Health Consultation

Mercury in St. Paul Residence

St. Paul, Ramsey County, Minnesota

September 2001

Prepared By:

The Minnesota Department of Health
in Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

FOREWORD

This document summarizes health concerns associated with a house contaminated with mercury from a natural gas regulator in St. Paul, Minnesota. This document is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). A number of steps are necessary to do such an evaluation, and include the following:

- Evaluating exposure: MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is found on the site, and how people might be exposed to it. Usually, MDH does not collect environmental sampling data. We rely on information provided by the Minnesota Pollution Control Agency (MPCA), U.S. Environmental Protection Agency (EPA), and other government agencies, businesses, and the general public.

- Evaluating health effects: If there is evidence that people are being exposed—or could be exposed—to hazardous substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. The report focuses on public health—the health impact on the community as a whole—and is based on existing scientific information.

- Developing recommendations: In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by a site, and offers recommendations for reducing or eliminating human exposure to contaminants. The role of MDH in dealing with hazardous waste sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. However, if there is an immediate health threat, MDH will issue a public health advisory warning people of the danger and will work to resolve the problem.

- Soliciting community input: The evaluation process is interactive and ongoing. Typically, MDH begins by soliciting and evaluating information from various government agencies, the organizations responsible for cleaning up the site, and the community surrounding the site. Any conclusions about the site are shared with the groups and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, we encourage you to contact us*.

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The Minnesota Department of Health (MDH) was contacted on June 8, 2001 by the Minnesota

Pollution Control Agency (MPCA) and Judy Grant, a representative of Xcel Energy Company (Xcel), with concerns about the contamination of a house with mercury. A reportedly small amount of mercury was spilled from a piece of equipment which had been removed from the natural gas line in the basement of the house by Mueller Pipeliners under contract to Xcel. Elemental mercury vaporizes and can be inhaled by individuals in the vicinity of a spill. Exposure to mercury vapors have been associated with permanent and severe central and peripheral nervous system effects.

This Health Consultation contains a summary of cleanup operations and the health implications of mercury vapor data from this residence. Throughout this document Xcel is cited as the party assuming the obligation to clean up the spill. MDH may have identified some tasks performed by subcontractors, as tasks performed by Xcel.

A Xcel Energy report on the spill and cleanup activities is attached to this health consultation (Attachment #1; Xcel Energy, 2001c). Additionally, a record of mercury vapor concentrations measured in the house is attached (Attachment #2; Xcel Energy, 2001d). These reports contain a summary of daily activity at the site and a compilation of mercury vapor data collected.

Instruments and Methods

Mercury vapor data was collected from handheld instrument operated by employees of MDH, MPCA, Xcel, and Weston, Inc (Chicago). Table #1 contains a list of the instruments used on the site, operating parameters, and instrument limitations. Information about the Tekran mercury vapor analyzer is also included because it has been used by MDH and MPCA at other residences in Minnesota.

Table #1: Portable Mercury Vapor Analyzers

Instrument	Model	Flowrate	Sampling Period	Detection Limit	Sensitivity (resolution)	Limitations
Jerome (Arizona Instrument, Tempe, Arizona)	431-X	0.75 L/min	4 - 13 sec	0.001 mg/m^3	0.003 mg/m^3	High detection limit / low sensitivity
Lumex (OhioLumex, Cleveland, OH)	RA-915$^+$	20 L/min	10 sec	2 ng/m^3	(1 ng/m^3)	sensitivity decreases near 50,000 ng/m^3
Nippon (Nippon Instrument Corporation, Osaka, Japan)	EMP 1-A	1.5 L/min	60 sec (survey - 1 sec)	0.001 mg/m^3	(0.001 mg/m^3)	High detection limit / low sensitivity
Tekran (Tekran, Inc., Toronto, Ontario)	2537A	1.5 L/min	300 sec	0.10 ng/m^3	(0.10 ng/m^3)	operates from trailer - 60 foot teflon hose connection

L/min - liters per minute
sec - seconds
mg/m^3 - milligrams (1/1000 gram) per cubic meter
ng/m^3 - nanograms (1/1,000,000 milligram) per cubic meter

Three different handheld instruments were used to measure mercury vapor concentrations real-time, at the St. Paul house. A Jerome meter was used by BayWest; MPCA, MDH, and Xcel used a Lumex; and Weston used a Nippon. In addition, Applied Environmental Services collected air samples in SKC Hydrar tubes. Air was drawn through the tubes at a rate of 0.5 L/min for about 6.5 hours. These tubes were then analyzed using OSHA ID-140 methods.

Summary of events

The removal of a mercury containing piece of equipment attached to natural gas residential service and the subsequent mercury spill occurred on June 5, 2001. The mercury containing equipment was taken to an Xcel Energy service shop and disassembled. At the time it was disassembled, it contained a couple of tablespoons of mercury (Xcel Energy, 2001c). The device was identified as a low pressure gas regulator or 'slam-valve'. Previous limited experience with this type of equipment was the basis for Xcel personnel suggesting that similar regulators contained 5 to 6 pounds (lbs) of mercury and were sold as add-on equipment for low pressure protection of individual houses prior to 1950.

Xcel Energy contracted BayWest to clean up the spill in the basement of the residence on June 7. Cleanup entailed:

- Vacuuming (Minutemen Mercury Vacuum)
- Mercury cleanup powder (Mercury Absorb, Lab Safety)
- Wiping areas of concern (Mercon Wipes, Mercon)
- Spraying areas of concern (Mercon Vap, Mercon)
- Ventilating through a basement window with fans.

The maximum mercury vapor concentration measured during this cleanup was reported to be 349,000 nanograms per cubic meter (ng/m^3) (Xcel Energy, 2001a). This high concentration was not expected and therefore, questions about possible interference, or cross-sensitivity from ammonia in a cat litter box were raised. It was confirmed that kitty litter and other odorous material can interfere with correct readings on the Jerome meter.

Following cleanup, BayWest reported mercury vapor concentrations in the basement, with windows open and fans blowing, were 'going down to' the Jerome detection limit of 0.001 milligrams per cubic meter (mg/m^3; 1,000 ng/m^3) (Xcel Energy, 2001a).

Carol Hubbard, of MPCA, and Carl Herbrandson, of MDH, accompanied Judy Grant of Xcel Energy Environmental Services into the house on the afternoon of June 8. Using a Lumex, with a detection limit of 2 ng/m^3, mercury levels were measured outside the house, on the main floor, and in the basement. Mercury concentrations in ambient air outside the house fluctuated between less than 30 ng/m^3 and more than 150 ng/m^3. The high concentrations were recorded when the instrument and the sampling hose were in the sun. The instrument readings appeared to stabilize below 30 ng/m^3 when the instrument was held in the shade. Typical mercury concentrations outdoors are 1-3 ng/m^3. It is assumed that the elevated readings outdoors were a result of outgassing of mercury from the sampling hose and, perhaps, outgassing of internal parts of the instrument. At a later date it was confirmed that the meter had been recently used in a highly contaminated environment. Apparently, the sampling tube became contaminated, making it difficult to accurately record low mercury vapor concentrations.

We entered the kitchen through the back door and measured mercury concentrations between 1,500 and 3,500 ng/m^3 in the kitchen. The mercury concentration increased on the stairs to the basement. Mercury concentrations in the basement ranged from 20,000 to 51,000 ng/m^3. According to the manufacturer, the sensitivity of the Lumex flattens out as mercury concentrations in air approach 50,000 ng/m^3. Therefore, actual mercury vapor concentrations in the basement on June 8 may have been greater than recorded data.

The Lumex is not thought to be sensitive to ammonia, and readings near the kitty litter box were consistent with what was encountered in other areas of the basement.

The owner of the house was advised, by Xcel, that she would be put up in a hotel since levels of mercury vapor were above levels of health concern (see below). The resident stayed in her house for a couple of nights between June 8 and July 11, when MDH sent her a letter advising

her that the house was safe to reoccupy (Attachment #3: MDH, 2001). She spent the other nights at a hotel, or at friends' or relatives' houses.

On Wednesday June 13, a contractor experienced in cleaning mercury spills in basements (Weston, Chicago, IL) was hired by Xcel Energy to clean the residence. Using a Nippon mercury survey meter, Weston recorded a maximum reading of 756,000 ng/m^3 during their initial inspection. Moveable items in the basement were bagged and an initial cleanup was performed. Following this cleaning, Weston recorded a maximum mercury vapor reading of 757,000 ng/m^3.

Weston continued cleanup operations on June 14 and 15. On June 15 all moveable items were removed from the basement. Cleaning methods included use of mercury cleanup (amalgamating) kits, washing and scraping. Further information about the cleanup can be obtained from the Weston Mercury Cleanup Report (Mueller Pipeliners, 2001). Cleanup continued until all levels of mercury vapor, except those near the floor drain, were below the calibration limit (1,000 ng/m^3) on a Nippon mercury vapor survey meter (Xcel Energy, 2001a). On Friday afternoon (June 15th) Weston sealed the floor with an enamel paint. Friday night the house was vented.

Early on Saturday, June 16, the house was sealed and the furnace turned on to raise the temperature to about 80° F. At about 11:00 AM, Carl Herbrandson, MDH, accompanied the owner and Judy Grant, of Xcel, on what was to be a final inspection prior to collection of air samples for laboratory analyses. Mercury vapor concentrations on the main floor of the house were between 265 and 589 ng/m^3 (Lumex mean of 3 - 10 second samples). Mercury concentrations in the basement ranged from 881 ng/m^3 to a maximum of 1231 ng/m^3. Since these concentrations were above levels of concern, sample collection was postponed and clean up by Weston continued on Wednesday June 20.

Areas of the floor near the bottom of the basement stairs and a small partition on the north side of the eastern wall, as well as the washtub drain, were identified as potential source areas of mercury vapor. The washtub and partition were removed. Newly applied enamel and some concrete was scraped and/or chiseled from the floor in areas where high mercury readings were recorded. Fast-drying concrete was used to fill cracks and divots in the floor. On June 21, cleaning continued and floor areas associated with elevated concentrations, as well as areas of the walls in the northeast corner of the basement, were then sealed with clear epoxy.

On June 21 Lumex sampling showed mercury vapor levels throughout the house, including the basement, to be below 300 ng/m^3. MDH considers a mercury vapor of 300 ng/m^3 to be a safe exposure concentration (see below).

On Monday, June 22, air sampling was conducted by Franklin Dickson, Certified Industrial Hygenist, Applied Environmental Services, Inc. (AES). EPA-ATSDR developed protocols (see Attachment #4), used for similarly contaminated houses in Illinois, were used during this sampling. These protocols included, closing up the house and heating it to between 75 and 80°

F. for two hours prior to drawing air samples. Samples were taken in 5 SKC Hydrar tubes (plus one outside sample). Two samples were drawn on each of the first and second floor, and one sample was taken near the laundry area in the basement. A field blank and 2 laboratory blanks were also prepared. The sample tubes were analyzed by Braun Intertech Laboratory. Mercury concentrations throughout the house were below the identified level-of-concern of 300 ng/m^3 (see below). Analytical results are listed in Table #2, below (AES, 2001).

Table #2: SKC Hydrar Tube Data - 6½ hour samples

Sample #	Location	Mercury Concentration
1.	Living Room	210 ng/m^3
2.	Dining Room	180 ng/m^3
3.	Master Bedroom	140 ng/m^3
4.	Second Bedroom	100 ng/m^3
5.	Basement	270 ng/m^3
6.	Outdoors - back porch	less than 100 ng/m^3

On July 3, AES completed their report and faxed it to MDH. Upon review of the AES report and the Xcel summary report, MDH mailed a letter to the resident on July 11, 2001, notifying her that mercury vapor levels in the house were below levels of concern and that it was, therefore, safe to reoccupy (Attachment #3; MDH, 2001b). On July 13, Carl Herbrandson, MDH, met with Judy Grant and the owner of the house to answer questions and to conduct followup testing with the Lumex (Xcel Energy, 2001a). During this visit, the basement door and windows were closed, but windows on the first and second floor were open. Air flow from outside probably forced the mercury vapor concentrations on the first floor (2 and 16 ng/m^3) to levels which may not be indicative of exposure levels in a closed house. But the low levels recorded in the basement (93 to 269 ng/m^3) demonstrated a continuing decrease in mercury vapor concentrations in the basement.

Summary of mercury vapor sample data

Differences were noted between readings with the Lumex and the Nippon meters. Direct comparisons was made between the 2 mercury vapor meters on June 13 and again on June 15. Side-by-side comparisons are difficult because the Lumex is about 1000 times more sensitive than the Nippon and because the sampling times and the sample flowrates for the 2 instruments are different (see Table #1). Seven of the 11 comparative readings taken with the Nippon on June 15 were at the instrument detection limit (0.001mg/m^3). At this level the Nippon would not be expected to be very sensitive to changes in concentration. The remaining readings on the Nippon were between 2 and 5 times the detection limit. Thirty side-by-side samples were taken on the first and second floors on June 13. Another eleven side-by-side samples were taken in the basement (see Attachment #2). The data recorded from the 2 instruments were different. There is no clearly identifiable reason for the differences, however it is probable that the differences resulted from different sample rates and periods, as well as different detection limits (see Table #1). In addition, some data (4) from the Nippon in the basement exceeded 50,000 ng/m^3. The Lumex response is known to decrease near this concentration.

MDH and the MPCA have confidence that, while the baseline readings may be elevated by

contamination of the sampling hose and contamination of the Lumex instrument itself (such as on June 8) , the Lumex appears to be accurate and consistent at concentrations above this baseline. The Lumex's accuracy is supported by the close agreement between Lumex data and the data from air samples analyzed in the Braun Intertek laboratory. MDH has not operated Nippon or Jerome meters.

Real-time sampling with handheld instruments was conducted for 2 different purposes: to identify 'hotspots' or source areas; and to determine reasonable estimates of exposure to people in the house. Statistical sampling methods were not incorporated when sampling areas of the house. Therefore, while reported mean mercury concentrations in air (Table #3) generally reflect concentrations found in areas of the house, they do not represent true average concentrations. Reported means may overestimate potential human exposures. Maximum recorded concentrations may be close to the actual maximum concentration in an area of the house.

Attachment #2 is a record of data collected at the house by Judy Grant of Xcel Energy. Mercury vapor sampling data were recorded on June 8 (instrument used; Lumex), 13 (Lumex and Nippon), 14 (Lumex and Nippon), 15 (Lumex and Nippon), 16 (Lumex), 18 (Lumex), 20 (Lumex and Nippon), 21 (Lumex), 22 (Lumex and SKC Hydrar tubes), 25 (Lumex), July 3 (Lumex), and July 13 (Lumex).

BayWest did not record mercury vapor concentrations in this house prior to cleanup. Additionally, according to Xcel, BayWest did not submit a written report of their activities to Xcel (Xcel Energy, 2001b). Information about the original cleanup was related to Xcel verbally. Data provided by BayWest are not recorded in Attachment #2. BayWest reported maximum mercury concentrations during their cleanup, on June 7, of about 349,000 ng/m^3. While they reported mercury vapor concentrations near the Jerome detection limit (0.001 mg/m^3) following their cleanup, mercury concentrations as recorded by Xcel and MDH rose to over 30 times that level the next day, and to over 80,000 ng/m^3 within 5 days (see Table #3 or Attachment #2).

Mercury vapor concentrations generally decreased throughout the cleanup. However, there were days, such as June 13, 16, and 20, when concentrations increased (see Table #3 or Attachment #2). On these days it is probable that either there was less ventilation, the temperature was higher, or additional sources of mercury vapor were uncovered or disturbed.

Table #3 is a summary table of available data. Calculated means of Lumex and/or Nippon data are on the left side of the table in bold. Maximum and minimun data are on the right side of the table. Data are categorized as basement, 1st floor and 2nd floor data. Data that were obtained on the stairs to the basement is not included in the table. See Attachment #2 (Xcel Energy, 2001c) for individual sample data.

