MassDEP Field Assessment and Support Team

After Incident Report	NE-10-06603
Peabody High School Mercury Spill Incident	October 2010

EXECUTIVE SUMMARY AND CONCLUSIONS

Over the weekend of 10/29/10 to 10/31/10, personnel from MassDEP provided technical assistance, data, and recommendations to municipal officials on efforts to assess and cleanup a relatively minor spill of elemental mercury at Peabody High School.

Contamination was primarily contained within a stockroom and an office used by the Science Department. Both rooms were thoroughly cleaned by a hazardous materials remediation contractor. As an added precaution, an elemental mercury neutralizing agent was applied to the flooring in a classroom adjacent to the stockroom, and to over 300 feet of corridors and staircases.

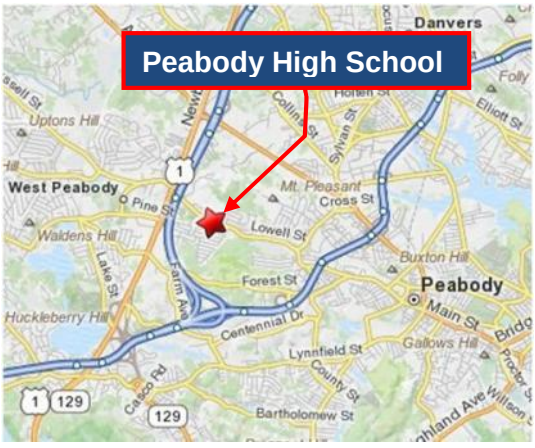
Air testing on 10/31/10 by three different mercury meters confirmed that all levels of mercury in all impacted areas were below levels established by the Massachusetts Department of Public Health (DPH) for school buildings.

The shoes, clothing, and car mats from custodial and teaching staff with the highest exposure to contaminated areas were tested by MassDEP personnel. With the exception of a custodian that had directly handled some of the spilled mercury, contaminant levels were relatively low, and unlikely to be tracked off school property at significant levels. Follow-up testing within the automobile and home of the custodian failed to identify any significant levels of mercury contamination.

On the basis of the above, it is highly unlikely that any other school employees or students would have encountered significant levels of mercury residues and/or would have tracked significant amounts of mercury out of the school building.

BACKGROUND

At 1:15 PM on Friday, October 29, 2010, MassDEP received a report from the Peabody Health Department of a potential spill of mercury at Peabody High School, located at 485 Lowell Street.



Reportedly, during the previous week, personnel at the school had moved a barometer from a science laboratory stockroom to a mechanical storage room on a lower floor level. The barometer contained about 1 cup of elemental mercury, and some minor spillage (less than one teaspoon) was noted by a custodian on route to the mechanical storage room. Upon discovery of the spillage, the barometer and spill residue were packed into/secured within multiple plastic bags and trash cans.

Upon receiving the call from the Health Department, a scientist from the MassDEP NERO Emergency Response (ER) section was dispatched to the school, to analytically screen air in potentially impacted areas with a Model 915+ Lumex Mercury Analyzer. The screening data indentified significant concentrations of elemental mercury in the air within a laboratory stockroom (10,000 – 20,000 ng/m^3), with evidence of some minor spillage in areas along the transit pathway

of the barometer.

Based upon these findings, a recommendation was made to school officials to engage the services of a hazardous materials cleanup contractor, along with a mercury air testing specialist. Municipal officials immediately retained ENPRO Services of Newburyport, who subcontracted air testing services to Covino Environmental Associates of Woburn.

NERO ER notified DPH of this situation, and requested assistance from the MassDEP Field Assessment and Support Team (FAST). A FAST member arrived at the school at approximately 6 PM on Friday evening, and worked over the weekend with ER personnel, crews from ENPRO and Covino, and school and municipal officials.

MERCURY

Mercury is a naturally occurring metal which can exist in several different forms. Elemental mercury (also known a metallic mercury or "quicksilver") is a dense, shiny, bead-forming silver-colored liquid. In the past, it was widely used in thermometers, as well as in medical and scientific equipment, including barometers.

