Health Consultation

HARRY L. HALLYBURTON ELEMENTARY SCHOOL

DREXEL, BURKE COUNTY, NORTH CAROLINA

SEPTEMBER 28, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Prepared By:

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Acronyms

µg	microgram
AEGL	Acute Exposure Guideline Level
AT	Averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
BW	Body weight
CF	Conversion factor
Cm	Centimeter
CR	Contact rate
DAF	Dermal absorption efficiency
Decon	Decontamination
DOE	U.S. Department of Energy
ED	Exposure duration
EF	Exposure frequency
EMEG	ATSDR Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
EQRR	EQ Resource Recovery
ERPG	Emergency Response Planning Guideline
HAZMAT	Hazardous Materials
HUD	U.S. Department of Housing and Urban Development
IRi	Inhalation rate
IURF	Inhalation Unit Risk Factor
K	Re-suspension factor
Kg	Kilogram
M	Meter
mg	milligram
$\mu g/m^3$	micro-gram
Ng	nano-gram
LOAEL	Lowest Observed Adverse Effect Level
NA	Not applicable
NCDHHS	North Carolina Dept Health Human Services
NIOSH	National Institute for Occupational Safety and Health
NOAEL	No Observed Adverse Effect Level
RfC	Reference Concentration
RfD	Reference Dose
SAd	Dermal surface area available for absorption
SAg	Dermal surface area available for ingestion
SVOC	Semi-volatile organic compound
VOC	Volatile organic compound

Executive Summary: The principal for the Harry L. Hallyburton Elementary School in North Carolina's Western Region, contacted the NC Department of Health and Human Services (DHHS) Division of Public Health Epidemiology Branch on October 2006 to request assistance with a mercury spill incident which occurred October 2006 at approximately 10:00. The incident involved a mercury thermometer which was broken by one of the students while in class at the Allied Services building located at Hallyburton Elementary school. The Allied Services Building is used by East Burke High School students as a training area for first aide and health care worker techniques. The local fire department and HAZMAT teams were activated, and they decontaminated the students and classroom materials. The Allied Services building was evacuated and the adjoining hallways cordoned off restricting access from surrounding classrooms.

On October 12, 2006, three members of the NC DHHS Epidemiology Branch went to the school with a Lumex mercury vapor analyzer (model RA_915+, serial number 173182). The purpose of this document is to review environmental and survey data in order to determine if mercury is at levels that could potentially affect public health. Another goal of the investigation was to determine the presence of mercury on the clothing and personal items of the students who were potentially exposed to the mercury. Lastly, key personnel were given guidance for cleanup and remediation procedures. This helped them to effectively mitigate this potential exposure in an expeditious manner.

Initially, first responders believed mercury levels to be above the recommended EPA values. Several steps were taken in order to reduce the amount of mercury in the classroom before NC DHHS arrived on October 12, 2006. Based on the information received at the time of the incident, it was understood that the exposure amount and duration was short for both students and staff. However, before DHHS arrived with the Lumex mercury analyzer, there was an indeterminate, or unknown, health hazard because of the lack of quantifiable data.

The initial steps included ventilating the room and removing the carpet in the affected areas. After DHHS arrived, initial screening samples were taken, which showed elevated levels of mercury. Bagged personal items were removed and the room was ventilated some more. After these actions were taken the ambient breathing air samples were reduced to acceptable levels except for a few hot spots in the remaining carpet. Each individual plastic bag containing the contents of individual students' belongings were checked separately. Some of the bagged personal items had elevated levels of mercury. The bagged items with elevated levels were separated from the rest of the bags, ventilated, and placed outdoors in the open air.

Based on instrument data the school staff, principal, and local health department were instructed that the bags containing the student's personal items should remain outdoors to allow for proper evaporation of the mercury. The room was also ventilated and the remaining carpet was removed. After data was analyzed and aforementioned activities carried out, NC DHHS categorized the incident as "no apparent public health hazard".

Background: The Harry L. Hallyburton Elementary School is located in Drexel, North Carolina (http://www.burke.k12.nc.us/Hallyburton/). At the time of the incident, the Burke County Fire Marshall responded to the incident and started coordination between the local fire department and HAZMAT response teams. He also took control of the scene assessing the situation. The State Medical Assistance Team (SMAT) was called in to clean up the mercury. The decision was made to decontaminate the students, their personal items and the room where the incident occurred.

The decontamination process had begun with the students removing all of their clothing and personal items which potentially could have been exposed to mercury from the thermometer. The next step of the decon process involved shower units which each student was required to use in order to prevent potential mercury exposure. The students were assured that their personal items would be decontaminated before they could get them back.

Clothes and personal items were placed in individual bags and marked with the owners names. In addition, the room was quarantined for a period of time before the windows were opened and a fan was used to circulate fresh air in and out of the room.

NC DHHS was called by the local health department for additional guidance once the students were taken through the decontamination process, personal items bagged, carpet sections removed, and the room sealed off and ventilated. The NC DHHS Epidemiology branch visited the site with a LUMEX mercury vapor analyzer to test for any remaining mercury residue.