Table #3: Mercury Vapor Data (ng/m^3) - Means and Ranges

Date	Basement	1st Floor	2nd Floor		Basement		1st Floor		2nd Floor	
	Mean	Mean	Mean		Max	Min	Max	Min	Max	Min
6/8/01	**34,876**	**1,916**	**432**		51,000	23,160	3,525	1,170	674	268
6/13/01	**86,114**	**3,971**	**1,849**		757,000	2,000	16,410	0	2,089	1,687
6/14/01	**3,977**	**216**	**76**		21,000	0	1,000	0	111	46
6/15/01	**698**	**30**			2,055	101	41	18		
6/16/01	**1,063**	**428**			1,231	881	589	265		
6/18/01	**521**	**213**			3,047	60	288	154		
6/20/01	**1,506**	**268**			14,770	649	1,000	0		
6/21/01	**457**	**46**			1,800	0	337	7		
6/22/01	**221**	**128**	**109**		270	165	171	93	127	92
6/25/01	**192**	**17**	**7**		249	137	37	5	7	6
7/3/01	**165**	**18**			212	138	18	18		
7/13/01	**139**	**9**			269	93	16	2		

Mercury toxicity health-based exposure values

Health-based exposure values, developed by agencies of state and federal governments, are calculated to be safe exposure concentrations for defined exposure durations. Exposure to chemicals at or below the chronic health-based values for a lifetime, or the acute health-based values for an hour should not result in adverse health effects to the general public including sensitive subpopulations. Protective uncertainty factors have been included in health-based exposure criterion to limit the probability of anyone experiencing an effect, in addition to limiting the severity of any possible effect. However, as the exposure concentration increases above the health-based value, the risk of experiencing an adverse effect increases.

MDH uses health-based reference values from different sources based on availability. Typically, MDH uses health-based numbers in the following preferential order: proposed MDH Health Risk Values (HRVs); US Environmental Protection Agency (EPA) Integrated Risk Information System (IRIS) reference concentrations (RfCs); California Reference Exposure Levels (RELs); EPA Health Effects Assessment Summary Tables (HEAST) RfCs and other health-based values, such as Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs).

Currently there is not a MDH HRV for elemental mercury.

Chronic exposure values: mercury (elemental)
The US EPA IRIS database (2001) specifies a RfC for chronic exposure to mercury vapor of 300 ng/m^3. A RfC is an exposure concentration which is not expected to result in adverse health effects in most people, including sensitive subpopulations, exposed over a lifetime. The mercury RfC is based on multiple studies of occupational exposures. Most studies were conducted by studying employees in chlor-alkali plants who were exposed to mercury vapor. The critical effects seen were: hand tremor; increases in memory disturbances; slight subjective and objective evidence of autonomic nervous system dysfunction. The lowest observable adverse effects concentration (LOAEC) in the occupational studies converge at 25 micrograms per cubic meter ($\mu g/m^3$). (Affected workers had mean whole blood mercury concentrations of 10 - 12 micrograms per liter ($\mu g/L$).) Adjusted to a 24 hour, 7 day per week exposure, the $LOAEC_{adj}$ = 9.0 $\mu g/m^3$. An uncertainty factor of 30 was applied to the $LOAEC_{adj}$ to reduce the RfC to a level which is assumed to be associated with no adverse effects. The uncertainty factor includes a factor of 10 for human variation in sensitivity, and a factor of 3 for lack of studies on the reproductive and developmental effects of elemental mercury. Therefore, it is presumed that exposure below the RfC will incur no adverse effect.

The calculation of this RfC assumes that there is a threshold level for effects. A threshold for toxicity from mercury vapor exposure is presumed in the standard model used by EPA for non-carcinogens.

The California Office of Environmental Health Hazard Assessment (OEHHA) has adopted a Reference Exposure Level (REL) for chronic inhalation exposure to mercury which is based on the same studies used to develop the IRIS RfC. However, instead of using a cumulative uncertainty factor of 30, which was used by the US EPA, OEHHA has adopted an uncertainty factor of 100. This is based on a factor of 10 for the uncertainty of using a LOAEC exposure instead of a No Observable Adverse Effects Concentration (NOAEC) when calculating the REL, and a factor of 10 for human intraspecies variability. The California REL for mercury (elemental and inorganic) is 90 ng/m^3 (CA OEHHA, 2001).

The US Agency for Toxic Substances and Disease Registry (ATSDR) has a health-based minimum risk level (MRL) for mercury of 200 ng/m^3 (ATSDR, 1999). This MRL is calculated from the same data that was used to calculate the IRIS RfC. However, the MRL calculation assumes that in an occupational exposure 1/3 of the daily inhaled air each working day is contaminated, whereas the RfC assumes that 1/2 of the working daily inhalation is contaminated.

MDH uses IRIS RfCs for giving exposure advice when there is not a HRV. MDH has some concern that the uncertainty factor of 30 in the EPA RfC, may not be sufficiently protective of a sensitive subpopulation given that the basis of the underlying value is a LOAEL. While the California chronic mercury REL does provide this additional protection, practical application of the mercury REL at contaminated sites may be problematic, since personal exposure to mercury from other sources, including dental amalgams, may be in the range of the REL. MDH therefore recommends that the EPA criterion be used, but that care be taken to ensure that chronic exposures to mercury from all sources does not exceed this level.

Acute exposure values: mercury (elemental)
California OEHHA has developed an acute REL for mercury vapor based on developmental effects in the offspring of exposed rats. Central nervous system effects in pups were noted following exposure of dams to 1.8 mg/m^3 for 1 hour/day during gestation. A cumulative uncertainty factor of 1000 is attached to this REL because: it is based on a LOAEL (10X); the primary study was an animal study (10X); and human response to all chemicals is variable (10X). The OEHHA acute REL for mercury vapor is 1,800 ng/m^3, with a critical endpoint of reproductive or developmental effects (CA OEHHA, 2001).

Biomarkers of mercury exposure
Biomarkers of exposure may be used to establish a connection between an environmental exposure and an internal level of a toxicant that may cause harm. Biomarkers of mercury exposure are mercury concentrations in whole blood, blood plasma, urine, and hair. The EPA based their mercury RfC on the apparent relationship between whole blood mercury concentrations of 10 µg/L, following chronic exposure to mercury vapor, and adverse health effects. The resident of the house where the spill occurred was examined by a physician, and the physician ordered laboratory analysis of urine, whole blood, and hair. This section contains a discussion of biomarkers of human mercury exposure and the difficulties in interpreting these data.

Exposure to any source of mercury, such as consumption of fish (methylmercury) or inhalation of vapors from dental amalgams, contribute to one's total mercury exposure. Therefore, it can be difficult to relate a concentration in a biological specimen to a specific exposure. The intake of mercury from multiple sources may decrease the utility of biomarkers for exposure to low, yet significant, levels of mercury vapor. This difficulty in associating biomarkers with elevated environmental exposures is typical of human epidemiological studies.

Mercury can be taken into the body in 3 different forms: inhaled as elemental mercury; ingested or dermal absorption of organic mercury, and; ingested or dermal absorption of mercury salts. Exposure to mercury salts is typically related to use of now-banned medicinal creams and teething powders, or occupational exposure. While the largest amount of organic mercury intake comes from the ingestion of fish, there are other potential sources of organic mercury. They include the antiseptics merbromin (mercurochrome) and thimerosal (merthiolate), and dimethyl mercury which is typically found in significant concentrations only in scientific laboratories. Methyl mercury is found in relatively high concentrations in predatory fish, and therefore, a diet that includes these fish will result in the intake of potentially significant amounts of methyl mercury. Once in the blood, methyl mercury is transported throughout the body. It can cross through the blood-brain barrier and the placenta, and it accumulates in nervous tissue and the kidneys. Similarly, elemental mercury in the blood can be transported anywhere in the body. As it is slowly converted to inorganic mercury, its mobility becomes restricted.

Whole blood may be a better biomarker of mercury from a diet containing fish than of exposure to mercury vapors. Daily consumption of fish containing 200 µg methyl mercury (very high fish

consumption) has been associated with a whole blood concentration of 200 µg/L (WHO, 1990 as cited in ATSDR, 1999), whereas inhalation of 110 µg elemental mercury per day has been associated with a whole blood concentration of 9.8 µg/L (from data supplied in Ngim et al., 1992). Given methylmercury's affinity for organic compounds and disulfide groups, methylmercury in blood is found predominantly in red blood cells (Sandborgh-Englund et al., 1998). It is assumed that inorganic mercury is found predominantly in plasma, and therefore, plasma may be a better indicator of elemental mercury exposure than whole blood (Sandborgh-Englund et al., 1998). Unfortunately, most available biological mercury data are whole blood and urine concentrations. These data may be influenced by an individual's consumption of fish.

Hair can also be used as a biomarker of mercury exposure (Katz & Katz, 1992), however, analysis of mercury in hair is difficult and results can vary significantly between laboratories (Kruse-Jarres, 2000; Seidel et al., 2001). This variability could be the result of differences in pre-analytical preparation of hair samples by different laboratories (Kruse-Jarres, 2000). Additionally, a diet high in fish will lead to high levels of mercury in hair. Therefore, hair may be a better measure of methylmercury exposure than elemental mercury exposure (Wilhelm & Idel, 1996).

It is important to consider that blood mercury is a measure of mobile mercury. Since mercury is sequestered in tissues in the body (e.g. in the kidneys and nervous system) and released slowly (Ozuah, 2000; Sandborgh-Englund et al., 1998; Ekstrand et al., 1998), blood concentrations may not be a measure of a total body burden. Similarly, urine mercury is a measure of mercury excretion and, therefore, cannot be used to determine the total body burden unless measurements are conducted over an extended period of time. An advantage to using hair as a biomarker is that it presumably retains an amount of mercury that is proportional to the concentration in whole blood at a specific time (Toribara, 2001). As a result, even though comparison of hair mercury between individuals may not correlate with exposures, analyses of sequential segments of an individual's hair can be used to develop a historic record of changes in whole blood mercury over time.

<u>Quantitative evaluation of biomarkers of exposure</u>

Human whole blood generally contains less than 10 µg/L (Leavelle, 2001; Ozuah, 2000) mercury. Below 10 µg/L (20 µg/L; Ozuah, 2000) is considered normal urine mercury (Leavelle, 2001). Blood plasma mercury levels in individuals with no known source of inorganic mercury are about 0.22 µg/L (Sandborgh-Englund et al., 1998). While inter-laboratory differences in pre-analytical hair preparation make hair a sub-optimal biomarker, mercury concentrations in hair of less than 1-5 parts per million (ppm; µg/g) have been considered normal (Ozuah, 2000).

Biological measures of exposure from the resident, whole blood mercury and urine, were considered by an occupational physician to be normal (blood mercury below 5 µg/L, urine mercury below 10 µg/L, and hair mercury below 1 µg/g).

Even relatively high exposures to mercury may not be associated with elevated biomarkers. Fifteen minute exposure of 9 volunteers to about 400,000 ng/m^3 mercury vapor (220 times the

acute REL), led to a median (n=9) maximum whole blood concentration of 1.4 µg/L (at 7.1 hours post exposure), median maximum plasma concentration of 1.2 µg/L (at 8.9 hours post exposure), and median maximum urinary excretion of 0.6 µg/day (at 8.5 days post exposure) (Sandborgh-Englund et al., 1998). In another study chronic exposure to an average of 5,500 ng/m^3 elemental mercury for 5.5 years (18 times the chronic RfC), which appears to result in adverse health effects, was associated with an mean whole blood mercury level of 9.8 µg/L (n=98) (Ngim et al., 1992). This is only 2 times a blood mercury concentration that is considered 'normal.'

Furthermore, differences in individual's diet and the number of dental amalgams can affect mercury biomarkers. Pooling data from available data on the relationship between amalgams and plasma mercury, Ekstrand et al. (1998) calculated that the amalgam contribution to plasma mercury is about 0.02 µg/L/amalgam surface. Therefore, individuals with a typical number of amalgam surfaces (25) may have associated plasma mercury concentrations of 0.50 µg/L. Typical whole blood mercury concentrations in people who do not eat fish is about 2 mg/L (Nordberg et al., 1992).

Discussion

Exposure to mercury at St. Paul residence

Since being notified of the spill on June 8, MDH has consistently recommended that the resident of this house consult her physician or an occupational physician. Physicians can determine if biomarkers of exposure are elevated, determine if there are specific symptoms of exposure, and they can recommend treatments if appropriate.

It has been reported to MDH that mercury levels in the owner's blood and urine remained within the normal range in all samples taken to-date. Additionally, analysis of hair taken in August showed no elevated levels of mercury. Therefore, there are no positive results from analyses of biomarkers of exposure. As noted above, hair is interesting because it can retain a record of mercury exposure in sequential segments. If hair mercury was elevated, time-correlated samples of segments of individual hairs could have been analyzed to determine a probable exposure scenario.

According to the Environmental Incident Reporting Form, as reported in Attachment #1 (Xcel Energy, 2001a), more than 1 pound of mercury may have spilled from the regulator. If the regulator contained 5-6 pounds of mercury when it was installed, and it contained 'a few tablespoons' of mercury when it arrived at the service center on June 5, 4-5 pounds of mercury remain unaccounted. This discrepancy has not been addressed in documents summarizing the spill at this house. More mercury being spilled during this event than reported could explain the extremely high mercury vapor concentrations measured in the house during the early cleanup stages. If mercury was spilled or ejected from the regulator prior to the spill on June 5, the residents' exposure to mercury vapor could have been considerably greater than exposure estimates in this document. However, if ambient levels of mercury vapor in the house in the months prior to June 2001 approached levels sampled during the cleanup, MDH would have expected the resident to have elevated biomarkers of exposure.

Relatively high exposures to mercury vapor may have occurred in this house, especially from June 5 through June 13. Exposures during this 9 day period may have been: between 2,000 and 4,000 ng/m^3 on the first floor; 400 and 1800 ng/m^3 on the second floor; and 35,000 to 86,000 ng/m^3 in the basement. It is probable that during this time some individuals, including the resident, were exposed to mercury vapor concentrations above the California acute REL of 1,800 ng/m^3. Additionally, exposures above the acute REL may have occurred in the basement for a couple of days after June 13.

As the basement was cleaned, mercury concentrations on the first and second floor, generally, decreased as can be seen in Table #3. This suggests that there was not a significant amount of tracking of mercury out of the basement. Consequently, exposure to mercury vapor on the first and second floor of the house would have been related to the amount of air flow from the basement into the rest of the house, and the exchange of air with the outdoors.

Current daily exposure to mercury in this house is well below levels of concern. Means of measured concentrations on the last sample days listed in Table #3 show, ambient mercury vapor concentrations in the basement of 139 ng/m^3; first floor, 9 ng/m^3; and second floor, 7 ng/m^3. If, in a conservative exposure estimate, an individual spends 22 hours a day on the first and second floor, and 2 hours in the basement, about 450 ng of mercury vapor may be inhaled daily. In contrast, published estimates of mercury inhalation from amalgam fillings are 1,000 to 10,000 ng/day (Ekstrand et al., 1998).

Failure to clean up mercury in this house could have led to significant exposure of current and future residents. Using realistic exposure scenarios, the daily exposure to a resident may have been about 200 times the current exposure and 15 times a 'safe' exposure calculated using the EPA RfC.

By all measures to date, cleanup of this house appears to be successful.

The resident has expressed some concern that sealing mercury into the basement floors or walls with epoxy will only delay the release of mercury vapor. While MDH shares some similar concerns, it is unlikely that remaining potential sources will become exposed at a single time in the future. Therefore, mercury vapor concentrations should remain below levels of concern for the life of the house. As a precaution, MDH recommends that mercury vapor hotspot sampling be conducted in this house quarterly for at least one year. Furthermore, MDH plans to place this site on a list of houses with cleaned mercury spills for future reference. Future studies of mercury spills in residences may create future interest for mercury vapor monitoring in this house.

<u>Mercury vapor in ambient air in Minnesota residences</u>

In the last 2 years MDH has reviewed mercury vapor data from a number of households as well as in ambient outdoor air. Typical outdoor mercury vapor concentrations are about 2 ng/m^3. Air in homes where no known mercury spills have occurred have ranged between 5 and 31 ng/m^3 (Tekran; n=5) (MDH, 2001a, in preparation).