The use of elemental mercury has been discontinued in recent decades due to its toxicity. Of particular concern is the chronic, long-term exposure to high levels of mercury vapor in air. Unlike most metals, elemental mercury is volatile, and can slowly evaporate into the air over a long period of time (i.e., months or years). This can be especially problematic if a significant amount of this material becomes trapped in cracks in floors and other surfaces.

Mercury is typically measured in air in units of nanograms per cubic meter (ng/m^3). The enforceable occupational (OSHA) standard in a work place is 100,000 ng/m^3. The US Agency for Toxic Substances and Disease Registry (ATSDR) recommends that levels of mercury within the breathing zone of schools and homes be less than 1000 ng/m^3, which has also been the recommendation of the Massachusetts DPH.

The goal of the effort at Peabody High School was to ensure that all "breathing zone" locations were less than 1000 ng/m^3, with the breathing zone being 3 to 5 feet above floor level.

TASKS

On Friday 10/29, agency staff recommended the following tasks/actions to address this incident:

- Establish the area of interest and potential contamination by exactly re-tracing the route followed to move the barometer from the stockroom to the mechanical storage room;
- Identify and characterize the areas of contamination in the school using mercury testing meters;
- Determine whether mercury could have been tracked off-site by teachers or students walking through areas of contamination;
- Clean the areas of highest contamination by physical and chemical means; and
- Determine if post-cleanup air levels in the school were within acceptable health-based guidelines.

Establishing the Areas of Interest

The school custodian and science teacher who had moved the barometer were at the school on Friday evening (10/29), and explained exactly how and where they had moved the unit.

The barometer was being stored in the Science Laboratory Stockroom, between Classroom Science Labs C-268 and C-269, located on the second floor in the northwest corner of the building (see Figure 1). It was hand-carried through room C-268 and then into the corridor, where it was moved in a southerly direction for about 300 feet to the Science Office. It was then carried easterly to a nearby staircase, where it was transported downstairs. At some point, the custodian had noted that a small amount of elemental mercury had spilled onto his hand (less than one teaspoon), and he returned to the Science Office, where the science teacher helped him pack and secure the barometer in a plastic bag/trash can. The trash can was moved down the stairs and into the nearby mechanical storage room. These movements are illustrated via the blue arrows in Figure 1.

Identifying and Characterizing Areas of Contamination

On Friday night and Saturday (10/29 and 10/30), personnel from MassDEP, ENPRO, and Covino tested air within areas of interest/potential contamination using portable meters.

MassDEP and ENPRO personnel used Lumex Mercury Analyzers ("Lumex"), which utilize a high capacity air sampling pump (20 liters/min) in combination with an Atomic Absorption Spectrometer. These units are capable of detecting as little as 2 ng/m^3 (approximately 2 *parts per trillion*) of elemental mercury, with no known interfering agents. Covino personnel used a Jerome Mercury Vapor Analyzer with a 500 ng/m^3 detection limit. While unable to detect low levels of mercury in air, the Jerome Analyzer has utility in the detection of contaminated surfaces, especially when these surfaces are agitated.

On Friday night, two "hot spots" were identified:

- The Laboratory Stockroom, with levels of mercury in the breathing zone of 10,000 to 20,000 ng/m^3, and visual and/or analytical evidence of mercury beads on floor areas; and

- the Science Office, with levels of mercury in the breathing zone of 1500 ng/m^3, and the visual presence of mercury beads at and near the door.

Somewhat elevated levels of mercury (several hundred ng/m^3) were identified in the breathing zone within some corridors and stairways within the area of interest. Brooms and mops that had been in use in the previous week were also screened, and found to contain low to moderate levels of off-gassing mercury (200 – 500 ng/m^3). According to school personnel, there were no vacuuming or buffing operations within the area of interest in the previous two weeks.

On Saturday, personnel from Convino and ENPRO conducted further evaluations of corridors and stairs, including agitating (scrubbing) areas of potential contamination and subsequently measuring the overlying air space, to look for evidence of mercury "off gassing" from liquid droplets. This effort focused on floor cracks and the floor/stair/wall interface, where mercury beads may have been pushed during sweeping/mopping operations. On the basis of these evaluations, small pockets of mercury contamination were noted in various areas.