Students also were asked to submit blood samples for medical tests at the time of the incident. Blood samples have the potential for detecting elevated blood mercury levels. The blood mercury samples were normal for all subjects tested. All subjects tested were within normal limits with values registering on the low end of the reference range (see Table 8). The detections could be an indication of diet and other environmental factors not related to this incident.

Site Layout and Description: The Allied Services building is used by East Burke High School students. See Appendix A for building diagram. The Allied Services building is connected to the Elementary school by a hallway with doors, which were used to seal the room off from the rest of the school. In addition, the heating, ventilation, and air conditioning (HVAC) was cut off to the Allied Services section.

Methods: Sampling was conducted to determine if the affected area(s) and personal items were contaminated and needed additional consideration. Sampling was accomplished with a Lumex Mercury Vapor Monitor. The Lumex instrument readings are given in ng/m^3 but for the purpose of this report all units will be converted to $\mu g/m^3$. The criteria used for clearance samples during this event was 3.0 $\mu g/m^3$ (=3000 ng/m^3), the ATSDR suggested action levels for mercury in schools (see appendix B). Area clearance samples were taken approximately 36 inches above the floor.

The criteria used for clearance samples on personal items used during this survey is 10 $\mu g/m^3$ (10000 ng/m^3) (see appendix B). The survey of the personal items was conducted by inserting the sample probe of the Lumex into the plastic bags' headspace.

Before any readings were taken, two background samples were collected for a comparison of mercury levels in the building and the air. Sixteen (16) building area samples, four (4) open room samples, four (4) closed room samples, and four (4) custodian closet and adjoining room samples were measured for mercury. Thirty (30) bags containing the personal belongings of the students were sampled for mercury as well, including nine (9) previous samples (aired out between 1030 and 1130) and the seventeen (17) bags containing the cell phones and wallets. Data points that indicated values above the recommended clearance level for general space or personal items were determined to be "high" and flagged for further action.

Sampling Data: The results of the mercury sampling are tabulated below. The background mercury was measured at 0.083 $\mu g/m^3$; this is below the action level of 1.5 $\mu g/m^3$. Some area clearance and personal items had levels of mercury above the recommended limit (Table 2, 3, 4 & 5). Clearance samples were measured again after personal items (bags) were removed, windows and doors were opened and the portable high volume fan turned on (Table 3). Quantitative measurements from the Lumex demonstrated that the mercury levels were reduced significantly after these actions were taken.

Bags with personal items and clothing were tested separately to determine if the materials were contaminated with mercury using guidance from the EPA and the Agency for Toxic Substances and Disease Registry (ATSDR) (Table(s) 6, 7 & 8). Some of the bags of clothing were above the recommended criteria for mercury. The bags were then opened and allowed to ventilate for one hour and then re-tested. The repeat test confirmed that the mercury levels were lower than the initial readings. There were still some bagged personal items and clothing that had elevated levels of mercury above the health values and were set aside for specific instructions. DHHS explained to officials that the personal items set aside and marked as being over the health values for mercury were to remain outside in the open air for at least one more business day. Exposing the clothes to as much air and sunlight as possible would promote evaporation of mercury.

Table A: Area samples

Mercury Sample Data	Temp °F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (1.5 µg/m^3)	Above Recommended Limit (3.0 µg/m^3)
Max	65.0	57.0	6.08	Yes	Yes
Average	65.0	57.0	3.31	Yes	Yes

µg/m^3 = micrograms per cubic meter

Table B: Bags containing clothing and personal items

Mercury Sample Data	Temp °F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (5.0 µg/m^3)	Above > Recommended Limit (1.0 - 10 µg/m^3)
Max	63.0	57.0	50.0	Yes	Yes
Average	62.4	57.0	5.08	Yes	Yes

µg/m^3 = micrograms per cubic meter

Table C: Mercury Blood levels

Blood Mercury Data	Mercury Blood Level Results (µg/L) ref range mercury 0.0-14.9 *	Above > Recommended Reference Range
Max	3.30	No
Average	1.28	No

*Reference range is considered the acceptable range of mercury levels in humans as indicated by the laboratory conducting the tests
µg/L = micrograms per Liter

Discussion: Mercury is a naturally occurring element that is found in air, water and soil existing in several forms: elemental or metallic mercury, inorganic mercury compounds, and organic mercury compounds. The health effects of mercury exposure at high levels, according to the Environmental Protection Agency (EPA), can harm the brain, heart, kidneys, lungs, and immune system of people of all ages.

According to the EPA, "when elemental mercury is spilled or a device containing mercury breaks, the exposed elemental mercury can evaporate and become an invisible, odorless toxic vapor" (EPA 2006). This is especially true in warm or poorly-ventilated rooms or spaces. Sources of potential exposure to elemental mercury are described below. Metallic mercury is often found in school laboratories as well as in thermometers, barometers, switches, thermostats, and other devices found in school science labs. It is important to clean up mercury spills properly and to report them to the proper authorities when necessary.