MDH is writing a health consultation on another house where 4 thermometers were broken on a carpet (MDH, 2001a, in preparation). The owner cleaned by removing visible mercury and glass from the carpet where the thermometers broke, and vacuuming with a standard vacuum cleaner. When ambient air in the house was sampled 2 weeks later, mercury vapor concentrations were 750 to 800 ng/m^3 (Tekran) throughout the house. Two days after the affected carpet was removed, mercury concentrations dropped to about 110 ng/m^3 (Tekran). Fourteen months after the incident, in August 2001, followup sampling of mercury vapor were below 10 ng/m^3 (Lumex) throughout the house. For additional information, see the health consultation on this house (MDH, 2001a, in preparation).

MDH has also written health consultations for a house where precious metals were recovered from silverware and electronic equipment using cyanide and mercury (MDH, 1998; MDH, 2001b, in preparation). These documents describe decreasing concentrations of mercury vapor in the house over 3 years. Following the initial cleanup in 1998, the maximum concentration measured in the basement was 4,000 ng/m^3 and 400 ng/m^3 (OSHA Method ID-140) in living areas. The resident was allowed to return to her house because: the resident had no known symptoms of exposure including no elevated biomarkers of exposure; the resident of the house was a widow who wanted to remain in the house; known sources had been removed from the house; mercury vapor concentrations were expected to decrease over time, and; mercury vapor levels in living quarters in the house were near the EPA mercury RfC. When the house was next tested in July 2000, mercury levels had decreased significantly throughout the house. Due to the limited sampling hose length (Tekran - see Table #1), only one area of the basement was sampled at about 4-5 feet above the floor (breathing zone) in 2000. The highest concentration recorded at that location was 166 ng/m^3. The highest mercury vapor concentration measured on the first floor at that time was 22.7 ng/m^3 (Tekran). When MDH returned to the house in August 2001, mercury vapor concentrations in the breathing zone of the basement ranged from 107 to 147 ng/m^3 (Lumex). Higher mercury vapor concentrations were found near the floor. These data are discussed in (MDH, 2001b, in preparation).

Children's Health (Health of sensitive sub-populations)
EPA RfC's are developed to be protective of sensitive individuals and children. Children and fetuses have been demonstrated to be sensitive to some mercuric compounds including methylmercury. However, increased sensitivity to elemental mercury has not been studied closely and has not been demonstrated. MDH believes that the uncertainty factors recommended by EPA (30) and OEHHA (100) can be justified. If the maximum concentration in ambient air is kept below 300 ng/m^3, exposure to mercury vapor in this house should not affect health.

Because there are many potential sources for exposure to mercury and many routes of possible exposure, MDH recommends minimizing exposure of children and women of child-bearing age to mercury vapor.

Summary and Conclusions
A private home was contaminated by mercury spilled from a gas regulator on June 5, 2001. Three separate cleanups of the house were undertaken by 2 different companies over a period of

2 weeks. MDH stated that the house was safe for reoccupancy on July 11, 2001.

Exposure to mercury vapor in this house does not now represent a public health hazard. While a spill of mercury from a gas regulator resulted in very high mercury vapor concentrations in this house, the cleanup was successful in lowering levels below those of concern. Further, venting of the house since the cleanup has resulted in additional decreases in mercury vapor concentrations.

Public Health Action Plan

MDH is concerned that there may be other houses in Minnesota with mercury-containing gas regulators. Xcel and other natural gas companies in Minnesota have stated that they are not aware of the regular use of mercury-containing gas regulators in Minnesota, nor are they aware of additional houses containing low pressure regulators similar to the one found at this house. Given the high mercury concentrations in this house, and the potential for mercury vapor at these concentrations to cause health effects, MDH will be writing a factsheet on mercury-containing gas regulators and health-related concerns. In addition, MDH will be recommending to Xcel and other natural gas companies operating in Minnesota, that they:

- remove all mercury-containing regulators from customers' houses over the next few years
- perform removal with care so as to assure that no mercury is spilled
- use a sensitive realtime mercury vapor analyzer (e.g. a meter with a detection limit below 100 ng/m^3) following removal to assure that residents will not be exposed to elevated levels of mercury vapor
- confirm that mercury vapor concentrations in indoor ambient air that may have been impacted by a spill from a mercury regulator are below 300 ng/m^3
- notify customer about any exceedances of the EPA IRIS RfC for mercury vapor (300 ng/m^3)
- maintain permanent records on houses from which mercury-containing gas regulators are removed

MDH is planning to make information on mercury-containing gas regulators available on the web.

Recommendations

MDH recommends that mercury vapor hotspot and ambient air sampling be conducted in this house quarterly for at least one year.

Additionally, MDH recommends that the Public Health Action Plan for this site be adopted and completed.

While MDH has a limited number of recommendations specific to this site, MDH has the following general recommendations.

<u>Recommendations: Characterization of contamination</u>

The following general recommendations are related to characterization of mercury contamination at indoor spill sites. These recommendations have been reviewed and supported by MPCA staff involved in characterizing mercury contamination in the environment.

- Sampling for the purpose of determining occupancy of a contaminated site should be conducted using protocols developed by EPA and ATSDR for use in Illinois (Attachment #4). Sampling methods include:
  - controlled ventilation (e.g., no open doors or windows)and no air exchange with outdoor air,
  - indoor ambient temperature greater than 75° F, and
  - sampling in high traffic living areas, breathing zone, and over an extended period of time (typically 6 - 8 hours).
- Instruments used to characterize contamination should have detection and quantification limits below 100 ng/m^3 (e.g. Lumex or Tekran).
- If there are accompanying concerns about personal exposure and adverse health effects MDH recommends:
  - blood plasma and urine are the preferred biomarkers of exposure.
  - biological sample data should be reported to the analytical detection limit, not an arbitrary reporting limit.
  - hair analyses should be undertaken only if important information may be obtainable from sequential segment analysis.

<u>Recommendations: Site cleanup</u>

Activities and ambient air sampling results described in this document reinforce general MDH recommendations on the cleanup of mercury spills. These recommendations were developed with, and are supported by MPCA staff.

1. Protect yourself. Before beginning to cleanup a mercury spill:
   - open windows,
   - change into old clothes that can be discarded if mercury spills on them,
   - remove all jewelry,
   - wear gloves and
   - wash thoroughly after cleanup.
2. DO NOT use a vacuum cleaner or other household cleaning accessories (including brooms) which can cause turbulence or dispersal of small mercury droplets.
3. Ventilate affected rooms and other rooms sharing common heating and air conditioning systems, during and following cleanup.
4. Put bulk mercury in a screw-top container, seal it and label it.
5. Double-bag and label all cleaned-up mercury and contaminated items including tools, gloves and clothing.
6. Store mercury wastes out of reach of children and away from heat or flames.
7. Eye-droppers, razor blades, stiff paper and moist cotton balls can be used to pick up visible mercury contamination.
8. Sticky tape can remove some mercury residues.
9. Mercury cleanup kits can be used to collect spilled mercury that is not clearly visible.
10. Remove and dispose of contaminated carpets and other contaminated permeable

materials.

11. Dispose of unused mercury-containing thermometers, bulk mercury, bagged items, and other items containing mercury (including spill cleanup aids, items and tools) at an appropriate hazardous waste facility.
12. For help with a mercury spill call the MPCA through the Minnesota Duty Officer at:

    Twin Cities metro area (651) 649-5451
    Statewide (800) 422-0798

This consultation was prepared by:

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References

Applied Environmental Sciences, Inc. (2001) Environmental Health Survey Report: Mercury clearance testing. Dickson, F., AES, Minneapolis, MN. 7/3/01.

Agency for Toxic Substances and Disease Registry (1999) Toxicological Profile for Mercury. Research Triangle Institute, ATSDR, U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA. March 1999.

California Office of Environmental Health Hazard Assessment (2001). Reference Exposure Levels. Office of Environmental Health Hazard Assessment, CA OEHHA, Sacramento, CA. http://www.oehha.org/air/hot_spots/index.html (1/22/01).

Ekstrand, J., Bjorkman, L., Edlund, C., Sandborgh-Englund, G. (1998) Toxicological aspects on the release and systemic uptake of mercury from dental amalgam. Eur J Oral Sci 106:2 Pt 2 p678-86.

Environmental Protection Agency, U. S. (2001) Integrated Risk Information System. Online, Office of Health and Environmental Assessment, Environmental Criteria Office, EPA IRIS, Cincinnati, OH http://www.epa.gov/iris/

Katz, S. A., Katz, R. B. (1992) Use of hair analysis for evaluating mercury intoxication of the human body: a review. J Appl Toxicol 12:2 p79-84.

Kruse-Jarres, J. D. (2000) Limited usefulness of essential trace element analyses in hair. Am Clin Lab 19:5 p8-10.

Leavelle, D. E. (2001) Mayo Medical Laboratories Interpretive Handbook. In. Mayo Press, Rochester, MN, pg 456-458.

Minnesota Department of Health (1998). Chemically Contaminated South Minneapolis Residence. Minneapolis, Hennepin County, Minnesota. Herbrandson, C., MDH, ATSDR Concurrance: June 11, 1999.

Minnesota Department of Health (2001) Herbrandson, C. Letter to: Resident, Concerning: Mercury levels 'safe' to reoccupy house. July 11, 2001.

Minnesota Department of Health (2001a, in preparation). Mercury in ambient air in a Minnesota house: Contamination from broken thermometers. Marine, Washington County, Minnesota. Herbrandson, C., MDH, Prepared in collaboration with ATSDR:

Minnesota Department of Health (2001b, in preparation). Chemically Contaminated South Minneapolis Residence: Followup. Minneapolis, Hennepin County, Minnesota. Herbrandson, C., MDH,

Mueller Pipeliners (2001) Mercury clean up: XXXXXXXXXXXXXXXXX, St.Paul, MN, 13-21 June 2001. prepared by: Roy F. Weston Inc., Mueller Pipeliners, New Berlin, WI. July 2001.

Ngim, C. H., Foo, S. C., Boey, K. W., Jeyaratnam, J. (1992) Chronic neurobehavioural effects of elemental mercury in dentists. Br J Ind Med 49:11 p782-90.

Nordberg, G., Brune, D., Gerhardsson, L., Grandjean, P., Vesterberg, O., Wester, P. O. (1992) The ICOH and IUPAC international programme for establishing reference values of metals. Sci Total Environ 120:1-2 p17-21.

Ozuah, P. O. (2000) Mercury poisoning. Curr Probl Pediatr 30:3 p91-9.

Sandborgh-Englund, G., Elinder, C. G., Johanson, G., Lind, B., Skare, I., Ekstrand, J. (1998) The absorption, blood levels, and excretion of mercury after a single dose of mercury vapor in humans. Toxicol Appl Pharmacol 150:1 p146-53.

Seidel, S., Kreutzer, R., Smith, D., McNeel, S., Gilliss, D. (2001) Assessment of commercial laboratories performing hair mineral analysis. Jama 285:1 p67-72.

Toribara, T. Y. (2001) Analysis of single hair by XRF discloses mercury intake. Hum Exp Toxicol 20:4 p185-8.

World Health Organization (1990) Methyl Mercury. Vol 101: (as cited in ATSDR, Toxicological Profile for Mercury), WHO, International programme on chemical safety, Geneva, Switzerland.

Wilhelm, M., Idel, H. (1996) Hair analysis in environmental medicine. Zentralbl Hyg Umweltmed 198:6 p485-501.

Xcel Energy Company (2001a) Activity and Information Summary June 5 - July 13, 2001: XXXXXXXXXXXXXXXXXXXX, St. Paul MN. Grant, J., Xcel Energy, Environmental Services, Minneapolis, MN. July 25, 2001.

Xcel Energy Company (2001b) Gerlach, M. Email: Herbrandson, C., Minnesota Department of Health. Concerning: Availability of reports. August 9, 2001.

Xcel Energy Company (2001c) Grant, J. Phone call to: Herbrandson, C., Minnesota Department of Health. Concerning: Mercury contaminated House, St. Paul. June 8, 2001.

Xcel Energy Company (2001d) Mercury vapor data - June 5 - July 13, 2001: XXXXXXXXXXXXXXXXXXXX, St. Paul MN. Grant, J., Xcel Energy, Environmental Services, Minneapolis, MN. July 25, 2001.

CERTIFICATION

This Mercury in a St. Paul Residence Health Consultation was prepared by the Minnesota Department of Health 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 consultation was begun.

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Technical Project Officer, SPS, SSAB, DHAC, ATSDR

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

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Chief, Superfund Site Assessment Branch, DHAC, ATSDR

Attachment #1

Activity and Information Summary

[redacted], St. Paul MN

by Judy Grant, Xcel Energy Environmental Services

Date	Activities
6/5/01	In the afternoon a Mueller house piping crew removed a device from the basement of [redacted]. The device was on customer owned piping, on the customer side of the meter and was taken out when the old meter was removed from the basement and a new meter installed outside. There was no regulator on the company owned piping since the house was on a low pressure gas distribution system. A regulator was installed as part of this job. The Mueller crew indicated that they removed the device, carried it out of the house without bagging it, and because they were curious took it partially apart when they got to their truck which was parked on [redacted]. It was at this point that they said they realized that the device contained mercury. They indicated that they then taped it up and brought it to the Mueller site at 843 Hardman Avenue South. Tom Anderson in Xcel Energy's Gas Training group was contacted about the device either late Tuesday (6/5) or early Wednesday (6/6). Jack Bedner was given as the contact at Mueller. Dan Kealy and Brain Bartsch were the Mueller employees who removed the device.
6/6/01	Tom Anderson called the situation into Environmental Services at 8:00 AM indicating: a gas regulator filled with mercury was removed from this location, the crew did not believe mercury was spilled, Mueller wanted assistance with disposal of the device which was bagged and stored at the Mueller Contract Yard at 843 Hardman Avenue South and the Mueller contact was Jack Bedner; 612-369-4524. The Environmental Incident Reporting Form also indicated that there was a chemical spill > RQ and the amount released was > 1 pound. The issue was turned over to me at 9:00 AM. I indicated to Melissa Klamerus; 651-265-7035, that a visual inspection of the house would need to be done to ensure no mercury was spilled. Melissa contacted her supervisor, Dan Woehrle; 651-229-2211, and left a voice mail with the home owner, [redacted]; 651-[redacted], indicating that a device containing mercury was removed from her basement and we would like to do a visual inspection to verify that no mercury was spilled. Melissa determined that the initial installation probably occurred between 1913 and 1915, when the house would have been serviced by coal gasification gas. We later found out that the house was built in 1913. In the afternoon Dan Woehrle, Melissa Klamerus, and I inspected the device at the Mueller site with Jack Bedner. We took it partially apart so we could see where the mercury was and radioed the two employees who removed the device from the home. These employees indicated that Brian held the device upright as he carried it out of the house, that they used the South entrance, walked through the kitchen and down the stairs, and that their truck was parked next to the house on [redacted], 10 feet from the stop sign on [redacted] and [redacted]. It was also indicated that no visual inspection of the house was done to verify that no mercury was spilled, and that some mercury spilled into a bag when the device was un-taped at the Mueller site. In taking the device partially apart we could see the following items in this order: • *Cap* - formed a metal on metal seal with one screw holding it in place and a small lip shaped vent - if the device was not held upright the mercury could leak or pour out around the cap • *Ball Jar Lid* - this was probably added as a spacer by the home owner to prevent the device from shutting off the gas • *Lead Weight* with the number 10 on it - as a weight • *Steel Disk* or Diaphragm with a nut in it (later found to be hooked to a shaft, and the shaft connected to a plug at the bottom - as the diaphragm moves up it pulls the shaft up and the plug seats reducing or shutting off the gas) • *Mercury* - located around the disk and shaft and later found to complete the seal and may also have been used as a weight – the mercury may have been expelled from the device though the vent in the cap under high pressure or high flow conditions • We later found out that there was a metal seal below the mercury separating the mercury from the gas line.

