in the air of the SDHS gym. WDPH reached the following findings regarding the human health implications of mercury-containing polyurethane gym floor at SDHS:
Conclusion 1	WDPH concludes that mercury vapors typically emitted from the floor during the typical activities in the SDHS gym will not harm students or staff.
Basis for Decision	Indoor air screening of the SDHS gym found mercury vapor concentrations below comparison values and levels known to cause adverse health effects among SDHS students and staff.
Conclusion 2	WDPH concludes that breathing mercury vapors during floor cleaning and resurfacing preparation in the SDHS gym is not likely to harm students or staff.
Basis for Decision	Air monitoring inside the resurfacing preparation pilot test structure found mercury vapor levels slightly above an acute inhalation comparison value. However, resurfacing activities inside of the larger SDHS gym are expected to result in lower mercury vapor levels that are below acute and chronic inhalation comparison values and not pose a health concern for students or staff.
Next Steps	When cleaning or resurfacing preparation of the SDHS gym floor MPS can take several measures to further minimize potential mercury releases and exposures. WDPH will continue to assist MPS with assessing the health implications of mercury-containing floors at SDHS and in other buildings throughout the school district.

Background

Mercury-Containing Gym Floors

In the 1960s, a number of companies began manufacturing and installing a thin layer of synthetic, polyurethane flooring on top of concrete sub-floors, to provide a resilient and rubber-like surface. Typically, proprietary liquid polyurethane was poured on top of the sub-floor and organo-mercuric salts were incorporated to catalyze the polymerization/curing process to

produce a solid, rubber-like floor. These polyurethane floors are reported to contain between 0.1 and 0.2 percent total mercury (ATSDR 2006a). Mercury-containing polyurethane floors were widely installed in school gymnasiums across the US, until being discontinued in the mid-1980s amid concerns over their emissions of elemental mercury vapor (NEWMOA 2010). However, many of these floors remain in place today, and recent reports have demonstrated that some emit notable amounts of elemental mercury vapor (ATSDR 2003; 2004; 2006a; 2006b), which has raised questions about inhalation health risks, particularly for children in schools.

Mercury in Floor at SDHS Gym

The polyurethane floor in the SDHS gym was reported by MPS to have been installed in 1976 and was manufactured by Robbins Sport Flooring. November 16, 2009, marked the first meeting at SDHS between staff from WDPH and MPS. The SDHS gym floor was light brown and various colored line markings, some of which appeared to be plastic tape, and others that appeared to have been painted (*Appendix A*). WDPH staff screened the mercury content of the SDHS gym floor using a portable Thermo Scientific Niton X-ray Fluorescence (XRF) analyzer (Table 1), which is capable of simultaneously measuring concentrations of up to 18 metals in solid materials. Mercury concentrations at various unmarked areas of the SDHS gym floor averaged 168 mg/kg (milligrams per kilogram). Mercury levels measured in line markings were marginally higher, averaging 183 in striping tape and 239 mg/kg in paint. In October 2009, MPS removed a small sample of painted flooring and submitted it for bulk analysis, and the laboratory reported a mercury concentration of 190 mg/kg.

Some of these colored line markings apparently contained elevated levels of lead. WDPH screening with the XRF measured average lead levels of 1,693 mg/kg on the unmarked portions of the floor without striping or painting, while lead levels in tape markings averaged 3,298 mg/kg. The highest lead level of 15,510 mg/kg occurred when screening a yellow line/stripe painted on the floor. The lead levels in both the floor and the striping are high enough to be considered lead-based by WDPH ($\geq$ 600 mg/kg), however, the painted and taped markings exhibited no obvious deterioration or flaking, and MPS reported that children under 6 years of age do not regularly visit the gym during normal school hours.