Often times during a spill, mercury breaks into tiny beads that roll, and can easily become trapped in small cracks in the surface. A mercury spill can be cleaned with minimal effort, if the proper instructions are followed (EPA 2006).

NC DHHS often receives requests to assist with elemental mercury spills. NC DHHS professionals can offer assistance in the form of verbal and written guidance. In some cases, NC DHHS will respond to a location to offer on-site assistance and take samples. NC DHHS can also request and coordinate with other agencies including local health departments, fire departments, NC Department of Environmental Natural Resources (DENR), and the U.S. EPA Emergency Response Branch NC DHHS is also available to provide follow up information and fact sheets for concerned citizens.

Some of the initial screening levels detected by DHHS in the room did exceed 3 ug/m^3, which is the ATSDR suggested action levels for mercury (see Appendix B). The samples that were above the recommended level were flagged for future action. Some personal items were also above the recommended 10 micrograms per cubic meter of air (ug/m^3) and set aside for additional decon using natural draft, evaporation and sunlight.

The main routes of exposure for elemental mercury are inhalation, skin absorption, ingestion, skin contact, and eye contact. Of the three, inhalation is the primary route of entry and can be particularly harmful to children and women of childbearing age. Metallic mercury is absorbed through the lungs by rapid diffusion. Target organs include the eyes, skin, respiratory system, central nervous system, and kidneys (NIOSH, 2005).

The nature and severity of the toxicity that may result from mercury exposure are functions of the magnitude and duration of exposure, the route of exposure, and the form of the mercury or mercury compound to which exposure occurs (ATSDR 1999). The ATSDR states that workers who were exposed to mercury vapors in an occupational setting exhibited hand tremors, increases in memory disturbances, and slight subjective and objective evidence of autonomic nervous system dysfunction. Although it is important to monitor worker health in situations where mercury is present, there are special considerations for children and mercury exposure.

Child Health Considerations

Children are not small adults. They differ from adults in their exposures and may differ in their susceptibility to hazardous chemicals. Children's unique physiology and behavior can influence the extent of their exposure. Children are at greater risk than adults from exposure to hazardous substances. There are many reasons why they have the potential for increased risk to hazardous substances such as engaging in hand-to-mouth behaviors, having increased metabolisms, and undeveloped body systems which can be particularly vulnerable to toxic chemicals. The lower body weight and higher intake rate of children can result in a greater dose of a substance. The developing body systems of children can be permanently damaged if toxic exposures are high enough during critical growth stages (ATSDR, 1999).

According to the ATSDR, children who breathe metallic mercury vapors for an extended period of time may develop a disorder known as acrodynia, or "pinks disease." The symptoms of this disorder include severe leg cramps, irritability; and abnormal redness of the skin, followed by peeling of the hands, nose, and soles of the feet. Itching, swelling, fever, fast heart rate, elevated blood pressure, excessive salivation or sweating, rashes,

fretfulness, sleeplessness, and weakness may also be present. This disorder may also occur in teenagers and adults. Exposure to mercury vapors is more dangerous for children than for adults, because inhaled mercury vapors easily pass into the brain and nervous system of young children and may interfere with the development process. It should be noted that acrodynia is caused by chronic (long term) exposure to mercury. The children at Hallyburton Elementary were not in contact with the mercury for a long period of time. The exposure potential for acrodynia or other health related problems due to mercury exposure should be considered **low**.

Conclusions: The Hallyburton Elementary School Allied Services section was a contamination incident with an unknown amount of mercury that had a one (1) day duration opportunity for exposure. Before DHHS arrived with the Lumex mercury analyzer, there was an indeterminate, or unknown, health hazard to students and staff. After an analysis of the sampling data, clean-up procedures, exposure duration, contact potential, and blood sample results, it was determined that this event should now be considered no apparent public health hazard.

Recommendations: At the time of the response, the following recommendations were made:

- Remove the remaining carpet in the Allied Health Building. Cut in strips lengthwise for easy removal.
- Keep doors and windows open with good circulation promoted by the mechanical fan for at least one more full business day.
- Place items of clothing marked with a double asterisk on Table 7 outside in the open air for at least one more business day. Exposing the clothes to as much air and sunlight as possible to promote evaporation of mercury. The rest of the items were cleared to return to the owners at the earliest convenience of the school.
- Change out filter in the HVAC unit including the one in the Speech Therapy Class.

Additionally, the Safety Energy Environmental stated that his staff would be wiping down the desks and chairs in the classrooms.

It is strongly recommended that a copy of this report and attachments be made available to all affected students, parents, management and faculty.

Public Health Action Plan: All recommendations were given and no further actions are needed at this time. The school or the local health agency will contact NC DHHS if further assistance is required. Currently NC DHHS is working on a comprehensive Mercury Standard Operating Procedure SOP and guidance document complete with websites and support network. This should enhance NC DHHS response to mercury incidents in the future and provide guidance to outside agencies.