	Dan determined that the mercury was not in contact with the gas and therefore would not have contaminated the customer gas piping. He also suspected that the device was a regulator or slam shut relief valve. Dan brought the device to Rice Street for a thorough dissection. I brought the mercury contaminated plastic bag in a drum to the HWSF for proper disposal. Late Wednesday the homeowner returned Melissa's call and indicated that 1:00 PM on Thursday would be the soonest we could get into the house for the visual inspection.
6/7/01	Shortly after 1:00 PM Dan Woehrle, Melissa Klamerus and I met [redacted] at her home. Using flashlights we carefully went into the house through the South door, through the kitchen and downstairs looking for mercury on the route taken by the Mueller employees. Dan located a small number of mercury beads below the newly installed piping where the device had been removed. I contacted Lee Eberley to report the findings and then reported the spill to Bruce Denney who arranged for Bay West to come to the house to clean up the spill. Bruce also called the spill in to the state duty officer. Bay West arrived on site at approximately 2:45 PM. Their procedure included: - Vacuuming (with a Mercury Vacuum made by Minutemen) the kitchen, the stairs and the basement in the areas of concern. This area of concern included the NE corner where the beads had been observed and the device had been located, between this corner and the stairs and some of the area under the stairs. The Bay West employees were questioned about the vacuum and they indicated that all the necessary filters were in place, so the vacuum would not release mercury vapors. - Spreading a mercury powder (Mercury Absorb from Lab Safety) in the basement in the areas of concern and vacuuming it up. - Wiping the basement floor in the areas of concern with mercury wipes (Mercon Wipes from Mercon). - Spraying the basement floor in the areas of concern with a mercury spray (Mercon Vap from Mercon). - Opening the basement window which was located beside the South stairs going into the house and installing a fan to clear out the air in the basement since readings on their Jerome meter were not going down. - Bay West indicated several times that during the cleaning process they were stirring things up and disturbing mercury which was why they thought the mercury levels detected on their Jerome meter were not going down. - By 7:30 PM after ventilating and while the fans were still running measurements on the Jerome, which reads down to 0.001 mg/m3 or 1000 ng/m3, were going down to the detection limit of this meter. The Bay West employees who did the clean up were Barry Lindsay and Craig Rebischke. They indicated that the highest level of mercury detected in the basement using the Jerome meter was 0.349 mg/m3 or 349,000 ng/m3. The next day the manufacturer of the Jerome indicated that the kitty litter in the basement, which was quite strong smelling, would cause a significant interference; therefore, this measurement does not provide an accurate indication of the level of mercury present. They also indicated that the boxes in the basement had been moved several times during the cleaning process. As they left they said that they had done everything they could do to clean up the spill. Arrangements were made with [redacted] to do clearance sampling at 1:00 PM the next day, Friday, June 8.

Activity and Information Summary
[redacted], St. Paul MN
by Judy Grant, Xcel Energy Environmental Services

12/20/01

6/8/01	In the morning Bay West was called regarding substances that can interfere with their Jerome meter and whether the kitty litter, which was in the basement during the cleaning, could have caused any interference. They were not aware of this as a problem, but provided the manufacturer of the Jerome meter's telephone number. Arizona Instruments was called and their technical assistance people indicated that kitty litter most definitely causes an interference along with many other things that have strong odors such as cleaners and cigarette smoke. They indicated that all of these would produce false positive readings on the Jerome but did not know the actual numerical increase that would result. Ed Swain; 651-296-7800, at the MPCA was contacted regarding required clean-up levels and put me in contact with Carl Herbrandson; 651-215-0925, in the Department of Health. Carl indicated that the appropriate clearance level to use after a mercury spill was 300 ng/m3. He mentioned the 1000 ng/m3 clearance level that the ATSDR considered allowable but had concerns with that level and felt the 300 ng/m3 limit was more appropriate. At 1:00 PM Carol Hubbard from the MPCA met Dan Woehrle, Melissa Klamerus and I at the house. Carl Herbrandson from the Minnesota Department of Health arrived shortly after. A large number of readings were taken with the Lumex which has a detection limit of 1 ng/m3. These readings can be found in the table titled; *Lumex Readings,* [redacted]*, Friday, June 8, 2001*. The title of the Excel document is "lumex 6-8-01." Readings in the basement were between 20,000 and 51,000 ng/m3, readings on the first floor were between 1500 and 3500 ng/m3, and readings on the second floor were between 300 and 529 ng/m3. Because levels of mercury were above the clearance level Dan Woehrle told [redacted] that she would be put up in a hotel. I contacted Lee Eberley and requested that we seek an experienced contractor who had worked in the Chicago area where Nicor Gas had cleaned over 1000 mercury contaminated homes. Lee agreed and late in the afternoon Al Peterson began calling contractors. Al also located a summary of the Nicor mercury spill clean-up procedure on the Nicor web site. [redacted] and her cat stayed in the house Friday night.
6/9/01	[redacted] stayed in Duluth overnight. Her cat stayed at her house.
6/10/01	[redacted] came back from Duluth and spent the night at the house with her cat.
6/11/01	[redacted] got a room at Holiday Inn Express on Energy Park Drive. Her cat went to her mother's house. Three contractors which were recommended by Nicor were evaluated. The contractor which came highly recommended, Weston, was chosen. Mueller Pipeliners was contacted to take financial responsibility. Chris Ernst; 262-641-7174, at Mueller, accepted Weston as the preferred contractor and verbally agreed that the following list of items to be covered for [redacted] was acceptable: Room Charges at a local, name brand hotel; Telephone charges for any calls she would normally make from home; Meals; Related Costs, such as costs for using a laundry mat; Medical charges for having a mercury test done; and Veterinarian charges for having her cat tested for mercury. This list was provided to [redacted] verbally.
6/12/01	A copy of the Mueller reimbursement list was provided to [redacted] along with the following written information on the health effects of mercury: a detailed Genium MSDS for mercury, the mercury section from the toxic metals chapter of the Cassart Toxicology book 5th edition, the mercury section from the ACGIH documentation of TLVs, and the mercury section from the ACGIH documentation of BEIs. Carol Hubbard at the MPCA checked my cloths and shoes for mercury contamination. Eric Keeley, from Weston, arrived in town and plans were made to meet him at the house at 8 AM Wednesday morning. Carl Herbrandson from the Department of Health was provided with [redacted]'s phone numbers and a list of the mercury information which had been provided to [redacted]. Friday's readings and the clothing readings from this day were put into a table for distribution.
6/13/01	Eric Keeley from Weston, Carol Hubbard from MPCA and I meet [redacted] at the house at 8 AM. Printouts of the readings from Friday 6/8 were provided. Side by side readings were taken with the Lumex and the Nippon which was brought by Weston and has a detection limit of 0.001 mg/m3 or 1000 ng/m3. The Nippon is a NIC Nippon Instrument mercury survey meter EMP-1A. Readings were higher then on Friday, June 8. These readings can be found in the table titled: *Nippon and Lumex Readings,* [redacted]*, June 13, 2001*. The title of the Word document is "01 - Nippon and Lumex Readings 6-13-01."

	The Weston crew arrived at the house at 11:30 AM. At lunch they developed a work plan and began working on the clean-up after lunch. The Weston written workplan includes the procedures which were used and when they were accomplished. These procedures called for installing containment, bagging up the material in the basement, dong an initial cleaning with HgX and taking additional readings with the Nippon. These readings are also in the 6-13-01 table mentioned above. Shawn Thorsen, from Mueller Pipeliners, arrived on site at 2:30 PM and was briefed on the situation. Arrangement were made to ship the waste generated by the clean-up to the Xcel Energy Hazardous Waste Storage Facility at the Chestnut Service Center. Shawn provided [redacted] with a check for her cat's mercury test which was scheduled for Thursday, June 14 at 2:00 PM. Weston left the site at approximately 8:00 PM. At this time almost all the items in the basement had been bagged. HgX powder and solution was left on the floor in the NE corner and HgX solution was on the floor up to the drain and under the stairs.
6/14/01	The Weston crew arrived at the house at 8:00 AM and took initial readings with the Nippon. These readings can be found in the table titled: *Nippon and Lumex Readings,* [redacted]*, June 14, 2001*. The title of the Word document is "02 - Nippon and Lumex Readings 6-14-01." Ten steel 55 gallon drums were delivered at approximately 10 AM. Another Weston crew member arrived in the late morning. Eric Keeley left the site in late morning and returned to Chicago. The now three person crew (Sarah, Tim and Stuart) continued to clean in the basement. The plan was to get the basement cleaned today - Thursday, painted Friday and cleared Saturday. Eric Keeley indicated that if the basement was below 1000 it would be acceptable to paint. In late morning readings were taken on the first and second floors with the Nippon and the Lumex though the house was not closed up. These readings are also found in the 6-14-01 table mentioned above. The Weston crew continued scrubbing and rescrubbing the basement in the afternoon and at 2:00 and 4:00 PM additional readings were taken. The 4:00 PM readings did indicate that average readings on the Nippon were at or below 1,000 ng/m3 in all areas except at the floor drain.
6/15/01	The Weston crew and Carol Hubbard from the MPCA arrived on site around 8:00 AM and initial readings were taken with the Nippon and Lumex. These readings can be found in the table titled: *Nippon and Lumex Readings,* [redacted]*, June 15, 2001*. The title of the Word document is "03 - Nippon and Lumex Readings 6-15-01." Carol left the Lumex with me so preliminary clearance sampling could be conducted with the Lumex on Saturday. Weston crew did additional cleaning in the basement with HgX. Shawn Thorsen stopped by around 9:00 AM and wanted to sample the gas piping for mercury. The gas pipes were not opened at this time. The basement was painted with enamel paint. It was decided that the clearance level for the house of 300 ng/m3 would be the value used to clear [redacted]'s belongings which were in the basement in poly bags and were moved to the garden area next to the garage at approximately 10:30 AM, opened, and allowed to ventilate. Carl Herbrandson indicated that after the preliminary clearance with the Lumex we would need to have certification sampling done by an industrial hygienist with tubes that would need to be sent out for analysis. Several contractors who do this type of work were contacted and only Applied Environmental Services (AES); 763-545-5510, had a hygienist available. Preliminary arrangements were made to conduct certification sampling on Monday, if the preliminary clearance sampling on Saturday came out below 300ng/m3. Arrangements were made with Carl Herbrandson, from the Department of Health, to arrive at the house Saturday morning after the house had been closed and

	heated for several hours. The bagged material was put into the garage. The house was ventilated overnight.
6/16/01	The Weston crew arrived on site at around 8:00 AM. The house was closed, a heater was put on in the basement and the furnace was put on maximum. The bagged material was again put outside to ventilate. 9:00 AM the bagged material was closed and left in the sun to warm, so the air space in the bags could be checked for mercury. The mercury vapor readings for the rugs were very high; therefore, they were listed, photographed and placed in drums for disposal. Material between .008 and .009 mg/m3 on the Nippon was opened for additional venting. Items that were higher than this were listed, photographed and drummed. 11:00 AM Carl Herbrandson arrived on site. The house temperature was at 80 degrees F. Preliminary clearance sampling was conducted. These readings can be found in the table titled: *Lumex Readings,* [redacted], *June 16, 2001*. The title of the Word document is "04 - Lumex Readings 6-15-01." The levels of mercury vapor observed in the kitchen and basement were above the 300 ng/m3 clearance level; therefore, the house did not pass the preliminary clearance sampling. Since the basement smelled strongly of paint the paint was checked to determine if these vapors caused any interference. This test was done by putting the Lumex intake hose in a can containing some of the enamel paint used in the basement. This test indicated that the paint did not cause an interference. Eric Keeley indicated by phone that what remained to be done was to heat and ventilate the house. He suggested a circular ventilation method which involved opening and placing a fan in the window in the NE bedroom so air would travel through this bedroom, into the sunroom, through the SE bedroom, down the stairs to the second floor, through the living room, dining room and kitchen, down the basement stairs, through the basement and out the basement window which had a fan in it near the South stairs into the house. This method of ventilation was used for the weekend and preliminary clearance sampling was planned for Monday, June 18. The Weston crew stayed to assist with listing, photographing and drumming the bagged material to be disposed of. They left the site and headed back to Chicago just before 5:00 PM.
6/18/01	Arrangements were made with Ed Swain at the MPCA to do preliminary clearance sampling at 3:00 PM, and with [redacted] to close and heat the house two hours prior to this sampling. [redacted] closed and began heating the house at 1:15 PM. At 3:00 PM I arrived and noticed that the basement window fan was on; therefore, the house had not been closed as required to do the preliminary clearance sampling. Ed Swain arrived and it was decided that sampling would be done to determine if the house would fail even without having been closed. Shawn Thorsen from Mueller was also present. The readings which were taken can be found in the table titled: *Lumex Readings,* [redacted], *June 18, 2001*. The title of the Word document is "05 - Lumex Readings 6-18-01." This sampling indicated that even though the basement had not been closed up as required it was above 300 ng/m3 and failed the preliminary clearance. In addition areas were found that were higher than the ambient level in the basement. The highest location was the washtub which had a maximum reading of 4,868 ng/m3 and an average reading of 3,047 ng/m3. Because the washtub and the area under the footing of the stairs were considered sources of mercury contamination, that could continue to vaporize and make it difficult to clear the house, Chris Ernst gave authorization to bring Weston back to further clean these areas. Eric Keeley at Weston began organizing a crew and developing a workplan.
6/19/01	Eric Keeley developed a workplan. Arrangements were made to ship the ten drums of contaminated material to the Chestnut Hazardous Waste Storage Facility and deliver four additional drums on Wednesday, June 20. Ed Swain was contacted to borrow the Lumex in order to check mercury levels in the remaining bags

	of material from the basement. At 2:00 PM all the contaminated material in [redacted]'s garage was brought outside to ventilate in the sun and the clothing was hung on the line. At 3:00 PM the material in the bags was moved around to better ensure that all items were ventilating. At 5:00 PM the bags which were known to be higher were closed and moved into the garage and the bags which showed lower mercury levels were brought into the garage and left open to continue ventilating.
6/20/01	8:00 AM Weston crew (Sarah and Tim) met [redacted] and I at the house. The Weston workplan was reviewed. At 9:15 AM initial readings were taken with the Nippon. These readings can be found in the table titled: *Nippon and Lumex Readings,* [redacted]*, June 20, 2001*. The title of the Word document is "06 - Nippon and Lumex Readings 6-20-01." The highest levels of mercury vapor were detected in the wash tub. The basement was not being ventilated while these measurements were being taken and remained closed until after additional sampling was done using the Lumex. Ed Swain allowed me to borrow the Lumex to look for additional areas of concern in the basement and to check the bags against the 300 ng/m3 clearance level. At 11:00 AM the Lumex was turned on and measurements were taken. These readings are also found in the 6-20-01 table mentioned above. The highest levels were observed on the bottom north side of the wooden partition on the east wall. The maximum reading was 45,000 ng/m3. Indents in the floor in the NE corner were just below 2,000 ng/m3. At 3:30 PM all bagged material was put out in the sun to vent and the clothing was put on the line. Lumex readings were reviewed with Sarah. At around 4:30 the partition and the wash tub were removed, cut-up, bagged and drummed. The crew then cleaned the floor extensively with HgX. They also cleaned the wash tub drain and attempted to clean the floor drain; however, this drain was blocked and could not be cleared using their snake. At 5:00 PM the bags were closed and at 6:10 the following measurements were made with the Lumex in ng/m3: Bag 29: Alabaster – 6,664 Bag 30: Cereal boxes – 6,386 Bag 31: Shoes – 769 Bag 32: Pink laundry basket – 727 Bag 33: White laundry – 418 (can go to laundry) Bag 34: Laundry detergent – 106 (cleared) Bag 35: Tools & drill – 9,962 Bag 36: Shop vac – 7,437 Bag 37: Humidifier – 634 Bag 38: Red laundry tubs – 1,258 Bag 39: Cloths – 2,302 Bag 40: Mickey – 1,028 / 934 At 6:45 PM the furnace was turned up to 80 degrees F. and the house was closed up except for the window in the NE bedroom and the basement window, both of which had fans in them, and the circular ventilation method that was first used on 6/16 was used to fully ventilate the house. Plans were made to arrive at 7:00 AM to close up the house.
6/21/01	At 6:30 AM [redacted] turned off the fans and closed up the house. At 7:15 Tim from Weston put heaters in the basement. The house temperature was 80 degrees F.. The contents of the following bags 29, 30, 31, 32, 35, 36, 37, 38 and 40 were inventoried, photographed and drummed for disposal. The cloths in bag 39 were