Table 1 – Bulk Mercury and Lead Content of Gym Floor, Striping Tape and Floor Paint
South Division High School, Milwaukee, Wisconsin
November 16, 2009
Concentrations in milligrams per kilogram (mg/kg)

Location	Mercury		Lead	
	Range	Average	Range	Average
Main Floor	151 – 186	168	1,421 – 2,065	1,693
Striping Tape	143 – 213	183	3,156 – 3,563	3,298
Yellow Paint	239	239	15,510	15,510

On November 16, 2009, WDPH staff also screened indoor air of the SDHS gym for elemental mercury vapors using a Lumex of Ohio 916+ Mercury Vapor Meter. When first entering the gym, mercury levels were 104 ng/m^3 (nanograms per cubic meter), and while WDPH staff walked around the perimeter of the gym, adult breathing zone concentrations ranged between 89

and 225 ng/m^3 (nanograms per cubic meter). At several locations close to the floor, air screening revealed similar or slightly higher levels: 153 ng/m^3 at the opening of a cover plate on a sealed pole-vault pit; and 244 ng/m^3 directly above a hole in the floor where a bulk floor sample was previously removed by MPS. The highest mercury vapor levels were measured through a hole in the cover plate that rests on top of an unused long-jump landing pit, with concentrations peaking at 6,591 ng/m^3. During this visit, the gym's heating-ventilation-air conditioning (HVAC) system was running continuously and air temperatures averaged 65ºF.

During the November 16th visit, WDPH and MPS staff discussed worst-case conditions when the off-gassing of mercury vapors from the floor had the greatest potential to accumulate and reach the highest indoor air concentrations inside of the SDHS gym. WDPH and MPS concurred that the highest concentrations of elemental mercury vapor would likely occur when the SDHS facility was not being used for several consecutive days and the gym's HVAC system was turned off, resulting in the fewest indoor/outdoor air exchanges. The approaching Thanksgiving holiday was considered a good opportunity to conduct air screening, because the entire school and gym would not be in use for a 48-hour period. Consequently, MPS staff agreed to deploy a mercury vapor meter with data-logging capacity, to perform air monitoring when people were not using SDHS gym and the HVAC system was not in operation.

On November 25, 2009, the evening prior to the Thanksgiving holiday, MPS deployed a Lumex of Ohio 916-Lite Mercury Vapor Meter (property of WDPH) with data-logging capability in the SDHS gym. The HVAC system was shut down at approximately 5:00 pm on November 25, 2009, and the meter was placed on a table in the center of the gym, approximately 30 inches above the floor. At 7:29 pm the meter was turned on and began measuring and recording mercury vapor concentrations every 10 seconds, and every 20 minutes the meter performed an automatic, internal recalibration. On Friday, November 27, at 12:30 am, data collection was halted after 31 hours. During this monitoring period, indoor air mercury concentrations ranged between 100 and 200 ng/m^3.

Indoor Air Sampling During Floor Resurfacing Preparation Test at SDHS Gym

After screening indoor air mercury levels in the gym, MPS and WDPH staff discussed plans to resurface the older gym floor by applying a new, thin layer of a proprietary liquid polymer that is cured using a non-mercury catalyst. Pouring a new polymer layer on top of the older floor would be expected to seal and encapsulate mercury-containing vapors and dust, avoid the expense of removing and disposing of the old floor as mercury-containing waste, and provide a rejuvenated gym floor. In preparation for installing the new flooring material, the manufacturer recommended cleaning and physically abrading the surface of the older floor to promote a stronger bond with the new, top layer.

The gym floor manufacturer initially recommended resurfacing preparation by physically abrading the older floor by dry scouring with an abrasive floor pad, which raised concerns about generating and dispersing mercury-containing fugitive dust particles into the indoor air. Because of this concern, MPS contacted the manufacturer to discuss alternative surface abrading techniques. The manufacturer recommended wet application of a commercially-available, corrosive alkaline stripping solution, which turned out to be the same product MPS had already been using at SDHS to deep-clean the gym floor on an annual basis. The MSDS for the product (San-A-Care "#104 Rinse Free Stripper") reports a DOT classification of "Corrosive Liquid, Organic, Basic", and the hazardous components include 2-butoxyethanol and

monoethanolamine. The manufacturer recommended applying a 1:10 dilution of the stripping solution to the older floor with a wet mop and waiting 15 minutes before using an electric floor buffer with scrubbing pad to wet abrade the floor. Following chemical abrasion of the gym floor, the stripping liquid is to be removed from the floor by mechanical suction, and rinsed with clean water that is also removed by mechanical suction and discarded as waste.