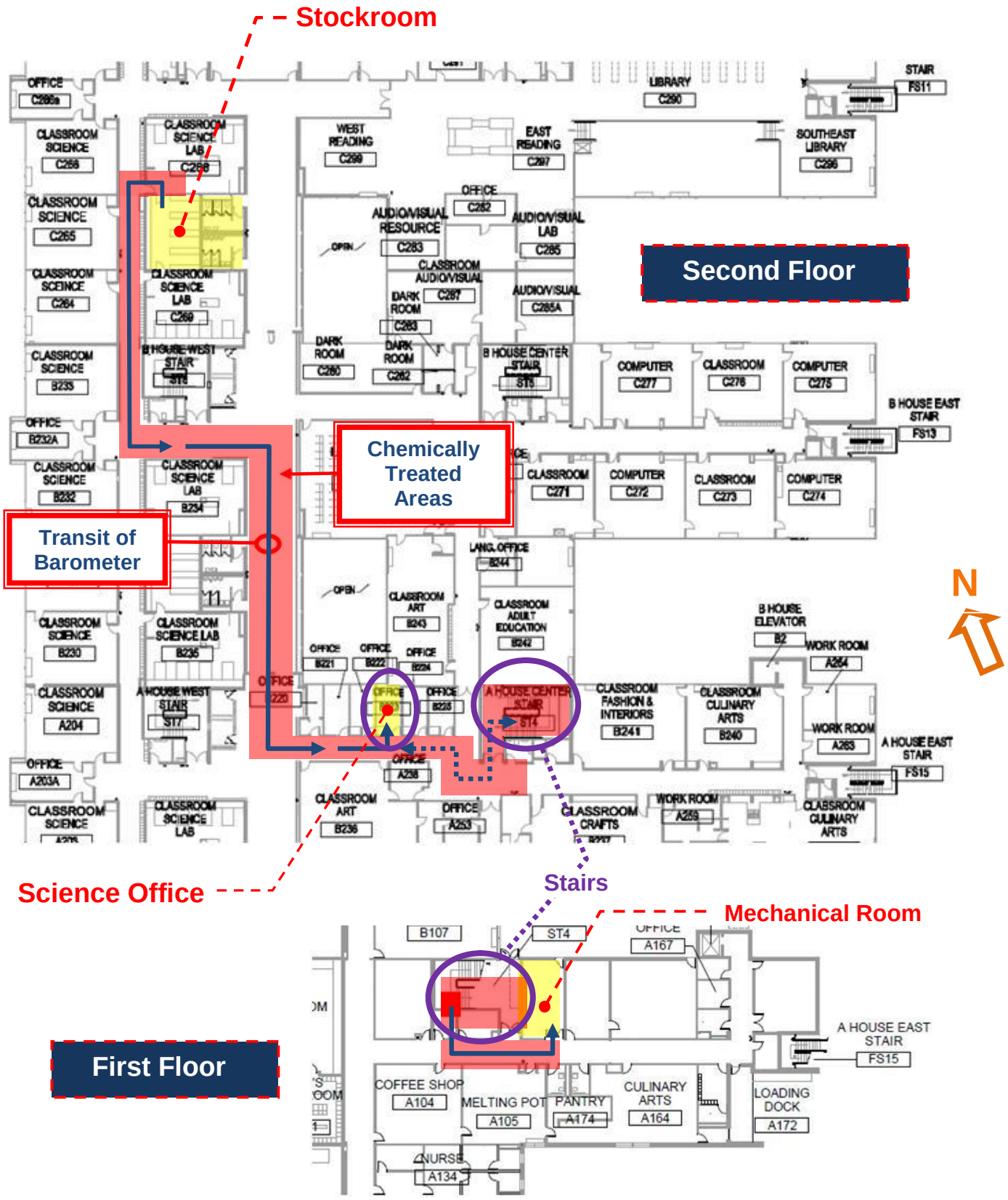


Figure 1- Details of Spill Area

Determining Whether Mercury Could Have Been Tracked Off Site

Teachers and students walking through areas of contamination could contact small droplets of mercury (typically on the soles of their shoes), and subsequently transport these droplets off site, where adhered beads could be re-deposited on floors or other surfaces.

In order to investigate this possibility, persons having the highest exposure potential were identified:

- The custodian who had moved the barometer;
- the science teacher who assisted the custodian;
- the science teacher who taught in Classroom Science Lab C-268, and who was most likely to use the Laboratory Stockroom; and
- the science teacher who taught in Classroom Science Lab C-269.

