A Hazard in a Gym Floor

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How the Burlington Township school district managed a crisis when it discovered flooring materials contained mercury

Burlington Township School District was preparing for the routine removal and replacement of the old gymnasium floor in the B. Bernice Young School, which serves students in grades pre-K to second grade. While preparing specifications for the work to be undertaken, the district became aware that it was likely that the existing rubberized gym floor, installed more than two decades earlier, contained mercury.

Mercury in Rubberized Gym Floors Mercury is a metal that exists in liquid and vapor form. It is commonly used in many consumer products and is typically encountered in homes, schools, hospitals, offices and industrial workplaces. In the 1960s, many manufacturers began to include mercury in their rubberized gym floor products to help keep the rubber flexible over time. According to the U.S. Centers for Disease Control's Agency for Toxic Substances Disease Registry (ATSDR), "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 rubberlike surface." According to the ATSDR, mercury-containing polyurethane floors were widely installed in school gymnasiums across the U.S., until being discontinued in the mid-1980s. Many of these floors remain in place today, and recent reports have demonstrated that some emit notable amounts of elemental mercury vapor, which has raised questions about inhalation health risks, particularly for children in schools.

Various groups have set different levels for how high a level of mercury vapor is safe for humans.

The U.S. Environmental Protection Agency (EPA) has developed an airborne exposure Reference Concentration (RfC) level for mercury vapor of an average of 0.3 micrograms per cubic meter (µg/m3) for lifetime exposure (average over 70 years) that is unlikely to cause measurable risk for adverse, health effects to the most sensitive members of the population including pregnant women and children. That figure assumes constant exposure to the mercury vapor. The U.S. Centers for Disease Control (CDC) Agency for Toxic Substances Disease Registry (ATSDR) recommends that areas of schools where mercury levels exceed 10 µg/m3 be restricted until airborne levels return to less than 3 µg/m3.

The Minnesota Department of Health (MDH), which is the only state to date that has issued recommendations concerning schools and gym floors, recommends that the general public should not be exposed to short-term (acute or one hour) mercury air concentrations above 1.8 micrograms mercury per cubic meter of air (µg/m3) in schools. They believe that this conservative criterion protects all people, including sensitive individuals, such as pregnant women and children. For longer term exposures, MDH recommends that school gym teachers should not be exposed to more than an average of 0.750 µg/m3 mercury vapor during 40-hour work weeks averaged over the school year, and children exercising in the gym should also be limited to an average of 0.750 µg/m^3 during 16 hours or less per week averaged over the school year.

The Federal Occupational Safety and Health Administration (OSHA) and the New Jersey Public Employees Occupational Safety and Health (PEOSH) Act Permissible Exposure Limit (PEL) for airborne mercury exposure to workers (including teachers) is an 8-hour time weighted average of 100 micrograms per cubic meter (equivalent to 100 µg/m3) for a 40-hour work week (approximately 133 times higher than the Minnesota guideline for teachers and students). To date, New Jersey has published no specific recommended exposure limits for members of the general public or children in schools for exposure to mercury (in air or on surfaces).

Burlington's Initial Hazard Assessment In January 2017, after learning that the gym floor contained mercury, the Burlington Township School District immediately contracted Dr. Richard Lynch, a certified industrial hygienist (CIH), to determine if the mercury within the gym floor posed any potential for mercury exposures to teachers, staff, students and visitors utilizing the gym.

Air monitoring was performed in the approximately 6,700 square foot gym and surrounding areas using a mercury vapor analyzer capable of detecting airborne mercury levels as low as 0.05 micrograms per cubic meter; well below the EPA and ATSDR guidelines listed above. Initial monitoring conducted approximately four hours after deactivation of the gym's ventilation system, revealed average airborne mercury vapor levels (at gym center 24 inches above floor level) of 0.65 µg/m3 with ventilation not operating overnight at approximately 72-74 degrees Fahrenheit. When the ventilation system was activated in normal occupancy mode, the average airborne mercury levels at the gym center dropped to approximately 0.36 µg/m3. Airborne mercury vapor levels in surrounding hallways were measured at approximately 0.05 µg/m3 (the approximately lowest limit of detection for the instrument) under all conditions of ventilation use; indicating no elevated exposure risk to persons outside of the gym.