	put on the line for additional venting. The Lumex was turned on a little after 10 AM and measurements were taken in the kitchen and basement. These readings can be found in the table titled: *Lumex Readings,* [redacted], *June 21, 2001*. The title of the Word document is "07 - Lumex Readings 6-21-01." These readings indicated that levels at the top of the stairs and in the basement were above the 300 ng/m3 clearance level. The highest levels were seen in the indents in floor near the NE corner and between the cement patches at the foot of the stairs. [redacted] indicated that if there was a health or safety reason to check the gas pipes for mercury then this should be done. In order to determine if mercury was coming through the gas pipes, and increasing airborne mercury levels in the house, the gas stove and oven were turned on and measurements were taken. These readings began at 12:26 PM and are recorded in the 6-21-01 table mentioned above. All readings were below the 300 ng/m3 clearance level. Plans were made to do preliminary clearance sampling Friday morning after ventilating over night. Readings from the gas piping was done at the request of Shawn Thorsen from Mueller Pipeliners and with the consent of [redacted] and her lawyer. These readings began at approximately 4:00 PM and are recorded in the 6-21-01 table. These readings did not indicate that mercury was present in the gas pipes. Mueller re-attached all piping. The Weston crew put clear epoxy on a section of the North wall in the NE corner of the basement and the following areas on the floor; the NE corner past the area where the partition had been, over the cement patch by the east post, around the floor drain, and over and around the new cement at the foot of the stairs. At 5:55 PM the Weston crew left the site and drove back to Chicago. Plans were with [redacted] to close and heat the house for preliminary clearance sampling with the Lumex on Friday, 6/22. The circle ventilation used previously was used to ventilated the house overnight.
6/22/01	At 8:00 AM [redacted] turned off the fans, closed the house, turned on the space heater in the basement and turned the furnace on maximum. At 9:40 AM the house was still cold and Mueller was called to re-light the pilot light on the furnace which would have been put out as part of the gas pipe monitoring done on 6/21. The items in the garage were put outside to ventilate. By 10:00 AM everything from the garage which needed to be aired and re-tested was outside. At 10:15 AM a Mueller crew arrived and reset the furnace so it would heat the house. The pilot light was on but the setting of the furnace was such that it would not heat. The furnace was put on at maximum. The temperature of the house was 73 degrees F at this time. This was higher than the temperature outside because the heater in the basement had been on since 8:00 AM. At 11:21 AM with the windows closed, the space heater on in the basement and the furnace on maximum the thermostat in the living room indicated that the first floor temperature in the dining room was 73 degrees F.. At 12:05 PM the thermostat in the living room indicated that the upstairs temperature was 78 degrees F.. At 12:15 the Lumex was turned on for preliminary clearance sampling. These readings can be found in the table titled: *Lumex Readings,* [redacted], *June 22, 2001*. The title of the Word document is "08 - Lumex Readings 6-22-01." At this time the basement was very warm; however, the exact temperature was not known. All readings were below the clearance level of 300 ng/m3; therefore, Frank Dickson, an Industrial Hygienist from Applied Environmental Sciences (AES), was called to conduct the certification sampling. At 2:15 PM Frank Dickson was at the house and setting up the certification samples. At this time additional Lumex sampling was conducted. These readings are recorded in the 6-22-01 table mentioned above. All readings were below the 300 ng/m3 clearance level. The heater in the basement was on during this sampling but was then turned off because there was a concern that the basement was exceeding the temperature range appropriate for certification sampling. At the time this sampling was done the certification samples on the 1st floor and in the SE bedroom were running. The others were being set-up. The temperature on the thermostat in the dining room and on the thermometer brought by Frank Dickson was 85 degrees F.. At 5:00 PM additional Lumex sampling was done. These are also recorded in the 6-22-01 table. All readings were below the 300 ng/m3 clearance level.

	Bagged material which was out ventilating was put into the garage. At 7:15 PM the temperature on the thermostat was 80 degrees F.. At 8:00 PM Lumex sampling was done while the certification samples were being taken down. These are recorded in the 6-22-01 table. All readings were below the 300 ng/m3 clearance level. [redacted] decided to check out of the hotel she was staying in and stay at her house.
6/25/01	At 10:00 AM all bagged material in the garage was put outside and the cloths were put on the line to ventilate. The outside temperature was 90 degrees, it was sunny and windy. At 12:00 just the bags were closed, put in the sun and allowed to warm. This was done to determine if the plastic bags were contaminated. At 1:00 PM levels of mercury in the bags were measured and the bag which contained the metal tools and the bag which contained the fan were found to be above 300 ng/m3. These bags were discarded as mercury contaminated waste. After these readings were taken the Lumex was taken into the house to measure ambient levels of mercury while the house was opened. These readings can be found in the table titled: *Lumex Readings,* [redacted]*, June 25, 2001*. The title of the Word document is "09 - Lumex Readings 6-25-01." At the time these readings were taken the windows on the first and second floors were open; however, the basement windows were closed and the door to the basement was closed. All readings were below the clearance level of 300 ng/m3. At around 3:45 PM the items which were outside ventilating were placed in their bags or clean bags, they were closed with duct tape such that an airspace was present and they were allowed to sit in the sun to warm. At 4:30 mercury vapor levels were measured with the Lumex in the bags which had been closed first. The results of these measurements were as follows and are given in ng/m3: Bag 41: Blue garbage can – 153, 161 (169 max) Bag 42: New tool – 29 Bag 43: Metal tools – 2524 (2500, 2700 max) Bag 44: Old tools and plastic handled tools – 433 Bag 45: Chalk tools – 313, 309 **Bag 46: Clothing 1 – 1014 (new fighting saints shirt, smith & hawkins pants, nylon pants)** **Bag 47: Clothing 2 – 3000, 2980 (overalls and black jeans)** Bag 48: Clothing 3 – 842, 901 (light clothing) **Bag 49: Fan – 10,720** **Bag 50: Fan stand – 4059, 8131** Bag 51: Records – 25 The items in bold were listed for reimbursement and placed in drums for disposal. Also listed was a wooden table which had been used in the basement by the Weston crew during the cleaning process.
6/29/01	The items in bag 43 above and some of the items in bag 44 were listed for reimbursement, photographed and placed in a drum for disposal. Eight 55 gallon drums containing mercury contaminated items, and one empty drum, were shipped to the Xcel Energy Chestnut Hazardous Waste Storage Facility for proper disposal.
7/3/01	At 10:00 AM Carol Hubbard from the MPCA and I met [redacted] at her house to take measurements in her garage and of two glass door knobs and two brass pulleys which she decided to keep from the bag of metal tools. Sampling inside the house was also conducted. The garage and the house readings can be found in the table titled: *Lumex Readings,* [redacted]*, July 3, 2001*. The title of the Word document is "10 - Lumex Readings 7-3-01." Before and during the time readings were taken in the garage it was closed. At the time readings were taken in the house the windows on the first and second floors were open; however, the basement windows were closed and the door to the basement was also closed.

Average readings in the garage were between 15 and 20 ng/m3.

Readings in the house were only taken in the basement and ranged from 138 to 225 ng/m3.

The bagged door knobs and pulleys were put in the sun at 10:27 AM. At 10:50 AM mercury vapor levels inside the bag were measured at 1" to 2" away from these items. The results were as follows:

max	ave.	R(%)
524	407	51
203	186	16
138	125	20

After the sampling in the basement was completed measurements were taken in the open bag of door knobs and pulleys. Readings ranged from 12 to 34 ng/m3 with a ten second average of 23 ng/m3, R(%) = 93%.

[redacted] indicated that she did not feel comfortable staying at the house until the final clearance letter was received from the Department of Health. She indicated that she would probably be staying at her sisters house.

Attachment #2

Lumex Readings, XXXXXXXXXXXXXXXX, St. Paul

The Lumex was operated by Carol Hubbard from the Minnesota Pollution Control Agency and Carl Herbrandson from the Minnesota Department of Health
- readings below recorded by Judy Grant, Xcel Energy

Lumex Test Cell 2: 5, 25, 24

Tubes*	Location	Comments	Reading**	+/- Error	Notes
Y	Outside - 2:53 PM	shade	34 - 60s		
Y	Outside - North side of the house	shade	39		
Y	Outside - South side of the house	near where Bay West fan had been blowing	566 & 417 & 546		
Y	Outside - South side steps into house	2nd step	702 & 848		
Y	1st Floor - Kitchen	just inside back door	1500		
Y	1st Floor - Kitchen	2 feet from top of basement stairs	1894 & 1700		
Y	1st Floor - Kitchen	at the top of the basement stairs	1600		
Y	Stairs - Kitchen to Basement	5th step from the top	2100		
Y	Stairs - Kitchen to Basement	8th step from the bottom	20,000		
Y	Stairs - Kitchen to Basement	3rd step from bottom	23,390		
Y	Basement	foot of steps 1' off floor	22,930 & 23,390		
Y	Basement	in the area by the vacuum	43,000		
Y	Basement	in the NE corner where the Hg drops seen	26,000 & 29,000 & 30,000		
Y	Basement	by large fan	40,000		
Y	Basement	under the stairs	29,700		
Y	Basement	by the kitty litter	27,000		
Y	Basement	dremel tool case closed	48,000		
Y	Basement	dremel tool case opened	46,000		
Y	Basement	joint compound	30,000		
Y	Basement	inside vacuum cleaner	36,000		
Y	Basement	floor under dremel tool case	46,000		
Y	Basement	dremel tool case - different location	27,000		
Y	Basement	wall near where pipe/device was removed	31,000 & 35,000 & 37,000		
Y	Basement	2 feet in front of large fan	51,000		
Y	Stairs - Kitchen to Basement	steps	31,500 - 29,000		
Y	Basement	under stairs	22,000 - 28,000		
Y	Basement	NE 1/4; 6' from N wall, 5' from E wall	34,000		
Y	Basement	NE 1/4; 6' from N wall, 5' from E wall	36,000 - 39,000		6 inches from the floor
Y	Basement	SE corner; 4' from each wall	29,000 - 30,000		
Y	Basement	washer / drier	32,000		
Y	Basement	foot of stairs	30,000		

- readings below recorded by Melissa Klamerus, Xcel Energy

N	2nd Floor - Bedroom #1 - SE bedroom	near NW corner of bed	529	5%	
N	2nd Floor - Sunroom area	south side of room	482	1%	One window was open
N	2nd Floor - Bedroom #2 - NE bedroom	at south side of bed	440	500%	
N	2nd Floor - In hallway	just outside NW bedroom door	391	4%	
N	2nd Floor - Bedrm #3 - NW w/ computer	middle of room	408	7%	
N	2nd Floor - Bathroom	middle of room	314	8%	
N	2nd Floor - Top of Stairs		317	11%	
N	w/ hoses				
N	1st floor - Dinning room runner	On runner	1575	8%	
N	1st floor - Landing of stairs	at bottom of stairs	1170	0%	
N	1st Floor - Living room	NE corner near stereo	1231	6%	
N	Stairs 1 to 2 - 8th step from landing	Lumex hose at step	1215	3%	
N	Stairs 1 to 2 - Top of Stairs	held at waist, hose 1.5' from floor	139	10%	window open at top of stairs
N	Stairs 1 to 2 - Top of Stairs	held below waist, hose 3-6" from floor	248	17%	
N	Stairs 1 to 2 - 2nd from top	held below waist, hose 3" from floor	414	33%	
N	Stairs 1 to 2 - 2nd from top	held below waist, hose 3" from floor	304	10%	

Attachment #2

Lumex Readings, XXXXXXXXXXXXXXXX, St. Paul

- readings below recorded by Melissa Klamerus, Xcel Energy

N	Stairs 1 to 2 - 4th from top		1099	3%	
Y	1st Floor - Kitchen	In front of basement door, hose 2-4" from floor	2292	4%	
Y	1st Floor - Hose in front of door		2348	4%	
Y	1st Floor - Kitchen	In front of back S door, on ceramic	3525	11%	
Y	1st Floor - Kitchen	1/2 between S back door and basement door	2618	7%	
Y	Outside - XXXX's New Balance shoe bottom	outside at top of S steps	232	92%	Readings were too erratic so moved to bathroom
Y	Outside - XXXX's Nikes	Kitchen S entrance	1419	30%	where lower readings were seen.
Y	2nd Floor - Bathroom	Cat's right front paw	381	-	
Y	2nd Floor - Bathroom	Judy's left shoe	323	8%	Judy Grant's shoes - black worn Friday 6/8/01
Y	2nd Floor - Bathroom	Judy's right shoe	298	2%	
Y	2nd Floor - Bathroom	Carol's left shoe	674	51%	Carol shoes
Y	2nd Floor - Bathroom	Carol's right shoe	625	13%	
Y	2nd Floor - Bathroom	XXXX's left shoe	268	25%	XXXX's New balance worn 6/7/01
Y	2nd Floor - Bathroom	XXXX's right shoe	289	5%	
Y	2nd Floor - Bathroom	Melissa's left shoe	365	21%	Melissa Klamerus worn both days
Y	2nd Floor - Bathroom	Melissa's right shoe	460	11%	
Y	2nd Floor - Bathroom	XXXX's left shoe	540	14%	XXXX's Nikes worn 6/8/01
Y	2nd Floor - Bathroom	XXXX's right shoe	664	11%	
Y	Outside - S Steps	2nd step from bottom	250	95%	Reading outside are erratic - possibly
Y	Outside - S Steps	2nd step from bottom	216	103%	due to air current.
Y	Outside - S Steps	2nd step from bottom	167	95%	
Y	Outside - S Steps	2nd step from bottom	29	167%	
Y	Outside - asphalt driveway	at door of car - car facing NW - car door closed	10	15%	Once opened door higher reading was seen, 160
Y	Car	drivers foot mat	35	23%	
Y	Car	drivers foot mat	22	50%	readings seen were 27,23,16
Y	Car	driver's seat	see notes		readings seen were 7, 8, 23
Y	Sidewalk - flowerbed I	at corner of flowerbed (w/ purple flowers),	509	80%	
Y	Sidewalk - flowerbed II	S side of house, at crack in walkway	198	50%	
Y	Sidewalk - at crack	7' S of S wall, 3" W of NE corner of house	80	102%	another reading was 200 with a very large error
Y	Sidewalk - at crack	5' E of E wall, 2' S of NE corner of house	247	37%	

NOTES
The Lumex takes instantanous readings every 10 seconds. A 30 second reading with error will be displayed after 3 -10 second readings are taken.
The Lumex was held at waist level unless otherwise indicated.
*Readings taken with the Lumex tubes installed, inlet air tube and muffler.
** Readings are shown in nanograms per meter cubed (ng/m3).
Suggested Cleanup level given by the EPA is < 300 ng/m3 (set for NICOR cleanup). Suggested human occupancy level set by ATSDR < or = 1000 ng/m.