Each of the above personnel were requested to place the shoes they wore during the previous week in a plastic bag. Additionally, the custodian and science teacher who had moved the barometer where also asked to bag the clothing they were wearing when moving the barometer. Any mercury droplets present on these items would be expected to volatilize and concentrate within the plastic bag. Each of these bags were subsequently analyzed by MassDEP personnel using a Lumex meter.

The bag containing the shoes and clothing of the custodian registered the highest reading (approximately 5000 ng/m^3). A further screening of individual items indicated that the most contaminated item was a pair of jeans; a pair of sneakers were found to be only minimally contaminated (200 – 500 ng/m^3). The inside of custodian's car was also screened, and found to be uncontaminated.

The bag containing the shoes and clothing of the science teacher who had assisted the custodian was only minimally contaminated (200 ng/m^3). The inside of his car was also screened, and found to be uncontaminated.

The bag containing the shoes and car floor mats from the science teacher from room C-268 was found to be somewhat more contaminated, at 1000 ng/m^3. The bag containing shoes, clothing, and automotive floor mat from the science teacher from room C-269 was minimally contaminated, at 70 ng/m^3.

On the basis of the above, a conclusion was made that only the custodian had enough contact with the spilled mercury to track a significant quantity off school property. Accordingly, MassDEP personnel used a Lumex meter to thoroughly examine his home, including floor surfaces, door knobs, washing machine, and dryer. All readings were very low - less than 30 ng/m^3, a concentration that is near "background" conditions at any home.

Cleanup

Areas with visible mercury beads (the Laboratory Stockroom and Science Office) were cleaned by ENPRO personnel using a mercury vacuum. In the science office, the impacted carpet was subsequently removed (given the difficulty in adequately removing residual mercury droplets

from porous surfaces). In the Laboratory Stockroom, the water trap in sink in the most highly impacted area was removed and replaced.

These initial measures removed most of the mass of spilled mercury. However, to address the small remaining droplets, especially in hard to reach places (e.g., cracks in floor), ENPRO personnel applied aqueous solutions of mercury neutralizing compounds, including the commercial product "HgX®", to impacted and potentially impacted surfaces. These products contain proprietary blends of sulfur compounds, which chemically react with elemental mercury to form mercuric sulfide (HgS), a much less volatile form of mercury.

The most contaminated floor surface – in the Laboratory Stockroom – received multiple applications of a highly concentrated solution (2:1 HgX®/water). Moreover, to be safe, a 1:1 solution of these agents were applied to all corridor and stair areas within the area of interest, as indicted in Figure 1.

To further mitigate potential source issues, recommendations were made to school officials to:

- Properly dispose of the mop heads and brooms used in the area of contamination;
- Properly dispose of the clothing worn by the custodian during the spill event; and
- Properly dispose of any other mercury containing items in the Laboratory Stockroom (which included a number of thermostats and a vial of mercury).

Post-Cleanup Air Concentrations of Mercury

On Sunday morning (10/31), personnel from Covino and ENPRO conducted a systematic air sampling effort throughout the area of interest. To increase the level of certainty, two Lumex meters were used to simultaneously sample air in impacted and potentially impacted rooms, corridors and stairs. Measurements were made at the 1 foot level and 5 foot level.

Over 250 discrete readings were obtained and recorded:

- All readings in all corridor and stair areas were less than 300 ng/m^3, and generally below 100 ng/m^3 in the breathing zone (5 feet above floor level).
- All readings in Classroom Science Lab C-268 were less than 300 ng/m^3.
- All readings in Classroom Science Lab C-269 were less than 120 ng/m^3.
- All readings in the Science Stockroom (1 foot, 5 foot, and above counters) were less than 1000 ng/m^3 (generally less than 300 ng/m^3).
- All readings in the Science Office were less than 500 ng/m^3, and generally below 300 ng/m^3.

Late in the morning on 10/31, MassDEP personnel spot-checked the above findings using an agency Lumex meter, and confirmed these results.

On the basis of these readings – confirmed by 3 different Lumex meters – MassDEP personnel communicated to school and municipal officials early in the afternoon of 10/31 its opinion that

sufficient assessment had been conducted to conclude that levels of mercury vapor within the areas of interest were below values recommended by the Massachusetts DPH in school buildings.