If any citizen has questions or concerns about mercury in schools or this health consultation, please contact the NC DHHS Occupational and Environmental Epidemiology Branch at (919) 707-5900.

Report Preparation

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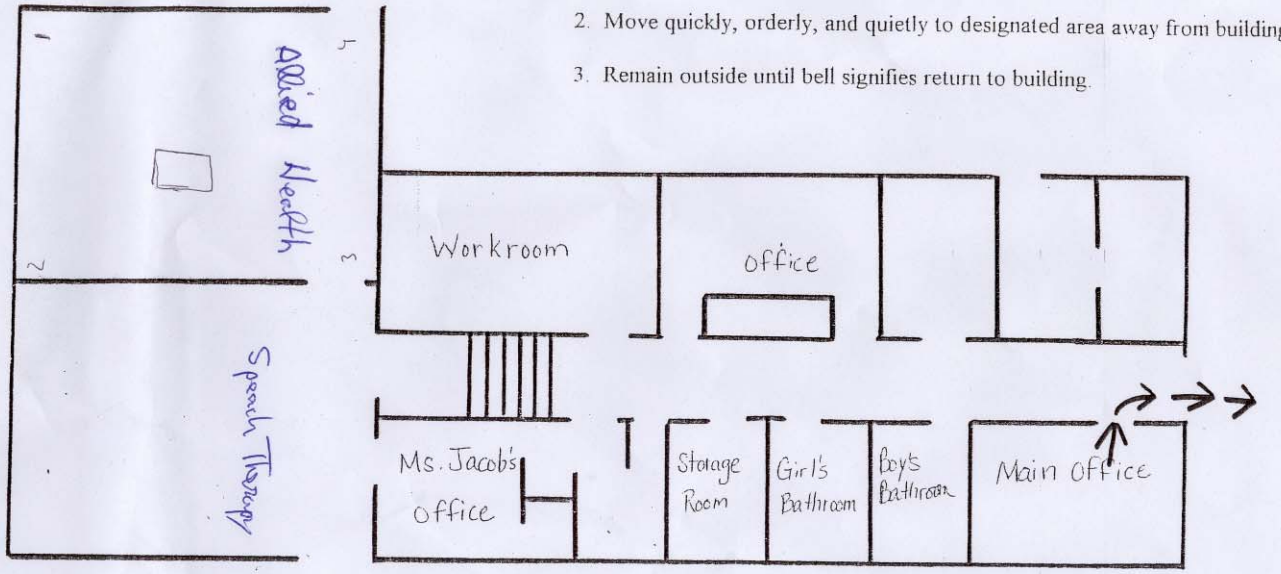
Appendix A

Site Layout and Location Map

FIRE EVACUATION PLAN

Evacuation Procedure

1. Follow route indicated by red arrows.
2. Move quickly, orderly, and quietly to designated area away from building.
3. Remain outside until bell signifies return to building.



Appendix B

ATSDR Suggested Action Levels for Mercury

Suggested Action Levels for Indoor Mercury Vapors in Homes or Businesses with Indoor Gas Regulators

Purpose: This document is intended solely as a quick reference guide for use by public health and environmental officials in evaluating data collected from structures in which mercury pressure regulating devices for natural gas meters were moved from inside to outside the structures as part of a modernization process. It does not provide detailed justifications for environmental sampling requirements, as health consultations or environmental sampling plans may do.

In the past, ATSDR has been reluctant to provide a list of suggested action levels such as this because of the site specific nature of exposures. ATSDR has recognized that action levels can differ according to differing populations, exposure durations, concentrations, and specific hazards. However, the immediacy and extent of the potential health risk associated with mercury contamination in the present situation require publication of this guide. Many parts of the country may be affected by the possible exposure to mercury resulting from re-positioning of mercury-containing gas pressure regulators and the subsequent response efforts of gas utilities, public health and environmental officials. Moreover, the involvement of multiple health and environmental jurisdictions creates a need for consistency in presenting health risk information. Therefore, ATSDR, at the request of a state health department and an U.S. EPA regional office, is attempting to provide suggested action levels for various response activities under different exposure scenarios.

Background: In this context, an *action level* is an indoor air concentration of mercury vapor, which should prompt consideration of the need to implement a recommended response by public health and environmental officials. The various suggested action levels provided in this document are intended as recommendations, not as regulatory values or cleanup values, although some may correspond to present or future values adopted by regulatory authorities.

The suggested action levels presented in this document recognize that an individual must be exposed to a sufficient concentration over some specific period of time in order for mercury vapor to cause adverse health effects. The suggested action levels also recognize that while individual susceptibility may vary, developing fetuses and young children under six years old are generally at higher risk than others of incurring adverse health effects from exposure to mercury vapor. If the indoor air concentration corresponding to any suggested action level is exceeded, then a potential health risk may be present, and responders should evaluate the exposures at that location and consider implementing appropriate protective measures to reduce or eliminate the risk.