While use of this stripping solution would minimize and possibly prevent any fugitive dust releases, MPS requested assistance from WDPH for assessing total potential mercury vapor releases to ambient air during chemical abrasion of the older floor. WDPH suggested MPS conduct a resurfacing preparation pilot test inside of a temporary, enclosed structure built within the SDHS gym. The temporary structure would provide a smaller, known surface area to conduct a controlled application of the liquid stripping agent to the existing floor. WDPH reasoned that covering walls and ceiling of the structure with polyethylene plastic to provide a smaller volume of air for screening, minimize the dispersal of potential mercury releases to the larger gym, and represent a worst-case scenario due to minimal air exchanges.

As a result, a 400 ft^2 (square foot) wooden framed structure (20 feet long, 20 feet wide) was constructed in a confined corner of the gym, and represented approximately 1.3% of the total gym floor area. Framed walls 10 feet high were added and sheets of 10 mm thick polyethylene plastic sheeting was stapled onto the wooden frame, with overlaying edges taped together to seal the seams and bottom edges taped to the gym floor (*Appendix A*). This temporary enclosed shelter had an approximate volume of 4,000 ft^3 (cubic feet) (*Appendix B*).

The floor resurfacing preparation pilot test was conducted in the SDHS gym on December 29, 2009. During the pilot test, the 400 ft^2 enclosed area was roughly divided into two halves to make the resurfacing more manageable. WDPH monitored mercury vapor levels at the breathing zone of the enclosed structure before and during the pilot test. Prior to the start of the pilot test, mercury vapor levels in the SDHS gym averaged 79 ng/m^3. The gym's HVAC system had been operating as normal, but the temporary pilot test structure was closed and unventilated for 24-hours preceding the pilot test. Prior to SDHS maintenance staff entering the pilot test structure and applying the stripping agent, WDPH staff screened air inside the enclosed structure and reported average mercury levels of 480 ng/m^3 (*Table 2*). While maintenance staff applied and removed the stripping agent and rinse solutions, WDPH staff remained inside the pilot test structure to monitor elemental mercury vapor levels. Maintenance staff first applied the stripping solution to a 200 ft^2 portion of the floor with a wet mop, waited approximately 15 minutes, and vacuumed the waste liquid from the floor into a holding canister of a mechanical suction device. The floor was then rinsed with water and a wet mop, and vacuumed into the same holding canister. This stripping and rinse process was repeated for the second 200 ft^2 portion of the floor. Overall, the floor resurfacing preparation pilot test was conducted and completed over a period of 97 minutes. Air screening found that mercury levels in air of the containment area rose throughout the test resurfacing, leveling-off around 1,700-1,800 ng/m^3 by the end, with a high value of 1,832 ng/m^3 (*Table 2*).

WDPH raised questions about the potential mercury content of stripping waste liquid and rinse water that were removed by mechanical suction from the floor during the pilot test. Two waste liquid samples of approximately 35 ml were collected from the catchment basin of the wet vacuum and submitted to the Wisconsin State Laboratory of Hygiene (WSLH). Because the water samples included a substantial amount of suspended solids, WSLH, in consultation with

WDPH, filtered one sample and gradually air-dried the filtered solids at room temperature to minimize the evaporation of elemental mercury. This sample was then analyzed for total mercury content using atomic absorption spectroscopy method SW846-7471A (*Appendix C*). The results estimated total mercury in solution at approximately 5.4 mg/L (milligrams per liter). The second sample underwent similar filtration and air drying, but was analyzed for lead by inductively coupled plasma-atomic emission spectrometry (method SW846-6010B). The results estimated lead in solution at approximately 5.6 mg/L. Since the filter media may not have captured lead and mercury dissolved in solution, it is likely that the above results under-report the total lead and mercury in the waste liquid.