Based upon these initial findings, the district was confident that occupants were not being overexposed to mercury and adopted the following immediate mercury vapor management strategies:

- Lower gym thermostat set temperature to 68°F
- Ensure the gym's HVAC system is operating in accordance with manufacturer recommendations for fresh air introduction whenever occupied by students, teachers, visitors or recreation and civic program users.
- Conduct regular periodic monitoring of the gym and active air quality management, throughout the remainder of the school year until the floor is repaired or replaced.
- Share monitoring results with the community including families, teacher and labor unions as they become available and recommend that any health questions from parents, teachers or staff be directed to their physician.
- Plan for safe removal and disposal of the floor to be scheduled during extended unoccupied periods (e.g. summer) under the guidance of a certified industrial hygienist.

Ventilation Stress Test Because all gyms are different with varying sizes, configurations, rates of ventilation and air conditioning, and because airborne mercury levels within the gym can be affected by gym floor temperature and ventilation rates, the CIH consultant conducted a series of "ventilation stress tests" to develop specific HVAC management recommendations to be followed until the gym floor is ultimately removed. The goal of the stress test was to determine the specific factors necessary to maintain safety in this particular gym.

The 6,700 square foot gymnasium has 20 foot ceilings and is serviced by a rooftop air handling system equipped with economizer fresh air damper controls and air conditioning. Total flow for the air handlers at this gym is approximately 6,000 cubic feet per minute. The HVAC contractor verified that fresh air dampers were set to introduce a minimum of 20 percent outdoor air. As such, the effective fresh air dilution ventilation rate for this gym is approximately 1.5 air changes per hour.

Findings of the ventilation stress test revealed that airborne mercury levels in the gym during the normal ventilated occupany mode were about 0.2-0.3 µg/m3 (as previously measured). Those levels increased approximately nine to 12 hours after the ventilation system was deactivated; and they continued to increase when measured 16-20 hours and 30 to 32 hours after the HVAC was turned off. It was found that when the HVAC system was reactivated, within two hours, airborne mercury levels returned to the 0.3µg/m3 level, and remained stable over 32 hours following that reactivation.

Based upon these findings the CIH concluded that, for this particular gym, the ventilation system in its normal occupancy mode was effective at controlling indoor air levels of mercury vapors at safe levels for students, staff and visitors and projected that the ventilation system would need to be deactivated for roughly 183 hours (approximately seven days) to reach an airborne mercury level of 10 µg/m3 (the level at which ATSDR recommends that access be restricted).

Based upon these findings, the CIH made additional recommendations for further lowering of the gym temperature (to 65°F), reducing the length of unventilated periods, and to upgrade to 24/7 ventilated occupied mode beginning April 1, after the threat of subzero temperature nights passed.

In the weeks that followed, additional air monitoring and air and surface sampling were conducted within the gym, gym office and other

areas to confirm the results described above, and to address specific questions raised by staff and labor union representatives. Members of the community were kept informed and provided with results. Monitoring and sampling will be continued into the spring and summer months throughout the end of the school year to ensure safety.

Community Engagement and Risk Communication The Burlington Township School District used its existing crisis management system, developed over the past decade, for communicating with stakeholders to keep teachers, parents and community members apprised of the initial findings and updates as follows

The district's board attorney and insurance carrier were notified of the findings and provided feedback and guidance to the district. By having copies of the reports, the Burlington County Health Department was able to prepare for questions which may be raised by community members. Labor unions were contacted directly and provided with copies of reports. Labor union representatives discussed the issue with teachers working in the area and voiced those concerns to the district. Discussions with labor unions over appropriate standards and guidelines, as well as requests for additional testing, occurred in a series of interactions. The district has conducted additional testing based upon the particular concerns raised by labor union representatives and teachers (e.g. gym office where staff spend their down time).