The suggested action levels presented here are based on data available in ATSDR's Toxicological Profile for Mercury (1999) or in the Hazardous Substance Databank of the Toxicology Data Network at the National Library of Medicine. ATSDR has also made use of additional data collected by the US Environmental Protection Agency (EPA) and of specific experiences of ATSDR at other sites. Other factors considered in the

development includes available information on normal background levels and analytical detection limits of various techniques for evaluating airborne contamination. Any information specific to the exposures at any given location as described below should also be considered before implementing a response action.

These suggested action levels are extrapolated from health guidance values (HGVs) independently developed by two federal agencies, ATSDR and EPA. These HGVs are based on both animal studies and human epidemiology studies that detail the health effects of inhalation of mercury-contaminated air. ATSDR has developed a chronic

Minimal Risk Level (MRL) of 0.2 ug/m^3 that is based on a 1983 study of workers exposed to an average Lowest Observed Adverse Effect Level (LOAEL) of 26 ug/m^3 over an average of 15 years. This workplace average exposure was adjusted from a 40 hour per week exposure to a 168 hour per week exposure (i.e., 24 hours/day, 7 days/week) and then divided by an uncertainty factor of 30 to account for the use of the LOAEL and the different sensitivities of individuals. In addition, EPA has used the same study to develop a Reference Concentration (RfC) of 0.3 ug/m^3, using different assumptions and uncertainty factors. ATSDR considers the RfC and the Chronic MRL to be the same value for all practical purposes. An MRL, then, is defined as an estimate of the daily exposure level to a hazardous substance (in this case, metallic mercury) that is likely to be without appreciable risk of adverse, non-cancer health effects (metallic mercury is not 1 considered to be a carcinogenic substance) over a specific exposure route and duration of exposure. For further information, see Section 2.5, Chapter 7, and Appendix A of the ATSDR Tox Profile and the EPA's Integrated Risk Information System (IRIS) on the Internet at www.epa.gov/ngispgm3/iris/index.html.

The suggested action levels in the tables below were designed for a group of structures where pressure regulators using approximately 2 teaspoons (and perhaps more) of mercury (~10 ml or 135 g) and the accompanying gas meters were re-positioned from the interior of buildings (including homes) to the exterior. During this adjustment of regulator location that may have taken place some time ago, mercury was spilled in some instances. However, spills of mercury may not have occurred indoors. Therefore, the categories of exposure include (a) buildings that may have had no spills; (b) buildings that had spills and needed cleanup but had air mercury levels that constitute no immediate health risk; and (c) buildings that had spills resulting in indoor air concentrations sufficient to warrant isolating humans from the exposure. In general, the screening for these homes or businesses consists of: (1) confirming that a natural gas meter had been in the building and moved outside; (2) observing the area where the gas meter had been originally for metallic mercury; (3) asking the resident if they had ever noticed metallic mercury in the vicinity of the gas meter; and, (4) evaluating the area with a Jerome™ meter or the equivalent. If there is any positive indicator of mercury on the Jerome Mercury Vapor Analyzer (a real-time air monitoring instrument) that cannot be explained by interferences, then the building is placed on the list for further characterization.

Visible mercury is not only a source of vapors but also a tracking hazard and an attractive nuisance. No matter what the airborne concentration is, free liquid mercury may pose a problem in the general population. Generally, a condition that no visible mercury be present is stipulated only at stages when cleanup is completed. This condition may be considered as much a check on the data quality as anything else. It is rare that liquid mercury exists at concentrations as low as would be considered safe in most exposure scenarios other than a workplace where mercury is used in the production process.

General Exposure Assessment Considerations: The primary route of entry for metallic mercury is by inhalation; ingestion and skin absorption of this form of mercury is usually not biologically significant. Sensitive populations to mercury exposure are those with developing central nervous systems, including young children and the fetuses of women who are pregnant. Other individuals of potential concern are those with pre-existing kidney conditions, usually at exposures to much higher concentrations than the first group. The specific exposure of these groups in any given situation should be considered when assessing the need for any given response action. Specific concerns are mentioned in the tables below. If there is any doubt, responders should consult with state or local public health officials before deciding on a course of action. Responders may also contact ATSDR at 404-639-0615, 24 hours a day.

Exposure Assumptions for Different Settings: For the purposes of this document, the residentially exposed population includes infants, small children, and pregnant women presumed to have inhaled mercury for a period up to 24 hours per day, 7 days per week potentially for months or even years. Occupational or commercial settings include those individuals that are primarily healthy adults exposed up to 8-10 hours per day, 40 hours per week, with transient exposures by sensitive populations (e.g., a retail establishment or schools). The concentrations provided as suggested action levels are for comparison to the environmental data collected in affected residences and workplaces.