Table 2. Adult Breathing Zone Mercury Vapor Levels
SDHS Gym During Floor Resurfacing Preparation Pilot Test
South Division High School, Milwaukee, Wisconsin
December 29, 2009
Concentrations in nanograms per cubic meter (ng/m^3)

Location	Activity Notes	Range (ng/m^3)	Average (ng/m^3)
Main Gymnasium	Baseline in main gym (full ventilation)	74 - 83	79
Enclosed Test Area	Baseline in containment area (no ventilation)	465 - 495	480
Enclosed Test Area	After application of stripping solution (1st half)	537 - 591	564
Enclosed Test Area	During active resurfacing (1st half)	678 - 998	823
Enclosed Test Area	Removal of resurfacing waste liquid (1st half)	1,033 - 1109	1,071
Enclosed Test Area	Water rinse and removal (1st half)	944 - 1,201	1,069
Enclosed Test Area	After application of stripping solution (2nd half)	1,041 - 1,664	1,276
Enclosed Test Area	During active resurfacing (2nd half)	1,544 - 1,832	1,702

Exposure Pathway Analysis

The main exposure pathway associated with the mercury-catalyzed polyurethane floor in the SDHS gym, and identified by WDPH, was the potential inhalation by school maintenance workers, teachers and students, of mercury vapors emitted from the regular daily gym use and when using a chemical abrasive for cleaning the floor or preparing the floor for resurfacing.

Mercury Vapor Inhalation During Regular Use of SDHS Gym

Indoor air screening of the SDHS gym by WDPH staff on November 16, 2009, measured mercury vapor concentrations ranging between 89 and 225 ng/m^3. These mercury vapor concentrations were 10 to 100 times higher than that experienced by WDPH at other cases and as described in the literature as a typical background concentrations in the indoor air of a home or school that has no suspected mercury contamination (Env Sci Tech 2001). However, this mercury vapor level was below chronic (750 ng/m^3) and acute (1,800 ng/m^3) mercury vapor comparison values that were established by the Minnesota Department of Health (MDH) for protecting human health in school gyms, and adopted by WDPH (ATSDR 2006a; discussed further below under "Health Guidance Values for Mercury Exposure in Schools").

Mercury Vapor Inhalation During SDHS Gym Floor Resurfacing Preparation

Air screening during typical SDHS gym use on November 16, 2009, found typical mercury vapor levels apparently emitted from the floor below 300 ng/m^3. This is also below the MDH chronic and acute mercury vapor comparison values for protecting human health in school gyms.

However, it was not known how resurfacing preparation of mercury-catalyzed polyurethane flooring would affect ambient mercury vapor levels inside the gym. Consequently, MPS conducted a pilot test within the enclosed structure to monitor the amount of mercury vapor emitted from the gym floor before, during and after resurfacing preparation activities. The pilot test structure provided 4,000 square foot unventilated space built to simulate worst-case conditions. Following completion of the 97-minute pilot test, airborne mercury concentrations peaked at 1,834 ng/m^3 (Table 2), which was slightly above the 1,800 ng/m^3 acute mercury vapor comparison value.

When floor resurfacing activities are occurring inside of the 763,750 cubic foot gym space gym with a continuously operating HVAC system, mercury vapor levels are not likely to reach 1,800 ng/m^3. The pilot test was intended to create worst-case conditions by conducting abrasion activities inside of the enclosed pilot test structure. During the pilot test the highest measured mercury concentration was 1,834 ng/m^3, which is slightly above the 1,800 ng/m^3 acute comparison value. Owing to the difference in heights, the surface-area-to-volume ratio (SA:V) for the pilot test space was approximately 1:10, compared to 1:25 for the entire gym. Extrapolating the maximum observed mercury concentration from the 4,000 cubic foot pilot test structure to the 763,750 cubic foot gym results in mercury vapor concentrations of 734 ng/m^3 (*Appendix B*). In the absence of ventilation or air exchanges, the height-driven increase in SA:V ratio for the entire gym (compared to the pilot test structure) could affect mercury vapor levels in the gym.

However, active ventilation inside the larger gym will further decrease mercury vapor levels below 734 ng/m^3. A prior investigation by MDH demonstrated that standard ventilation reduced ambient mercury vapor levels in a gym with a mercury-containing polyurethane floor by 77% (ATSDR 2006b). A similar ventilation-induced reduction in the extrapolated maximum mercury vapor concentration in the SDSH gym was calculated to result in a level of 169 ng/m^3 (*Appendix B).* Even though elemental mercury vapor is 6.9 times more dense than air and under a steady state condition will remain closer to the floor, active ventilation inside of the SDHS gym likely moves sufficient air to minimize or even negates this. The constant upward and circular airflow created by the HVAC system will distribute mercury vapors throughout the entire volume of the gym. Therefore, under the typical ventilated state of the SDHS gym the above calculations provide a very reasonable estimate of potential mercury vapor inhalation exposures during floor resurfacing.