As a final documentation of air quality, a recommendation was also made to obtain time-weighted air samples at 8 locations using sorbent media and modified NIOSH Method 6009. This would allow a more precise measurement of air concentrations over a longer period of time (4 to 8 hours), and would further verify the findings of the 3 Lumex meters. As a precaution, it was recommended that the Laboratory Stockroom and two adjacent classrooms (C-268 and C-269) be closed until such time as these verification data were obtained.

The sorbent media sampling effort was carried out by personnel from Covino over the course of Sunday afternoon (10/31). Sorbent tube samplers were deployed at 3 feet above the floor throughout the area of interest, including the Laboratory Stockroom, Classrooms C-268 and C-269, the Science Office, the corridors, and the staircase.

These data (by Contest Analytical Laboratory) were received by MassDEP on 11/2/10, and, as expected, were consistent with the Lumex readings. In fact, none of the 8 samples detected mercury, at a listed Reporting Limit of 64 ng/m^3. It was noted, however, that the Laboratory Control Sample (LCS) for the low-level spike had a poor recovery (61%), suggesting the actual detection limit (based upon the high level spike) may be closer to 200 ng/m^3. However, this is still well below the cleanup goal of 1000 ng/m^3.

DISCUSSION

Based upon available lines of evidence, this appears to have been a relatively small spill with relatively limited impacts:

Mass Balance

School officials estimated that only about 1 mL of mercury was spilled. This equates to about 1/5 of a teaspoon, and, at a density of 13.55 g/cm^3, about 14 grams of mercury, which is equivalent to 14,000 milligrams (mg).

This value is not inconsistent with the concentrations of mercury vapor identified in the air of impacted rooms and corridors. For example, an average of 10,000 ng/m^3 in the (115 m^3) Laboratory Stockroom would equate to a total mass of mercury of about 1.2 mg; an average of 100 ng/m^3 in the (2000 m^3) corridors would equate to a total mass of mercury of about 0.2 mg. While the ventilation rate in the stockroom is questionable, assuming 1-5 air exchanges/hour in the corridors yields a mercury mass removal rate of 5 – 25 mg/day, or 50 to 250 mg (of the initial 14,000 mg) since the spill event.

Thus, testing data and observations support the conclusion that total spillage could have been as little as 1 mL (1/5 teaspoon).

Impacted Surfaces

The limited amount of contamination on the shoes of tested custodial and teaching staff are telling. While tiny droplets of mercury beads were visible in and near the Laboratory Stockroom and Science Office, they appear to have been limited in extent, and in their “availability” and propensity to contact and adhere to the soles of shoes.

The low amounts of contamination in room C-269, and on the shoes of the science teacher from room C-269, is consistent with the observation of an obstruction in the doorway between the stockroom and room C-269, suggesting that there had been little traffic between these two adjoining rooms since before the spill event.

Notwithstanding the above conclusion, small amounts of mercury droplets remain in the area of interest, as evidenced by continued (albeit low) mercury detections in air, and by transient "hits" of mercury vapor detected when agitating certain areas, usually a floor or stair interface with a vertical surface. Further attempts to address these small and localized pockets, however, are not recommended:

- ☞ Contact with these tiny droplets is unlikely, given their location within recesses at vertical interfaces (e.g., the very edge of a stair);
- ☞ Removal would be tedious and impractical; and
- ☞ Impacts to overlying (breathing) air are minimal, and well below health metrics.

CONCLUSIONS

- ❖ Mercury spillage appears to have been relatively minor.
- ❖ Adequate steps were taken to remove and neutralize mercury residues.
- ❖ It is unlikely that faculty, staff, or students tracked significant quantities of mercury off site.
- ❖ Concentrations of mercury within building air are significantly below levels established by the Massachusetts DPH.

Photographs

Stockroom – location where barometer was stored

Stockroom – looking in from Classroom C-268

Stockroom – MassDEP and ENPRO Haff Technologies Mercury Spill Meters

Classroom C-268

Corridor outside Stockroom and Science Lab Classrooms

"Main Street" Corridor

Mechanical Storage Room – Testing Air with Lumex Meters

Corridor with applied "HgX®" neutralizing agent