Indoor Air Concentration (ug/m3)	Use of the Action Level	Rationale for Action Level	Method of Analysis *	Reference
<1.0	Level acceptable for occupancy of any structure after a spill (also called the residential occupancy level.)	A spill occurred in this building, and the risk manager needs to know if the building is safe for occupancy. ATSDR would prefer no one ever be chronically exposed to concentrations above the MRLs; however, experience has shown cleanup operations in a response to concentrations below 1 ug/m3 can be extremely disruptive to individual and family quality of life. While this concentration is slightly above HGVs, this level is still 25 times lower than the human LOAEL on which the MRL is based. An indoor air concentration of 1 ug/m3, as measured by the highest quality data (e.g., NIOSH 6009 or equivalent), is considered safe and acceptable by ATSDR, provided no visible metallic mercury is present.	NIOSH 6009 or equivalent	Based on HGVs above. ATSDR, 1999. EPA/ IRIS
No qualitative detection on an Arizona Instrument's Jerome™ Meter.	Screening level for homes that had indoor gas meters with no evidence of a spill	Mercury was present in the regulator inside the home, but no evidence of a spill is found. The qualitative detection limit of the most commonly available air monitoring instruments approximates 1 order of magnitude below levels of known human health effects. As there e was no spill, no visible metallic mercury should be present. Natural ventilation (e.g., windows, HVAC air changes, etc.) should reduce any concentration even lower with no disruption of family life or costs.	Real-time Air monitoring instrument (i.e., Jerome™ meter or equivalent)	
10	Isolate residents from the exposure	When adjusted from an intermediate to chronic exposures to a continuous exposure scenario (i.e., 24 hrs/day, 7days/week), this concentration approaches levels reported in the literature to cause subtle human health effects. Applied to acute exposures with good accuracy by real-time instruments, this value allows for interventions before health effects would be expected. Whenever possible, the mercury vapors should be prevented from reaching living spaces rather than temporarily relocating individuals. See the building evaluation protocol developed for these situations in your area and Section 2.1 of ATSDR's Toxicological Profile.	Real-time Air monitoring instrument (i.e., Jerome™ meter or equivalent)	ATSDR, 1999.
10	Acceptable level in a modified test procedure to allow personal effects to remain in the owner's possession	For personal effects, such as clothing, warmed in a discrete plastic container much smaller than a typical room (e.g., a garbage bag), this concentration in the air trapped inside the con tainer is considered safe by ATSDR based on a number of factors.	Real-time Air monitoring instrument (i.e., Jerome™ meter or equivalent)	

Indoor Air Concentration (ug/m3)	Use of the Action Level	Rationale for Action Level	Method of Analysis *	Reference
3.0	Re-occupancy after a spill of an occupational or commercial setting where mercury is not usually handled.	Based on residential occupancy level but adjusted for the shorter duration exposures typical of most workplaces. This concentration approximates one order of magnitude below levels of known human health effects, provided no visible metallic mercury is present to act as an attractive nuisance or a source for more vapors. Those exposed in this instance would not expect hazards associated with mercury as part of their normal work and may include transient exposures by more sensitive individuals (e.g., retail facilities).	NIOSH 6009 or equivalent	HGVs. ATSDR, 1999. EPA/ IRIS
25	Occupational settings where mercury is handled. •	Based on the 1996 ACGIH TLV. Assumes hazards communications programs as required by OSHA; engineering controls as recommended by NIOSH; and medical monitoring programs as recommended by the ILO, NIOSH, and ACGIH are in place. This concentration is ½ the peer-reviewed 1973 NIOSH REL and 1/4 the regulatory 1972 OSHA PEL. See HSDB at toxnet.nlm.nih.gov/sis on the Internet.	Real-time Air monitoring instrument (i.e., Jerome™ meter or equivalent)	HSDB, 1999
25	Response Worker Protective Equipment Upgrade. •	Response workers subject to HAZWOPER should evaluate need to upgrade protective equipment. Based on the 1996 ACGIH TLV. Assumes hazards communications programs as required by OSHA; engineering controls as recommended by NIOSH; an d medical monitoring programs as recommended by the ILO, NIOSH, AND ACGIH are in place. This concentration is half the peer-reviewed NIOSH REL and a quarter of the regulatory OSHA PEL. See HSDB at toxnet.nlm.nih.gov/sis on the Internet. For these workers, engineering controls are not typically in place, and it is not possible to control the exposure by other safety techniques.	Real-time Air monitoring instrument (i.e., Jerome™ meter or equivalent)	29 CFR 1910.120; 40 CFR 311; NIOSH, 1987
10,000	IDLH. Response Workers Protective Equipment upgrade.	Response workers subject to HAZWOPER should upgrade protective equipment. See http://www.cdc.gov/niosh/idlh/ on the Internet.	Real-time Air monitoring instrument (i.e., Jerome™ meter or equivalent)	29 CFR 1910.120; 40 CFR 311; NIOSH 1987

Appendix C

Tables

Table 1: Background Samples in Harry L. Hallyburton Elementary Allied Services Building

Location	Temp°F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (1.5 µg/m^3)	Above Recommended Limit (3.0 µg/m^3)
Background 1 Pre Sample 0930	61.3	57.0	0.083	No	No
Background 2 Post Sample 1200	65.0	57.0	0.038	No	No