Public Health Implications

Elemental Mercury Exposures From Resurfacing Preparation of SDHS Gym Floor

WDPH found that pilot test resurfacing preparation of the SDHS mercury-containing gym floors increased mercury vapor concentrations in indoor air. However, the maximum mercury vapor level measured in the enclosed pilot test structure was only slightly higher than the MDH acute inhalation comparison value. Floor chemical abrasion and air screening was conducted inside the pilot test structure to measure worst-case indoor air conditions for resurfacing preparation of

a mercury-containing gym floor. However, under typical resurfacing conditions this activity would have occurred in a larger, ventilated gym. Dilution and continuous ventilation in the gym is expected to rapidly decrease mercury vapor concentrations by dispersion and elimination and result in indoor air mercury vapor concentrations that remain below the MDH chronic inhalation comparison value for a school.

Extrapolating the highest mercury level found in the enclosed pilot test structure to the full sized gym results in a mercury vapor level of 169 ng/m^3 (*Appendix B*). This mercury level is well below both the chronic (750 ng/m^3) and acute (1,800 ng/m^3) MDH inhalation comparison values, as well lower than 200 ng/m^3, which is the ATSDR Minimal Risk Level for chronic residential inhalation to elemental mercury (ATSDR 1999). Therefore, WDPH concludes that resurfacing of the SDHS gym floor with a normally functioning and operational HVAC system would result in mercury vapor levels that pose no harm to students, staff or workers.

Nonetheless, these exposure estimates are based upon modeling and available information. To ensure mercury vapor levels remain low, MPS could conduct monitoring when conducting floor resurfacing preparation or cleaning the floor with liquid chemical abrasives. There can be substantial variation in ambient mercury vapor levels in gyms that have mercury-containing polyurethane floors, which depend on a number of factors, including the product and manufacturer, age of the floor, condition of the floor, total gym surface area and volume, gym temperature, ventilation system, ventilation rate, and aggregate amount and types of activity. Thus, it is important that chemical abrasive cleaning and resurfacing preparation activities are individually modeled and monitored to ensure that safe mercury vapor levels are maintained.

Waste Liquids from Chemical Abrasive Cleaning of Mercury Containing Floors

Analysis of waste liquid obtained during the SHDS pilot test, as a result of floor stripping and rinsing, raised questions about its appropriate handling and disposal, since the school is connected to a municipal waste water treatment system and plant (WWTP). Large WWTP users who have the potential to regularly discharge mercury-containing liquids may be required to establish monitoring and controls if mercury concentrations regularly reach or exceed 0.2 μg/L (micrograms per liter). While schools typically send larger amounts of waste water to a WWTP than a normal household, schools may not be sending volumes equivalent to larger industries. Also, the generation of waste liquids from scrubbing or washing mercury-catalyzed polyurethane floors would likely be infrequent, and represent a very small percentage of a school's total annual discharge. However, a school or other non-permitted entity with mercury-catalyzed polyurethane floors that regularly washes and treats with agents similar to that used by SDHS, should consider analyzing cleaning waste and rinse water for mercury content, and consult with their WWTP to determine the appropriate discharge or disposal method.

Health Guidance Values for Mercury Exposure in Schools

In many schools, proper ventilation can maintain mercury concentrations in gyms below levels of health concern. It is important to note, however, that seasonal temperature differences can affect mercury emission rates, and may necessitate increased ventilation in warmer months (MDH 2008). If ventilation adjustments are not sufficient to keep mercury levels below appropriate exposure guidance values, permanent removal of the floors is strongly recommended.

WDPH concurs with the MDH recommendation of 750 ng/m^3 as the maximum chronic mercury vapor concentration allowable in school gyms (MDH 2008). This guidance value is based on the U.S. Environmental Protection Agency (U.S. EPA) Integrated Risk Information System (IRIS) Reference Concentration (RfC) for chronic mercury exposure of 300 ng/m^3 (U.S. EPA 2004), which is a lifetime exposure concentration not expected to result in adverse health effects to most people, including sensitive subpopulations. Using estimates of typical exposure durations and ventilation rates for students and gym teachers, MDH adjusted EPA's RfC for chronic mercury exposure to arrive at their recommended guidance value of 750 ng/m^3 for gyms with mercury-containing floors.