	Readings below were measured at the MPCA on Tuesday June 12, 2001				
Y	MPCA Warehouse Workshop	ambient air	47	5%	
Y	MPCA Warehouse Workshop	Judy's right clog; toe / heal	153 / 115	28% / 27%	worn on Thursday during initial inspection
Y	MPCA Warehouse Workshop	Judy's left clog; toe / heal	76 / 115	15% / 30%	worn on Thursday during initial inspection
Y	MPCA Warehouse Workshop	Judy's right shoe; toe / inside	50 / 55	14% / 6%	worn on Friday during air monitoring
Y	MPCA Warehouse Workshop	Judy's left shoe; toe / inside	48 / 57	0% / 6%	worn on Friday during air monitoring
Y	MPCA Warehouse Workshop	Judy's pants; back	49 / 53	3% / 7%	worn in kitchen on Monday PM
Y	MPCA Warehouse Workshop	Bottom of computer bag	52	5%	placed on kitchen floor on Monday PM

Nippon and Lumex Readings, XXXXXXXXXXXXXXXXXXX, June 13, 2001

The Nippon was operated by Eric Keeley from Weston and the Lumex was operated by Carol Hubbard from the MPCA
- readings below were recorded by Judy Grant, Xcel Energy Environmental Services

Location of Readings	Nippon Readings mg/m3		Nippon Readings ng/m3		Lumex Readings ng/m3	
	Max	Ave	Max	Ave	Ave*	R(%)
Outside	0	0	0	0	18	12
1st Floor - 1" from mat inside kitchen door	0.031	0.01	31,000	10,000	3605	17
1st Floor - 4' above kitchen table – kitchen ambient	0.004	0.002	4,000	2,000	3139	5
1st Floor - 1" from black Nikes	0.009	0.008	9,000	8,000	8252 / 7881	51 / 11
1st Floor - 1" from white Nikes	0.031	0.026	31,000	26,000	5151	6
1st Floor - 1" from rug under table West side	0.031	0.015	31,000	15,000	7209	11
1st Floor - 1" from kitchen floor in front of basement stairs	0.026	0.018	26,000	18,000	16,410	4
1st Floor - 1" from kitchen floor in entrance to dining room	0.012	0.008	12,000	8,000	7,650	22
1st Floor - 1" from rug & blue clogs in front of sink (rug with pansies)	0.029	0.02	29,000	20,000	6,597	8
1st Floor - 1" from blue gardening clogs in front of sink	0.025	0.019	25,000	19,000	3,835	13
1st Floor - 1" from dining room runner (white and pink)	0.006	0.005	6,000	5,000	3,042	1
1st Floor - 4' above dining room table – dining room ambient	0.005	0.005	5,000	5,000	2,831	0
1st Floor - 1" from vacuum intake hole in dining room	0.004	0.004	4,000	4,000	3,130	0
1st Floor - 1" from living room floor rug around rocking chair	0.008	0.006	8,000	6,000	3,291	0
1st Floor - 4' below fan in living room – living room ambient	0.006	0.005	6,000	5,000	3,260	0
1st Floor - 4' above stereo equipment – living room ambient	0.005	0.005	5,000	5,000	3,387	0
1st Floor - 3" from carpet at the foot of the stairs going to 2nd floor	0.006	0.005	6,000	5,000	3,099	1
Stairs 1 to 2 – 3" from the carpet on the landing at the foot of the stairs	0.005	0.004	5,000	4,000	3,069	3
Stairs 1 to 2 – 3" from the 8th stair up from the landing	0.003	0.003	3,000	3,000	2,032	5
Stairs 1 to 2 – 3" from the 4th stair from the top	0.003	0.003	3,000	3,000	1,895	7
Stairs 1 to 2 – 3" from the 2nd step from the top of the stairs	0.003	0.003	3,000	3,000	1,783	4
2nd Floor – 3" from the floor at the top of the stairs	0.001	0.001	1,000	1,000	1,718	1
2nd Floor – 4' above the floor at the top of the stairs – 2nd floor ambient	0.005	0.005	5,000	5,000	1,961	5
2nd Floor – 4' above the floor in the SE bedroom near NW corner of bed	0.003	0.003	3,000	3,000	1,687	0
2nd Floor – 4' above the floor on the South side of the Sunroom	0.003	0.003	3,000	3,000	1,777	1
2nd Floor – 4' above the floor in the NE bedroom over the S. side of the bed	0.003	0.003	3,000	3,000	1,793	0
2nd Floor – 4' above the floor in the hallway outside NW bedroom	0.004	0.003	4,000	3,000	1,878	4
2nd Floor – 4' above the floor in the middle of the NW bedroom	0.003	0.003	3,000	3,000	1,887	0
2nd Floor – 3" to 6" above the floor in the middle of the bathroom	0.004	0.004	4,000	4,000	2,089	2
1st Floor – 4' above the floor in the middle of the front porch	0.001	0.001	1,000	1,000	59 / 54	16 / 5
1st Floor – 4' above the floor in the NW corner of the front porch	0	0	0	0	204	2
1st Floor – 4' above the floor on the North side of the front porch	0	0	0	0	363	10
1st Floor – 4' above the floor at the top of the stairs to the basement	0.008	0.008	8,000	8,000	6,010	1
Stairs to basement – 3" to 6" above the top step	0.037	0.036	37,000	36,000	23,530	5
Stairs to basement – 3" to 6" above the 5th step from the top	0.033	0.033	33,000	33,000	23,680	2
Stairs to basement – 3" to 6" above the bottom step	0.035	0.034	35,000	34,000	24,300	1
Basement – 4' above the floor at the bottom of the stairs	0.041	0.039	41,000	39,000	26,100	0
Basement – 1" above the floor in front of the large fan	0.138	0.075	138,000	75,000	31,470	17
Basement – 1" above the floor drain	0.053	0.035	53,000	35,000	31,430	3
Basement – 1" above the humidifier bucket	0.066	0.065	66,000	65,000	42,820	8
Basement – 1" above the shop-vac	0.037	0.036	37,000	36,000	27,330	4
Basement – 1" above the black plastic tray (was under device when removed)	0.104	0.085	104,000	85,000	43,050	16
Basement – 1" above the floor in the NE corner where device was removed	0.756	0.173	756,000	173,000	37,320	15
Basement – 4' above the floor in the NE corner 4' from each wall					57,080	5
Outside – near door on South side of house (Nippon filter on)	0.001	0.001	1,000	1,000		
Outside – near door on South side of house (Nippon filter off)	0.001	0.001	1,000	1,000		
Outside – near door on South side of house					320 / 211	
Outside – 2nd step to door on South side of house					187	28

Outside – near door on South side of house on landing	0.001	0.001	1,000	1,000	268	36
Outside – near door on South side of house highest readings on stairs	0.003	0.001	3,000	1,000		
Outside – sidewalk from the South door to the garage	0.002	0.001	2,000	1,000		
Outside – on slab outside basement window that was used for venting (closed)	0.002	0.001	2,000	1,000		
Outside – on slab outside basement window that was used for venting (open)	0.047	0.033	47,000	33,000		
Outside – near shrubs with a new filter in the Lumex					12	
Outside – near door on South side of house 4' above the landing, with the new filter and without the hose					165	9
Readings taken by Weston with the Nippon, between 5:15 and 5:35 PM on Wednesday, June 13 after initial cleaning with HgX accomplished						
1st Floor – Living room / dining room floor	0.002	0	2,000	0		
1st Floor – Kitchen floor	0.004	0.001	4,000	1,000		
1st Floor – 4' above the floor at the top of the basement stairs	0.001	0	1,000	0		
Stairs to basement – 3" to 6" above the 5th step from the top	0.001	0.001	1,000	1,000		
Basement – 3" to 6" above the floor at the bottom of the stairs	0.01	0.007	10,000	7,000		
Basement – 4' above the floor in the middle of the room – basement ambient	0.003	0.002	3,000	2,000		
Basement – 3" to 6" above the floor in front of the firebox	0.347	0.065	347,000	65,000		
Basement – 3" to 6" above the floor near the plastic milk crate	0.077	0.057	77,000	57,000		
Basement – 3" to 6" above the plastic shop vac	0.028	0.021	28,000	21,000		
Basement – 3" to 6" above the floor below the old service	2.05	0.757	2,050,000	757,000		

* - The average value is the average of the three ten second averages which the Lumex records. The R(%) is the variability which applies to this average.

Nippon and Lumex Readings, XXXXXXXXXXXXXXXXXXX, June 14, 2001

The Nippon was operated by Weston and the Lumex was operated by Carol Hubbard from the MPCA
- readings below were recorded by Judy Grant, Xcel Energy Environmental Services

Location of Readings	Nippon Readings				Lumex Readings		
	mg/m3		ng/m3		ng/m3		
	Max	Ave	Max	Ave	Max*	Ave	R(%)
Readings taken at 8:10 AM by Weston using the Nippon:							
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	0.002	0.001	2,000	1,000			
1st Floor – 1" to 2" above the floor in the middle of the kitchen	0.002	0.001	2,000	1,000			
Outside ambient	0.001	0	1,000	0			
1st Floor – 4' above the floor at the top of the stairs	0.001	0	1,000	0			
1st Floor – 1" to 2"above the floor at the top of the stairs	0	0	0	0			
Stairs to basement – 1" to 2" above the 5th step from the top	0.001	0	1,000	0			
Stairs to basement – 1" to 2" above the bottom step	0.004	0.003	4,000	3,000			
Basement – 1" to 2"above the floor at the bottom of the stairs	0.003	0.001	3,000	1,000			
Basement – 1" to 2" above the floor in front of the firebox	0.003	0.002	3,000	2,000			
Basement – 1" to 2" above the floor under the stairs	0.003	0.003	3,000	3,000			
Basement – 4' above the floor in the middle of the room – basement ambient	0.001	0.001	1,000	1,000			
Basement – 1" to 2" above the floor drain	0.003	0.003	3,000	3,000			
Basement – 4' above the floor over the bagged material in the SE corner	0.003	0.002	3,000	2,000			
Basement – 4' above the floor in the NE corner where the device was removed	0.003	0.002	3,000	2,000			
Basement – 1" to 2" above the floor in the NE corner	0.065	0.021	65,000	21,000			
Basement – 1" to 2" above the floor 5' in front of NE corner	0.022	0.013	22,000	13,000			
Readings taken at 11:30 AM by Weston using the Nippon and Carol Hubbard using the Lumex:							
1st Floor – 4" to 6" above the floor, doorway between the kitchen and dining room	0.001	0.001	1,000	1,000	183	131	13
1st Floor – 4' above the floor, doorway between the kitchen and dining room	0	0	0	0	76	69	19
1st Floor – 4" to 6" above the floor, in the dining room archway	0	0	0	0	96	39	5
1st Floor – 4' above the floor, in the dining room archway	0.001	0	1,000	0	41	37	3
1st Floor – 4" to 6" above the floor, middle of living room	0	0	0	0	51	42	6
1st Floor – 4' above the floor, middle of living room	0	0	0	0	42	37	2
1st Floor – 4" to 6" above the floor, foot of stairs	0	0	0	0	123	58	9
1st Floor – 4' above the floor, foot of stairs	0.003	0	3,000	0	44	43	4
Stairs 1 to 2 – 4" to 6" above the floor, 7th step above the landing	0	0	0	0	49	46	1
Stairs 1 to 2 – 4' above the floor, 7th step above the landing	0.001	0	1,000	0	50	47	3
2nd Floor – 4" to 6" above the floor, top of stairs	0	0	0	0	47	46	25
2nd Floor – 4' above the floor, top of stairs	0	0	0	0	57	52	12
2nd Floor – 4" to 6" above the floor, entrance to NW bedroom	0	0	0	0	69	64	7
2nd Floor – 4' above the floor, entrance to NW bedroom	0	0	0	0	57	52	5
2nd Floor – 4" to 6" above the floor, center of NW bedroom	0	0	0	0	86	77	15
2nd Floor – 4' above the floor, center of NW bedroom	0	0	0	0	72	62	11
2nd Floor – 4" to 6" above the floor, hallway	0	0	0	0	89	84	24
2nd Floor – 4' above the floor, hallway	0.001	0	1,000	0	82	77	6
2nd Floor – 4" to 6" above the floor, entrance to NE bedroom	0	0	0	0	98	93	4
2nd Floor – 4' above the floor, entrance to NE bedroom	0.001	0	1,000	0	95	86	3
2nd Floor – 4" to 6" above the floor, NE bedroom 4' in front of window	0	0	0	0	96	89	1
2nd Floor – 4' above the floor, NE bedroom 4' in front of window	0	0	0	0	94	88	7
2nd Floor – 4" to 6" above the floor, sun room SE of desk	0	0	0	0	50	48	7
2nd Floor – 4' above the floor, sun room SE of desk	0	0	0	0	51	49	9
2nd Floor – 4" to 6" above the floor, entrance to SE bedroom from sunroom	0	0	0	0	56 / 72	46 / 60	12-Sep
2nd Floor – 4' above the floor, entrance to SE bedroom from sunroom	0.001	0	1,000	0	59 / 62	55 / 56	8-Dec
2nd Floor – 4" to 6" above the floor, SE bedroom by bed	0	0	0	0	79	72	4
2nd Floor – 4' above the floor, SE bedroom by bed	0.001	0	1,000	0	102	85	15
2nd Floor – 4" to 6" from broom in SE bedroom	0.001	0	1,000	0	106	94	7
2nd Floor – 4" to 6" above the floor, entrance to SE bedroom from hall	0	0	0	0	120	111	8
2nd Floor – 4' above the floor, entrance to SE bedroom from hall	0.001	0	1,000	0	100	92	8

2nd Floor – 4” to 6” above the floor, entrance to bathroom	0	0	0	0	106	90	3
2nd Floor – 4’ above the floor, entrance to bathroom	0.001	0	1,000	0	96	93	2
2nd Floor – 4” to 6” above the floor, middle of bathroom	0.001	0	1,000	0	96	93	1
2nd Floor – 4’ above the floor, middle of bathroom	0	0	0	0	102	94	3
Readings taken at 2:00 PM by Weston using the Nippon:							
1st Floor – 4’ above floor in middle of kitchen – kitchen ambient	0.001	0.001	1,000	1,000			
1st Floor – 1” to 2” above the floor in the middle of the kitchen	0	0	0	0			
Outside ambient	0	0	0	0			
1st Floor – 4’ above the floor at the top of the stairs	0	0	0	0			
1st Floor – 1” to 2”above the floor at the top of the stairs	0	0	0	0			
Stairs to basement – 1” to 2” above the 5th step from the top	0.001	0	1,000	0			
Stairs to basement – 1” to 2” above the bottom step	0.001	0.001	1,000	1,000			
Basement – 1” to 2”above the floor at the bottom of the stairs	0	0	0	0			
Basement – 1” to 2” above the floor in front of the firebox	0.011	0.007	11,000	7,000			
Basement – 1” to 2” above the floor under the stairs	0.004	0.003	4,000	3,000			
Basement – 4’ above the floor in the middle of the room – basement ambient	0.002	0.002	2,000	2,000			
Basement – 1” to 2” above the floor drain	0.008	0.004	8,000	4,000			
Basement – 4’ above the floor over the bagged material in the SE corner	0.001	0.001	1,000	1,000			
Basement – 4’ above the floor in the NE corner where the device was removed	0.003	0.002	3,000	2,000			
Basement – 1” to 2” above the floor in the NE corner	0.017	0.011	17,000	11,000			
Basement – 1” to 2” above the floor 5’ in front of NE corner	0.01	0.007	10,000	7,000			
Readings taken at 4:00 PM by Weston using the Nippon:							
Basement – 1” to 2” above the floor drain	0.004		4,000				
Basement – all other areas	0.002		2,000				
Basement – washer	0.001		1,000				
Basement – drier	0		0				

* - The maximum value is the maximum value observed while the Lumex takes three ten second averages. The average of these is the average value provided and the R(%) is the variability which applies to this average.

Nippon and Lumex Readings, XXXXXXXXXXXXXXXXXXX, June 15, 2001

The Nippon was operated by Weston and the Lumex was operated by Carol Hubbard from the MPCA
- readings below were recorded by Judy Grant, Xcel Energy Environmental Services

Location of Readings	Nippon Readings mg/m3 Max	Nippon Readings mg/m3 Ave	Nippon Readings ng/m3 Max	Nippon Readings ng/m3 Ave	Lumex Readings ng/m3 Max*	Lumex Readings ng/m3 Ave	Lumex Readings R(%)
Readings taken at 8:15 AM by Weston using the Nippon and Carol Hubbard using the Lumex:							
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	0	0	0	0	41	39	12
Basement – 5"above the floor at the bottom of the stairs	0.001	0	1,000	0	153	131	12
Basement – 4'above the floor at the bottom of the stairs	0.001	0	1,000	0	116	85	2
Basement – 5" above the floor under the stairs	0.003	0.001	3,000	1,000	869 869	307 287	59 51
Basement – 4' above the floor under the stairs	0	0	0	0	101	87	14
Basement – 5" above the floor in front of the firebox	0.002	0.001	2,000	1,000	471	378	17
Basement – 4' above the floor in front of the firebox	0.001	0.001	1,000	1,000	232	169	12
Basement – 5" above the floor, 5 feet in front of the firebox	0.007	0.005	7,000	5,000	529	294	42
Basement – 4' above the floor, 5 feet in front of the firebox	0.001	0.001	1,000	1,000	268	170	14
Basement – 5" above the floor in the NE corner where the device was removed	0.015	0.004	15,000	4,000	1,222	463	25
Basement – 4' above the floor in the NE corner where the device was removed	0.014	0.003	14,000	3,000	2,055	1,368	37
Basement – 5" above the floor 5 feet in front of NE corner	0.005	0.001	5,000	1,000	848	611	46
Basement – 4' above the floor 5 feet in front of NE corner	0.002	0.001	2,000	1,000	1,051	391	16
Basement – wall under gas service in the NE corner	0.015		15,000		1,717		
Basement – 5" above the floor drain	0.004	0.002	4,000	2,000	600	539	10
Basement – 4' above the floor drain	0.001	0	1,000	0	831	634	28
Basement – inside washer	0.001	0	1,000	0	178	177	1
Basement – inside drier	0.002	0	2,000	0	237	182	22
Basement – 4' above the floor over the bagged material in the SE corner	0.002	0.001	2,000	1,000	906	569	18
1st Floor – 5" above living room carpet					18	11	13

* - The maximum value is the maximum value observed while the Lumex takes three ten second averages. The average of these is the average value provided and the R(%) is the variability which applies to this average.