Table 2: Area samples in room with personal items

Location	Temp °F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (1.5 µg/m^3)	Above Recommended Limit (3.0 µg/m^3)
A1 Door	65.0	57.0	0.07	No	No
A2 Avg Center Room	65.0	57.0	5.64	Yes	Yes
A3 Average	65.0	57.0	5.62	Yes	Yes
A4 Average	65.0	57.0	5.89	Yes	Yes
A5 Corner 1	65.0	57.0	5.68	Yes	Yes
A6 Corner 1	65.0	57.0	5.62	Yes	Yes
A7 Corner 1	65.0	57.0	5.72	Yes	Yes
A8 Corner 2	65.0	57.0	6.08	Yes	Yes
A9 Corner 2	65.0	57.0	6.05	Yes	Yes
A10 Corner 2	65.0	57.0	6.08	Yes	Yes
A11 Corner 3	65.0	57.0	5.78	Yes	Yes
A12 Corner 3	65.0	57.0	5.94	Yes	Yes
A13 Corner 3	65.0	57.0	5.91	Yes	Yes
A14 Corner 4	65.0	57.0	5.70	Yes	Yes
A15 Corner 4	65.0	57.0	5.69	Yes	Yes
A16 Corner 4	65.0	57.0	5.62	Yes	Yes

Table 3: Area sample in room with personal items removed doors open

Location	Temp °F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (1.5 µg/m^3)	Above Recommended Limit (3.0 µg/m^3))
A1_1 Corner 1	65.0	57.0	0.39	No	No
A1_2 Corner 2	65.0	57.0	0.25	No	No
A1_3 Corner 3	65.0	57.0	0.27	No	No
A1_4 Corner 4	65.0	57.0	0.14	No	No

Table 4: Validation sample >area sample room closed for 30 min

Location	Temp °F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (1.5 µg/m^3)	Above Recommended Limit (3.0 µg/m^3)
A2_1 Corner 1	65.0	57.0	0.73	Yes	No
A2_2 Corner 2	65.0	57.0	1.11	Yes	Yes
A2_3 Corner 3	65.0	57.0	1.05	Yes	Yes
A2_4 Corner 4	65.0	57.0	0.91	Yes	No

Table 5: Bags containing clothing and personal items

Location	Temp °F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (5.0 µg/m^3)	Above > Recommended Limit (1.0 - 10 µg/m^3)
B1	62	57.0	0.75	No	No
B2	62	57.0	0.98	No	No
B3	62	57.0	0.15	No	No
B4	62	57.0	1.89	No	No
B5	62	57.0	0.74	No	No
B6	62	57.0	0.96	No	No
B7	62	57.0	0.28	No	No
B8	62	57.0	0.51	No	No
B9	62	57.0	1.76	No	No
B10	62	57.0	1.13	No	No
B11	62	57.0	0.74	No	No
B12	62	57.0	0.75	No	No
B13	62	57.0	18.93	Yes	Yes
B14	62	57.0	9.19	Yes	No
B15	62	57.0	0.56	No	No
B16	62	57.0	2.48	No	No
B17	62	57.0	1.31	No	No
B18	62	57.0	4.37	No	No
B19	62	57.0	50.0	Yes	Yes
B20	62	57.0	9.31	Yes	No
B21	62	57.0	2.06	No	No
B22	62	57.0	35.37	Yes	Yes
B23	62	57.0	32.59	Yes	Yes
B24	62	57.0	3.48	No	No
B25	62	57.0	3.65	No	No
B26	62	57.0	2.43	No	No
B27	62	57.0	12.77	Yes	Yes
B28	62	57.0	50.0	Yes	Yes
B29	62	57.0	22.75	Yes	Yes
B30	62	57.0	0.28	No	No

Table 6: Area sample custodial closet & adjoining room

Location	Temp °F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (1.5 µg/m^3)	Above Recommended Limit (3.0 µg/m^3)
Custodial Closet Outside	65.0	57.0	0.06	No	No
Speech Therapy	Unk	Unk	0.32	No	No
Custodial Closet Inside	Unk	Unk	0.27	No	No
D1 55 Gal Containment Barrel	65.0	57.0	0.20	No	No

Table 7: Re-test bags opened 1030 sample taken @ 1130

Location	Temp °F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (5.0 µg/m^3)	Above > Recommended Limit (1.0 - 10 µg/m^3)
B26_1	63.0	57.0	0.007	No	No
B17_1	63.0	57.0	0.17	No	No
B20_1	63.0	57.0	0.06	No	No
B24_1	63.0	57.0	0.60	No	No
B16_1	63.0	57.0	1.24	Yes	Yes
B19_1	63.0	57.0	1.02	No	No
B25_1	63.0	57.0	1.11	No	No
B10_1	63.0	57.0	3.18	No	No
B11_1	63.0	57.0	1.51	No	No