A question posed is *what is an appropriate inhalation acute comparison value for SDHS staff who inhale mercury vapors when resurfacing the gym floor at SDHS*? WDPH relies on Minimal Risk Levels (MRLs) developed by the Agency for Toxic Substances and Disease Registry (ATSDR) and RfCs from EPA to assess exposure levels for the general public and sensitive subpopulations. Neither ATSDR or U.S. EPA have developed inhalation comparison values for acute inhalation exposures to elemental mercury vapors. However, MDH has adopted 1,800 ng/m^3 as an indoor air comparison value for acute mercury vapor exposures (ATSDR 2006b), which is based on the acute Reference Exposure Level (REL) developed by the California Office of Environmental Health Hazard Assessment (CA OEHHA) in 2004. This acute inhalation comparison value was based on developmental defects observed in the central nervous systems of offspring of rat dams exposed 1 hour/day during gestation to mercury vapor concentrations of 1,800,000 ng/m^3 (LOAEL). The original CA OEHHA inhalation comparison value was obtained by adding a 1,000-fold cumulative uncertainty factor to the LOAEL. CA OEHHA has recently adjusted its acute REL for mercury vapor inhalation to 600 ng/m^3, based on new methodology (CA OEHHA 2008). Since the revised acute CA OEHHA REL (600 ng/m^3) is less than the MDH-adjusted chronic exposure value recommendation for gym teachers (750 ng/m^3; based on a lifetime, 40 hour/week exposure duration), WDPH concurs with MDH that 1,800 ng/m^3 is an appropriate elemental mercury acute inhalation comparison value to be used by SDHS staff.

Child Health Considerations

Children are a primary concern when evaluating the risk posed by toxic substance exposures. Children have higher rates of respiration, and if exposed to toxic levels of contaminants during critical growth stages, their developing body systems can sustain permanent damage. Therefore, it is important to impose exposure guidelines that carefully consider the enhanced susceptibility of children to toxic insults. Indoor air mercury concentrations measured during typical use of the gymnasium were less than comparison values. The comparison values used in evaluating exposures during preparation resurfacing of the SDHS gym floor considers the entire population, including children and other sensitive subgroups. Nonetheless, children are present during actual

floor resurfacing activities, and the gym will be properly ventilated and secured to minimize any exposure to those individuals in other areas of the SDHS.

Conclusions

WDPH reached the following conclusion regarding resurfacing a mercury-containing polyurethane gym floor at SDHS in Milwaukee:

- *WDPH concludes that mercury vapors typically emitted from the floor during the typical activities in the SDHS gym will not harm students or staff.*

  Indoor air screening of the SDHS gym found mercury vapors levels ranging between 89 and 225 ng/m^3, which is below levels likely to cause adverse health effects among SDHS students, teachers, staff, and regular visitors.

- *WDPH concludes that breathing mercury vapors during floor cleaning or resurfacing preparation inside the SDHS gym is not likely to harm students or staff.*

  Air monitoring during a resurfacing preparation pilot test found mercury vapor levels slightly above an acute inhalation comparison value. However, resurfacing activities inside of the full SDHS gym are expected to result in mercury vapor levels below the comparison values and not pose a health concern.

Recommendations

While mercury vapor is not likely pose a health concern during cleaning or preparation resurfacing activities of mercury-containing floors at SDHS, as a precautionary measure MPS can consider the following actions to further minimize potential mercury releases and exposures.

- MPS could conduct air monitoring to ensure mercury levels remain low.
- the SDHS gym can be sealed from other portions of the school building to minimize potential cross-ventilation with the gym.
- the SDHS HVAC system could be continually operated (day and night) to ensure maximum exchanges with outdoor air.
- these activities could be conducted when the SDHS gym and school are not in use for consecutive days (possibly during academic holiday breaks or vacations).