Lumex Readings, XXXXXXXXXXXXXXXXXXXX, June 16, 2001

The Lumex was operated by Carl Herbrandson from the Department of Health
- readings below were recorded by Judy Grant, Xcel Energy Environmental Services

Location of Readings	**Lumex Readings ng/m3**		
	Max*	**Ave**	**R(%)**
1st Floor – 2' above floor in middle of kitchen – kitchen ambient		437	10
1st Floor – 2' above floor in the middle of the living room – living room ambient		265	0
1st Floor – 2' above floor at the top of the stairs	707	589	38
Stairs to basement – 2' above the 5th step from the top	1011	978	6
Stairs to basement – 2' above the bottom step	1112	1095	2
Basement – 2' above the floor below the stairs	1112	1101	2
Basement – 2' above the floor in front of the steps 1 foot from each wall	958	922	5
Basement – 2' above the floor by the old service in the NE corner	1156 1305	1098 1231	10 11
Basement – 2' above the floor 5' in front of the NE corner	1237	1180	8
Basement – 2' above the floor in front of the firebox	895	881	4
Basement – 2' above the floor 5' in front of the firebox	912	887	5
Basement – 2' above the floor drain	1157	1140	2
Basement – inside washer	1098	1087	1
Basement – inside drier	1106	1104	0
1st Floor – 2' above floor in middle of kitchen – kitchen ambient	440	421	7
Outside	24	23	8

* - The maximum value is the maximum of the three ten second averages which are recorded by the Lumex. The average of these is the average value provided and the R(%) is the variability which applies to this average.

Lumex Readings, XXXXXXXXXXXXXXXXXXXX, June 18, 2001

The Lumex was operated by Ed Swain from the Minnesota Pollution Control Agency
- readings below were recorded by Judy Grant, Xcel Energy Environmental Services

Location of Readings	Lumex Readings ng/m3		
	Max*	Ave	R(%)
1st Floor – 2' above floor in middle of kitchen – kitchen ambient	157	154	3
1st Floor – 2' above floor at the top of the stairs	195	182	12
Stairs to basement – 2' above the steps about half way down the stairs	359	341	11
Basement – 2' above the floor in front of the stairs	275 461	266 380	6 52
Basement – 2' above the floor in front of the firebox	343	328	7
Basement – 2' above the floor in the NE corner where the device was removed	453	372	38
Basement – 4' above the floor in the NE corner where the device was removed	368	347	10
Basement – 2' above the floor 5' in front of the firebox	280	268	7
Basement – 2" above the floor in the middle of the basement between the two beams	450	438	4
Basement – 5" above the floor in the middle of the basement between the two beams	385	321	33
Basement – 4' above the floor in the middle of the basement between the two beams	338	333	3
Basement – 5" above the floor drain	428	408	7
Basement – inside washer	355	347	5
Basement – inside drier	63	60	7
Basement – 2' above the floor under the stairs	410	409	0
Basement – 1" from a hole in the cement 2" from hole by stairs	440	427	6
Basement – 1" from the base of the steps, east footing, east side (outside), in broken concrete	548	519	11
Basement – 1" from the base of the steps, east footing, west side (inside), in broken concrete	864	820	15
Basement – 1" from the base of the steps, east footing, north side (front), in broken concrete	722	608	49
Basement – 1" from the base of the steps, west footing	328	379	5
Basement – 1" from the hole in the wall under the stairs were the sewer pipe goes out	264	251	8
Basement – 1" from the area behind the sewer pipe as it goes into the floor under the stairs	513	506	3
Basement – 1" from the hole in the floor under the wash tub on the right side of the drain	504	483	6
Basement – 2" above the floor in the middle of the basement between the two beams	462	450	5
Basement – 1" from the drain in the wash tub	4,868	3,047	110
Basement – 6" from the drain in the wash tub	866	773	25
Basement – 2" above the floor in front of and under the washer	451	441	4
Basement – 2' above the floor between the furnace and hot water heater	643	571	26
Stairs to basement – 2" above the steps checking for contamination; 3rd step	430		
1st Floor – 5" above floor at the top of the stairs	293	288	2
1st Floor – 5" above the floor, doorway between the kitchen and dining room	235	233	14
1st Floor – 4' above the floor, doorway between the kitchen and dining room	208	206	1
1st Floor – 5" above the floor, middle of living room	217	201	13
1st Floor – 4' above the floor, middle of living room	246	229	11

* - The maximum value is the maximum of the three ten second averages which are recorded by the Lumex. The average of these is the average value provided and the R(%) is the variability which applies to this average.

Nippon and Lumex Readings, XXXXXXXXXXXXXXXXXXX, June 20, 2001

The Nippon was operated by Weston and the Lumex was operated by Judy Grant, Xcel Energy Environmental Services
- readings below were recorded by Judy Grant and XXXXXXXXXXX

Location of Readings	Nippon Readings mg/m3 Max	Nippon Readings mg/m3 Ave	Nippon Readings ng/m3 Max	Nippon Readings ng/m3 Ave	Lumex Readings ng/m3 Ave*	Lumex Readings ng/m3 R(%)
Readings taken at 9:15 AM by Weston using the Nippon (recorded by Judy Grant)**:**						
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	0	0	0	0		
1st Floor – 4' above the dining room table – dining room ambient	0	0	0	0		
1st Floor – 3" above floor in middle of kitchen	0.001	0	1,000	0		
1st Floor – 4' above the floor at the top of the stairs to the basement	0.001	0.001	1,000	1,000		
1st Floor – 3" above the floor at the top of the stairs to the basement	0.001	0.001	1,000	1,000		
Stairs to basement – 4' above the 5th step from the top	0.001	0.001	1,000	1,000		
Stairs to basement – 3" above the 5th step from the top	0.001	0.001	1,000	1,000		
Stairs to basement – 3" above the 11th step from the top	0.001	0.001	1,000	1,000		
Basement – 4'above the floor at the bottom of the stairs	0.001	0.001	1,000	1,000		
Basement – 3"above the floor at the bottom of the stairs	0.001	0.001	1,000	1,000		
Basement – 4' above the paint in the storage area to the west at the bottom of the stairs	0.001	0.001	1,000	1,000		
Basement – 3" above the paint in the storage area to the west at the bottom of the stairs	0.001	0.001	1,000	1,000		
Basement – 4'above the floor in the middle of the basement between the posts	0.001	0.001	1,000	1,000		
Basement – 3"above the floor in the middle of the basement between the posts	0.002	0.001	2,000	1,000		
Basement – 4' above the floor under the middle of the stairs	0.001	0.001	1,000	1,000		
Basement – 3" above the floor under the middle of the stairs	0.001	0.001	1,000	1,000		
Basement – 3" from the base of the steps, east footing, west side (inside), in broken concrete	0.001	0.001	1,000	1,000		
Basement – 1" to 2" from the base of the steps, east footing, east side (outside), in broken concrete	0.002	0.001	2,000	1,000		
Basement – 1" to 2" from the base of the steps, west footing	0.001	0.001	1,000	1,000		
Basement – 4' above the floor, 5 feet in front of the firebox	0.001	0.001	1,000	1,000		
Basement – 3" above the floor, 5 feet in front of the firebox	0.001	0.001	1,000	1,000		
Basement – 4' above the floor in front of the firebox	0.001	0.001	1,000	1,000		
Basement – 3" above the floor in front of the firebox	0.001	0.001	1,000	1,000		
Basement – 4' above the floor 5 feet in front of NE corner	0.001	0.001	1,000	1,000		
Basement – 3" above the floor 5 feet in front of NE corner	0.002	0.001	2,000	1,000		
Basement – 4' above the floor in the NE corner where the device was removed	0.001	0.001	1,000	1,000		
Basement – 3" above the floor in the NE corner where the device was removed	0.001	0.001	1,000	1,000		
Basement – 4' above the floor in the SE corner 5 feet from each wall	0.001	0.001	1,000	1,000		
Basement – 3" above the floor in the SE corner 5 feet from each wall	0.001	0.001	1,000	1,000		
Basement – 4' above the floor in the SE corner	0.002	0.001	2,000	1,000		
Basement – 3" above the floor in the SE corner	0.001	0.001	1,000	1,000		
Basement – 4' above the floor east side of the hot water heater	0.001	0.001	1,000	1,000		
Basement – 3" above the floor east side of the hot water heater	0.001	0.001	1,000	1,000		
Basement – 4' above the floor west side of the hot water heater, east of furnace	0.001	0.001	1,000	1,000		
Basement – 3" above the floor west side of the hot water heater, east of furnace	0.001	0.001	1,000	1,000		
Basement – 4' above the floor west side of the furnace	0.001	0.001	1,000	1,000		
Basement – 3" above the floor west side of the furnace	0.001	0.001	1,000	1,000		
Basement – 3" above the floor drain	0.002	0.001	2,000	1,000		
Basement – inside the wash tub	0.007	0.005	7,000	5,000		
Basement – inside the wash tub, near the drain	0.008	0.007	8,000	7,000		
Basement – at the back of the wash tub	0.002	0.002	2,000	2,000		
Basement – on the floor under the wash tub	0.002	0.002	2,000	2,000		
Readings taken at 11:00 AM by Judy Grant using the Lumex (recorded by XXXXXXXXXXX)**:**						
Outside – under tree in front yard, hose off					4	11

					4	12
Outside – under tree in front yard, hose on					4	37
1st Floor – 4' above floor in middle of kitchen – kitchen ambient					73	2
1st Floor – 5" above floor in middle of kitchen					88	43
1st Floor – 4' above the floor at the top of the stairs to the basement					74	16
1st Floor – 5" above the floor at the top of the stairs to the basement					174	27
Stairs to basement – 4' above the 5th step from the top					551	11
Stairs to basement – 5" above the 5th step from the top					729	20
Stairs to basement – 4' above the 11th step from the top					643	13
Stairs to basement – 5" above the 11th step from the top					692	0
Basement – 4'above the floor at the bottom of the stairs					675	2
Basement – 5"above the floor at the bottom of the stairs					665	2
Basement – 4' above the paint in the storage area to the west at the bottom of the stairs					656	1
Basement – 5" above the paint in the storage area to the west at the bottom of the stairs					651	3
Basement – 4'above the floor in the middle of the basement between the posts					696	7
Basement – 5"above the floor in the middle of the basement between the posts					692	8
Basement – 4' above the floor under the middle of the stairs					734	4
Basement – 5" above the floor under the middle of the stairs					769	5
Basement – 1" to 2" from the base of the steps, east footing, west side (inside), in broken concrete					881 975	29 13
Basement – 1" to 2" from the base of the steps, east footing, east side (outside), in broken concrete					878	6
Basement – 1" to 2" from the base of the steps, west footing					798	9
Basement – 4' above the floor, 5 feet in front of the firebox					649	2
Basement – 5" above the floor, 5 feet in front of the firebox					691	1
Basement – 4' above the floor in front of the firebox					691	1
Basement – 5" above the floor in front of the firebox					723	10
Basement – 4' above the floor 5 feet in front of NE corner					716	1
Basement – 5" above the floor 5 feet in front of NE corner					941	18
Basement – 4' above the floor in the NE corner where the device was removed					803	15
Basement – 5" above the floor in the NE corner where the device was removed					975	24
Basement – 1" to 2" from the floor, 2" from the NE corner					1,969 1,436	50 16
Basement – 1" to 2" from the floor, 5" from the NE corner					2,470	42
Basement – 1" to 2" from the wall in the NE corner, 5.5 feet off the floor at small ledge					1,064	18
Basement – 4' above the floor in the SE corner 5 feet from each wall					804	5
Basement – 5" above the floor in the SE corner 5 feet from each wall					857	15
Basement – 4' above the floor in the SE corner					785	6
Basement – 5" above the floor in the SE corner					832	4
Basement – 4' above the floor east side of the hot water heater					806	2
Basement – 5" above the floor east side of the hot water heater					796	1
Basement – 4' above the floor west side of the hot water heater, east of furnace					816	8
Basement – 5" above the floor west side of the hot water heater, east of furnace					880	4
Basement – 4' above the floor west side of the furnace					880	4
Basement – 5" above the floor west side of the furnace					839	0
Basement – 3" above the floor drain					889 852	23 11
Basement – inside the wash tub, 3" from the drain					1,122	29
Basement – at the back of the wash tub					855	4
Basement – on the floor under the wash tub					782	0
Basement – 1" to 2" from drain cover of floor drain					904	8
Basement – 1" to 2" from rim of floor drain					794	5

Basement – 1” to 2” from floor drain and in floor drain					941	10
Basement – middle of wash tub					4,446	58
Basement – middle bottom of wash tub					1,250	13
Basement – hole in floor in front of wash tub					801	0
Basement – 1” to 2” from cement patch by east post, middle of east side of patch					1,071 1,203	14 21
Basement – 1” to 2” from cement patch by east post, near cracks on NE side of patch					1,470	22
Basement – 1” to 2” from cement patch by east post, SE side of patch					944	8
Basement – 1” to 2” from cement patch by east post, north side of patch (max = 1,550)					1,014	6
Basement – 1” to 2” from wooden partition on east wall, east side (max = 11,000)					5,809 3,327	113 2
Basement – 1” to 2” from wooden partition on east wall, north side (max = 45,000)					12,330	95
Basement – 1” to 2” from wooden partition on east wall, north side at east wall					14,770	34
Basement – 1” to 2” from wooden partition on east wall, north side on wood 2X4					3,024	74
Basement – 1” to 2” from indents in floor near NE corner					1,965	23
Basement – 4’above the floor in the middle of the basement between the posts					769 762	1 1

* - The average value is the average of three ten second averages recorded by the Lumex. The R(%) is the variability which applies to this average.