Table 8: Cell Phones and Wallets Bags

Location	Temp °F	Relative Humidity %	Mercury Detected µg/m^3	Above Action Level (5.0 µg/m^3)	Above > Recommended Limit (1.0 - 10 µg/m^3)	Mercury Blood Level Results (µg/L)ref range mercury 0.0-14.9 *
C1	63.0	57.0	0.25	No	No	1.3
C2	63.0	57.0	0.02	No	No	2.2
C3	63.0	57.0	0.24	No	No	1.1
C4	63.0	57.0	0.27	No	No	1.0
C5	63.0	57.0	0.26	No	No	2.1
C6	63.0	57.0	0.09	No	No	ND**
C7	63.0	57.0	0.12	No	No	2.0
C8	63.0	57.0	0.21	No	No	3.3
C9	63.0	57.0	0.19	No	No	1.2
C10	63.0	57.0	0.19	No	No	ND**
C11	63.0	57.0	0.20	No	No	ND**
C12	63.0	57.0	0.26	No	No	2.6
C13	63.0	57.0	0.31	No	No	1.9
C14	63.0	57.0	0.31	No	No	1.6
C15	63.0	57.0	0.22	No	No	1.6
C16	63.0	57.0	0.24	No	No	ND**
C17	63.0	57.0	0.16	No	No	ND**

*Reference range is considered the acceptable range of mercury levels in humans as indicated by the laboratory conducting the tests

** ND = None Detected

Appendix D

Photos

Figure 1E: Inside room with personal items

Figure 2E: Inside room with personal items

Figure 3E: Sampling personal items

Figure 4E: Sampling personal items method

Figure 5E: Sampling personal items close-up

Figure 6E: Access door inside hallway connecting Allied Services to school

Figure 7E: Personal items which exceeded limit placed outside for venting

Figure 8E: Inside carpet removed area photo

Figure 8E: Inside carpet removed area photo

Appendix E

ATSDR ToxFAQ's Mercury

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

MERCURY
CAS # 7439-97-6

Agency for Toxic Substances and Disease Registry ToxFAQs **April 1999**

This fact sheet answers the most frequently asked health questions (FAQs) about mercury. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to mercury occurs from breathing contaminated air, ingesting contaminated water and food, and having dental and medical treatments. Mercury, at high levels, may damage the brain, kidneys, and developing fetus. This chemical has been found in at least 714 of 1,467 National Priorities List sites identified by the Environmental Protection Agency.

What is mercury?
(Pronounced mŭr′kyə-rē)

Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas.

Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make.

Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments.

What happens to mercury when it enters the environment?

- Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants.
- It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity.
- Methylmercury may be formed in water and soil by small organisms called bacteria.
- Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.

How might I be exposed to mercury?

- Eating fish or shellfish contaminated with methylmercury.
- Breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fuels.
- Release of mercury from dental work and medical treatments.
- Breathing contaminated workplace air or skin contact during use in the workplace (dental, health services, chemical, and other industries that use mercury).
- Practicing rituals that include mercury.

How can mercury affect my health?

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.

Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea,

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service
Agency for Toxic Substances and Disease Registry

vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

How likely is mercury to cause cancer?

There are inadequate human cancer data available for all forms of mercury. Mercuric chloride has caused increases in several types of tumors in rats and mice, and methylmercury has caused kidney tumors in male mice. The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.

How can mercury affect children?

Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also can pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk.

Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

How can families reduce the risk of exposure to mercury?

Carefully handle and dispose of products that contain mercury, such as thermometers or fluorescent light bulbs. Do not vacuum up spilled mercury, because it will vaporize and increase exposure. If a large amount of mercury has been spilled, contact your health department. Teach children not to play with shiny, silver liquids.

Properly dispose of older medicines that contain mercury. Keep all mercury-containing medicines away from children.

Pregnant women and children should keep away from rooms where liquid mercury has been used.

Learn about wildlife and fish advisories in your area from your public health or natural resources department.

Is there a medical test to show whether I've been exposed to mercury?

Tests are available to measure mercury levels in the body. Blood or urine samples are used to test for exposure to metallic mercury and to inorganic forms of mercury. Mercury in whole blood or in scalp hair is measured to determine exposure to methylmercury. Your doctor can take samples and send them to a testing laboratory.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 2 parts of mercury per billion parts of drinking water (2 ppb).

The Food and Drug Administration (FDA) has set a maximum permissible level of 1 part of methylmercury in a million parts of seafood (1 ppm).

The Occupational Safety and Health Administration (OSHA) has set limits of 0.1 milligram of organic mercury per cubic meter of workplace air (0.1 mg/m^3) and 0.05 mg/m^3 of metallic mercury vapor for 8-hour shifts and 40-hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for mercury. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

CERTIFICATION

This health consultation was prepared by the North Carolina Department of Health and Human Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health assessment was begun. Editorial review was completed by the cooperative agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation, and concurs with its findings.

Alan Yarbrough
Team Leader
CAT, CAPEB, DHAC, ATSDR