Public Health Action Plan

The public health action plan (PHAP) identifies actions that have been or will be taken to protect the health of workers and students at SDHS. The PHAP ensures that public health hazards have been identified and that a plan of action is established to halt or prevent unsafe exposures to hazardous substances in the environment.

Actions that have been taken by agencies involved in this case include:

- WDPH provided technical assistance and advise on air monitoring during an enclosed test resurfacing at SDHS, and made suggestions for future resurfacing activities in the SDHS gym to ensure the protection of health of staff and students.

Current and future actions to be implemented by agencies involved in this case include:

- WDPH will continue to provide a Lumex mercury vapor monitoring instrument and appropriate instruction to MPS staff to perform air monitoring during any upcoming floor abrasion chemical cleaning or resurfacing preparation of the SDHS gym.

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Appendices

Appendix A.

Appendix B.

SDHS Enclosed Test Area Calculations

Approximate Dimensions:
20' long
20' wide
10' high

Surface Area = (20' long) x (20' wide) = **400 ft^2**

Total Volume = (20' long) x (20' wide) x (10' high) = **4,000 ft^3**

SA:V = 400:4,000 = 1:10

SDHS Total Gym Area Calculations:

Approximate Dimensions:
235' long
130' wide
25' high

Surface Area = (235' long) x (130' wide) = **30,550 ft^2**

Total Volume = (235' long) x (130' wide) x (25' high) = **763,750 ft^3**

SA:V = 30,550:763,750 = 1:25

Extrapolation of Maximum Observed Mercury Vapor Concentration [$Hg_{max\ obs.}$] in Unventilated Test Area to Ventilated Total Gym Area

- [$Hg_{max\ obs.}$] in unventilated test area: **1,834 ng/m^3**
- Fold difference in SA:V ratios between total gym and test area: **2.5**.
- Observed ventilation-induced reduction in Hg vapor concentration (ATSDR 2006b): **77%**.
- Reduction in [$Hg_{max\ obs.}$] due to dilution = (1,834 ng/m^3) ÷ (2.5) = **733.6 ng/m^3**.
- Reduction in [$Hg_{max\ obs.}$] due to ventilation = (733.6 ng/m^3) x (0.23) = <u>168.7 ng/m^3</u>.

Appendix C.

Wisconsin State Laboratory of Hygiene
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Inorganic Chemistry
WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: IU012144

RYAN WOZNIAK, DHS
1 WEST WILSON ST
MADISON WI 53703

Bill To
Billing ID: 1979
Customer ID: 325192

Fee Exempt

Field #: WOHL COMP# 4
Collection Start: 12/23/2009
Collection End:
Collected By:
County:
Sample Source: OTHER WASTE
Sample Depth:
Sample Information: COPY TO HENRY NEHLS-LOWE
Sample Location: SAMPLE FOR HEAVY METALS
Sample Description:

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: DH060
Project No:
Date Received: 01/04/2010
Date Reported: 01/28/2010
Sample Reason:

Analyses and Results:

Analysis Date	Lab Comment				
01/14/2010					
Analysis Method	**Result**	**Units**	**LOD**	**LOQ**	**Report Limit**
DIG 750.1, ICP, SOLIDS (SW846 3050B)	COMPLETE				

Analysis Date	Lab Comment				
01/20/2010					
Analysis Method	**Result**	**Units**	**LOD**	**LOQ**	**Report Limit**
LEAD, ICP, DRY WT (SW846 6010B)	238.	MG/KG	1	3	

Analysis Date	Lab Comment				
01/14/2010					
Analysis Method	**Result**	**Units**	**LOD**	**LOQ**	**Report Limit**
MERCURY, @60 DEG C, AA VAPOR, DRY WT (SW846 7471A)	228.	MG/KG	0.015	0.045	

CERTIFICATION

This Health Consultation for the Evaluation of Health Concerns Associated with Resurfacing Mercury-Containing Polyurethane Gym Floors in a Milwaukee Public School was prepared by the Wisconsin Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved methodology and procedures existing at the time the Health Consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

FOR: Jennifer Freed

Paul Mudge
Technical Project Officer
CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this Health Consultation and concurs with the findings.

Alan Yarbrough
Team Leader
CAT, CAPEB, DHAC, ATSDR