Electronic Newsletter and District Website As soon as initial monitoring results were received, the district's director of human resources and communications developed an electronic newsletter summarizing the findings. The newsletter was distributed to approximately 6,000 community residents, teachers, community officials and groups using the gym for recreation or civic activities, which prompted some parents, teachers and others to contact the superintendent for more information. Individual concerns were addressed by the superintendent and consultant as appropriate. Reports and laboratory results from the consultant were posted to the district website (www.burltwpsch.org). Overall feedback was positive and appreciative of the transparency.

10 Steps for Managing Mercury Containing Rubberized Gym Floors

1. Survey rubberized gym floors in your district. Sample to determine mercury content. Contract an expert certified industrial hygienist (CIH) to oversee sampling and monitoring.
2. Where mercury-containing rubberized floors are identified, monitor airborne mercury levels in the gym and surrounding areas under ventilated and unventilated conditions.
3. Develop site-specific risk management procedures to reduce mercury exposures including reducing gym floor temperatures and establishing appropriate dilution-ventilation of gyms. Optimal temperature and ventilation profiles should be developed in consultation with the CIH based upon specific knowledge of the site's physical attributes and HVAC equipment.
4. Develop best practices for maintaining and cleaning gym floors to prevent unintended exposures from improper maintenance or abrasion of surfaces.
5. Conduct sampling and monitoring programs to meet the specific needs of the facility and staff concerns. (Note: modifications to workplace sampling guidelines may be required to measure low microgram airborne mercury levels found in gyms). Work with a certified industrial hygienist to develop appropriate sampling and monitoring protocols.
6. Establish systems for routine and emergency risk communication with stakeholders. Use these systems to notify stakeholders of plans to evaluate gym floors in advance of testing.
7. Partner with board attorneys, insurance carriers and health professionals on developing risk communication messages. Review internal drafts of messages with staff, nurses or other professionals to ensure clarity and accuracy prior to publishing.

8. Share findings promptly with affected families, community groups, labor unions and staff.
9. Partner with experts in measurement of chemical hazards and HVAC systems (e.g. certified industrial hygienist) and environmental medicine physicians to address exposure questions and specific medical concerns by staff.
10. Develop plans for management, removal and replacement, or sealing of mercury containing rubberized gym floors. Factor increased costs of monitoring, energy and removal into upcoming budgets.

Consultation with Experts in Toxicology and Environmental Medicine Being one of the first New Jersey school districts to proactively manage this issue, the district reached out to experts at Rutgers University to provide independent review of the toxicological, epidemiological and risk assessment data used by the CIH to ensure that guidelines being applied to evaluating any risks to occupants were appropriate. Rutgers experts agreed that the guidelines utilized by the district CIH consultant were appropriate and sufficiently protective for staff, students and visitors. The Rutgers report was also posted on the district website. The district also contracted with a private practice board-certified occupational health physician to meet with any employees who had particular medical concerns for private evaluation and testing.

Liaison with NJ Association of School Business Officials (NJASBO) and Leadership for Educational Excellence (LEE) The district notified the New Jersey School Boards Association, NJASBO and other LEE organizations of the findings and approach taken to manage the concern. In response, the Leadership for Educational Excellence organization prepared a request to the N.J. Department of Health, N.J. Department of Education, and N.J. Department of Environmental Protection to provide any guidance.

Burlington Township is proceeding with its plans to remove and replace the gym floor in the B. Bernice Young School. A contract has been awarded and the work will be completed over the summer, so by September, mercury levels will not be a concern any longer.

Managing risks associated with mercury in rubberized gym flooring is likely to be a challenging issue for New Jersey schools and districts across the nation over the next several years. The challenges are technical and specific to the gym's configuration and equipment, and also complex in addressing legitimate health concerns for staff students and families.

It is our belief that the process described in this article coupled with the unique combination of gym configuration, air conditioning and ventilation system equipment, access to experts in industrial hygiene, toxicology and environmental medicine, along with the well-established and routinely executed emergency communication and risk management relationships, have contributed to help Burlington Township Schools effectively manage this novel challenge in a way that protects public health and allows the district to continue to meet its needs for continuity of operations.

Because the level of mercury emissions prior to discovery of the issue cannot be determined, we think it is essential that districts proactively take steps to become aware of the potential risks, and institute best practices to the factors that impact potential exposures to staff, students and visitors.

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