Lumex Readings, XXXXXXXXXXXXXXXXXXXX, June 21, 2001

The Lumex was operated by Judy Grant, Xcel Energy Environmental Services
- readings below were recorded by Sarah Meyers from Weston and Judy Grant

Location of Readings	**Lumex Readings ng/m3**		
	Max*	**Ave**	**R(%)**
Readings taken at 10:15 AM by Judy Grant using the Lumex: (Sarah Meyers recording readings)			
Outside – on back steps, no hose		32	160
Outside – in yard, no hose		7	40
Outside – in yard, with hose attached		4	16
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	202	198	4
1st Floor – 4' above floor at the top of the stairs with containment open	370	337	14
Basement – 4' above the floor in front of the stairs	406	396	5
Basement – 4' above the floor in the middle of the basement between the two posts – basement ambient	442	430	4
Basement – 4' above the floor in the NE corner where the device was removed	453	439	8
Basement – 4' above the floor over the area where the wooden partition had been removed	516	511	2
Basement – 2" above the floor over the area where the wooden partition had been removed	609	572	12
Basement – 5.5' above the floor in the NE corner on the wall where higher levels were detected before	765	687	22
Basement – scan of NE corner wall patch	~ 520		
Basement – 4' above the floor where the old wash tub had been removed (new not yet installed)	473	468	2
Basement – 3" above the floor drain	486	469	8
Basement – 1" to 2" from drain cover	515	497	6
Basement – 1" to 2" from cement patch by east post, north side of patch	702	659	10
Basement – 5" from indents in floor near NE corner	1,878	1,433	67
Basement – 5" from the floor in the NE corner	1,287	958	58
Basement – 4' above the floor in the middle of the basement between the two posts – basement ambient	497	476	10
Basement – 1" to 2" above new cement at the foot of the stairs	400 – 500		
Basement – 1" to 2" above new cement at the foot of the stairs, between cement patches	1,500 – 2,100		
Basement – 4' above the floor west side of the hot water heater, east of furnace	527	513	13
Basement – 4' above the floor east side of the hot water heater	517	493	10

Readings taken at 12:26 PM by Judy Grant using the Lumex: (Judy Grant recording readings)			
1st Floor – 4' above floor in middle of kitchen; gas off, door and window closed, air movement coming from upstairs to basement through kitchen	10 8 9 8	9 8 8 8	6 16 14 6
1st Floor – 5" from front right burner of stove, oven open, 4" above surface of stove – Gas Off	12 11 11	11 10 10	24 22 9
1st Floor – 5" from front right burner of stove, oven open, 4" above surface of stove – Gas/Flame On	12 13 12 10 10	10 11 11 10 9	36 27 30 15 18
1st Floor – 5" from front right burner of stove, oven open, 4" above surface of stove – As Gas Turned Off	13	11	22
1st Floor – 5" from front right burner of stove, oven open, 4" above surface of stove – Gas On No Flame	47	31	109
1st Floor – just inside open oven door – Gas Off	7	7	16
1st Floor – just inside open oven door – Gas On and oven set at 205 degrees	8	7	14
1st Floor – just inside open oven door – Gas On and oven set at 205 degrees – smelling gas	28	27	3
1st Floor – just inside open oven door – Gas On and oven set at 205 degrees – not smelling gas air becoming hot (may be exceeding	49 123	41 96	41 50
1st Floor – just inside open oven door – Gas On and oven set at 205 degrees – holding hose higher because of heat from oven (may be	120 90	112 80	11 35
Readings taken at around 4:00 PM by Judy Grant using the Lumex: (Sarah Meyers & Mueller Pipeliners recording			
Basement – 4' above the floor east side of the hot water heater	94	86	27
Basement – east side of the hot water heater – inside bag, near trap, trap ON	150 179 216	120 175 206	38 4 14
Basement – east side of the hot water heater – inside bag, near end of pipe where trap had been, trap OFF	236 175 155	215 154 137	18 28 23
Basement – east side of the hot water heater – inside bag, inside trap which was not attached to the pipe	287 263	271 259	12 2
Basement – 4' above the floor east side of the hot water heater	312	240	64
Basement – east side of the hot water heater – inside bag, near end of pipe where trap had been, trap OFF Taken after Mueller put gas	317 311	309 300	6 7

* - The maximum value is the maximum of the three ten second averages which are recorded by the Lumex. The average of these is the average value provided and the R(%) is the variability which applies to this average.

Lumex Readings, XXXXXXXXXXXXXXXXXXXX, June 22, 2001

The Lumex was operated by Judy Grant, Xcel Energy Environmental Services
- readings below were recorded by XXXXXXXXXXX and Judy Grant

Location of Readings	Lumex Readings ng/m3 Max*	Ave	R(%)
Readings taken at 12:15 PM by Judy Grant using the Lumex: (XXXXXXXXXX recording readings)			
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	143 146	141 141	3 5
1st Floor – 4' above floor at the top of the stairs	152	149	3
Basement – 4' above the floor, in front of the stairs	166	165	1
Basement – 4' above the floor, in the middle of the basement between the two posts – basement ambient	185 176	173 174	1 2
Basement – 4' above the floor, 3' in front of the east corner of the firebox on the edge of the epoxy	180	179	1
Basement – 4' above the floor, under the middle of the stairs	180 189	179 182	1 7
Basement – 4' above front right corner of the washing machine	209	206	3
Basement – inside washer	235	228	8
Basement – 4' above the floor drain area at the edge of the epoxy	232	217	16
Basement – 4' above the floor, in the middle of the basement between the two posts – basement ambient	207	203	3
Basement – 4' above the floor, in the middle of the basement between the two posts after walking around	215	210	4
Basement – 4' above the floor, 3' west of the over the area where the wooden partition had been removed	211	209	2
Basement – 4' above the floor, 2' west of the over the area where the wooden partition had been removed	215	212	3
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	172	168	4
1st Floor – 4' above the floor in the dining room above the dining room table – dining room ambient	119	113	9
1st Floor – 4' above the floor in the middle of the living room in front of the fireplace	115	115	1
Stairs 1 to 2 – 4' above the floor on the landing of the stairs	106	106	0
2nd Floor – 4' above the floor at the top of the stairs by the bathroom	102	101	1
2nd Floor – 4' above the floor in the SE bedroom near the corner of the bed	101	100	2
2nd Floor – 4' above the floor in the sun porch	103	100	6
2nd Floor – 4' above the floor in the NE bedroom, over SW corner of bed	95	92	5
2nd Floor – 4' above the floor in the hallway	100	99	1
2nd Floor – 4' above the floor in the NW bedroom	103	103	0
Readings taken at 2:15 PM by Judy Grant using the Lumex: (Judy Grant recording readings)			

1st Floor – 4' above floor in middle of kitchen – kitchen ambient	173	171	1
1st Floor – 4' above the floor in the dining room above the dining room table – dining room ambient	162	156	8
1st Floor – 4' above the floor in the middle of the living room in front of the fireplace	148	144	6
2nd Floor – 4' above the floor in the SE bedroom near the corner of the bed	127	127	0
2nd Floor – 4' above the floor in the sun porch	119	118	1
2nd Floor – 4' above the floor in the NE bedroom, over SW corner of bed	112	111	1
Basement – 4' above the floor, in front of the stairs	214	204	10
Basement – 4' above the floor, in the middle of the basement between the two posts – basement ambient	235	228	6
Basement – 4' above the floor, 3' in front of the east corner of the firebox on the edge of the epoxy	197	193	4
Readings taken at 5:00 PM by Judy Grant using the Lumex: (Judy Grant recording readings)			
Outside – on south steps	57	40	86
Outside – foot of the south steps	3	1	121
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	113	110	8
1st Floor – 4' above the floor in the dining room above the dining room table – dining room ambient	125	124	0
1st Floor – 4' above the floor in the middle of the living room in front of the fireplace	134	132	1
2nd Floor – 4' above the floor in the SE bedroom near the corner of the bed	127	125	1
2nd Floor – 4' above the floor in the sun porch	119	118	1
2nd Floor – 4' above the floor in the NE bedroom, over SW corner of bed	108	108	1
Basement – 4' above the floor, in front of the stairs	256	244	9
Basement – 4' above the floor, in the middle of the basement between the two posts – basement ambient	261	256	6
Basement – 4' above the floor, 3' in front of the east corner of the firebox on the edge of the epoxy	238	235	3
Basement – 4' above the floor, near the drier where the certification sample was set up	272 267	270 265	1 1
Readings taken at 8:00 PM by Judy Grant using the Lumex: (Judy Grant recording readings)			
Outside – in yard	5 3	4 2	47 47
Outside – foot of the south steps	8	6	76
Outside – on south steps near certification sample	15	9	114
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	94 99	93 96	3 4
1st Floor – 4' above the floor in the dining room above the dining room table – dining room ambient	106	105	0
1st Floor – 4' above the floor in the dining room, SE corner of table near certification sample (done)	107	102	9

1st Floor – 4’ above the floor in the middle of the living room in front of the fireplace	120	119	2
1st Floor – 4’ above the floor in the living room, north side of table near certification sample (done)	121	121	0
2nd Floor – 4’ above the floor in the SE bedroom near the corner of the bed	118	115	4
2nd Floor – 4’ above the floor in the SE bedroom, NE corner of dresser near certification sample (done)	121	121	1
2nd Floor – 4’ above the floor in the sun porch	111 100	108 97	6 7
2nd Floor – 4’ above the floor in the NE bedroom, over SW corner of bed	116	114	4
2nd Floor – 4’ above the floor in the NE bedroom, over NE corner of bed near certification sample (done)	113	112	0
Basement – 4’ above the floor, in front of the stairs	233 241	231 238	1 1
Basement – 4’ above the floor, in the middle of the basement between the two posts – basement ambient	245 249	241 245	4 2
Basement – 4’ above the floor, 3’ in front of the east corner of the firebox on the edge of the epoxy	262 265	258 260	4 5
Basement – 4’ above the floor, near the drier where the certification sample was set up	259 256	251 252	7 3

* - The maximum value is the maximum of the three ten second averages which are recorded by the Lumex. The average of these is the average value provided and the R(%) is the variability which applies to this average.

Lumex Readings, XXXXXXXXXXXXXXXXXXXX, June 25, 2001

The Lumex was operated by Judy Grant, Xcel Energy Environmental Services

#NAME?

Location of Readings	**Lumex Readings ng/m3**		
	Max*	**Ave**	**R(%)**
Outside – with tube on (prior to bag sampling)	5	5	6
Outside – without tube on (prior to bag sampling)	8	7	31
	6	6	20
Outside – with tube on (after bag sampling)	10	10	6
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	20	17	41
	14	12	21
	22	16	55
	12	11	9
1st Floor – 4' above the floor in the dining room above the dining room table – dining room ambient	33	32	8
	44	37	32
	20	18	25
1st Floor – 4' above the floor in the middle of the living room in front of the fireplace	29	26	16
	25	22	21
2nd Floor – 4' above the floor at the top of the stairs	7	7	6
	7	7	6
2nd Floor – 4' above the floor in the SE bedroom near the corner of the bed	6	6	2
	8	7	11
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	5	5	4
	7	6	16
	7	7	5
Basement – 4' above the floor, in front of the stairs	170	169	1
	175	175	0
Basement – 4' above the floor, in the middle of the basement between the two posts – basement ambient	199	184	13
	194	191	4
Basement – 4' above the floor in the NE corner where the device was removed	188	183	5
	188	185	3
Basement – 4' above the floor over the area where the wooden partition had been removed	192	189	2
Basement – 5" above the floor over the area where the wooden partition had been removed	227	218	9
	234	232	2
Basement – 4' above the paint in the storage area to the west at the bottom of the stairs	142	137	5
Basement – 4' above the floor over the new wash tub	183	183	0
Basement – 5" above the floor drain	213	208	5
Basement – inside the drier	190	189	1
Basement – 5" from cement patch by east post, NE side of patch	250	249	2

* - The maximum value is the maximum of the three ten second averages which are recorded by the Lumex. The average of these is the average value provided and the R(%) is the variability which applies to this average.

Lumex Readings, XXXXXXXXXXXXXXXXXXX, July 3, 2001

The Lumex was operated by Carol Hubbard from the MPCA, readings below were recorded by Judy Grant

Location of Readings	**Lumex Readings ng/m3**		
	Max*	**Ave**	**R(%)**
Outside	9, 7	9, 6	15, 16
Garage – 4' above the floor in the middle of the garage	21	20	1
Garage – 4' above the floor in the SW corner, 4' from each wall (drums had been stored in this area)	17	16	5
Garage – 4' above the floor in the NW corner, 4' from each wall	16	15	10
Garage – 3" to 6" above the floor in the middle of the garage	17	16	3
Garage – 3" to 6" above the floor in the SW corner, 4' from each wall (drums had been stored in this area)	18	17	19
Garage – in bag of detergent (106 ng/m3 previously)	45	44	7
Garage – in bag of old tools (433 ng/m3 previously)	17	17	4
Garage – in bag of chalk tools (313 & 309 previously)	19	18	8
Garage – in blue garbage can that contained the new tool (161 and 29 previously)	16	15	3
Garage – above the 45s (25 previously)	16	15	4
Garage – 1" to 2" from brooms which were used in the basement before the spill on 6/5/01	14	14	3
Garage – 1" to 2" from new over yellow plastic disposable boots from Weston on table	14	13	5
Garage – 1" to 2" from partial roll of red duct tape from Weston on table	17	16	14
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	20	18	13
Basement – 4' above the floor, in front of the stairs	143	142	0
Basement – 4' above the floor, in the middle of the basement between the two posts – basement ambient	153	152	1
Basement – 4' above the floor in the NE corner where the device was removed	162	159	4
Basement – 4' above the floor, 5' in front of the NE corner where the device was removed	175	174	1
Basement – 4' above the floor over the area where the wooden partition had been removed	171	170	1
Basement – 5" above the floor, in front of the stairs	146	144	2
Basement – 5" above the floor, in the middle of the basement between the two posts – basement ambient	179	175	4
Basement – 5" above the floor in the NE corner where the device was removed	225	212	9
Basement – 5" above the floor, 5' in front of the NE corner where the device was removed	189	186	3
Basement – 5" above the floor over the area where the wooden partition had been removed	181	171	9
Basement – 5" above the floor 5' in front of the firebox	157	149	7
Basement – 4' above the floor 5' in front of the firebox	157	150	8
Basement – 1" above the floor drain	164	162	1
Basement – 4' above the floor drain	159	157	3
Basement – 5.5' above the floor in the NE corner where the device was, 1" from the lip which was removed	189	181	9
Basement – 5" above the floor in the NE corner, 4' from each wall	189	180	10
Basement – 5" above the NE corner of the drier where the certification sample was taken	165	163	2
Basement – in washer	164	162	2
Basement – in drier	144	143	1
Basement – 4' above the floor of the paint storage area to the west of the foot of the stairs	138	138	0
Basement – 5" from cement patch by east post, north side of patch	199	188	10

* - The maximum value is the maximum of the three ten second averages which are recorded by the Lumex. The average of these is the average value provided and the R(%) is the variability which applies to this average.

Lumex Readings, XXXXXXXXXXXXXXXXXXXX, July 13, 2001

The Lumex was operated by Carl Herbrandson from the Department of Health
Readings were recorded by Judy Grant and observed by XXXXXXXXXX

Location of Readings	Lumex Reading ng/m3 Ave *	R(%)
1st Floor – 4' above floor in middle of kitchen – kitchen ambient	8	25
1st Floor – in the pots on the lowest shelf, open shelving in the kitchen on the west wall	16	50
1st Floor – 6" above the floor in the middle of the living room in front of the fireplace	2	2
Basement – 1' above the floor, in front of the stairs	93	8
Basement – 1' above the floor 1' north of the area where the wooden partition had been removed	128	13
Basement – 1' above the floor in the NE corner where paint was removed, 4' from each wall	125	15
Basement – 1' above the floor in the NE corner where the device was removed	269	10
Basement – 4' above the floor in the NE corner where the device was removed	154	11
Basement – 1' above the floor drain	119	2
Basement – 2" from the east wall, 5'above the floor where the wooden partition had been removed	126	3
Basement – 4' above the floor, in the middle of the basement between the two posts – basement ambient	120	1
Basement – in washer	154	13
Basement – in drier	106	2

* - The average value is the average of the three ten second averages which were recorded by the Lumex. The R(%) is the variability which applies to this average.

July 11, 2001

Ms. [redacted]
[redacted]
St. Paul, Minnesota 551[redacted]

Dear Ms. [redacted]:

This letter is written in response to your request for a report on the mercury contamination in your house.

We were informed that in early June service personnel under contract with Xcel Energy, removed a piece of equipment containing mercury from you natural gas line. It was reported that a small amount of mercury was spilled on your basement floor. Xcel hired BayWest to cleanup the mercury spill. Mercury vapor in the basement was measured with a Jerome Meter after the cleaning process was complete. The maximum Jerome reading after the cleanup was reported to be 349,000 ng/m^3. This high concentration was not expected and therefore, questions about possible interference from ammonia in a cat litter box were raised. It was confirmed that kitty litter and other odorous material can interfere with correct readings on the Jerome meter.

Carol Hubbard, from the Minnesota Pollution Control Agency, and I accompanied Xcel Energy into the house on the afternoon of June 8th. Using a Lumex Mercury Vapor Analyzer, mercury levels were measured outside the house, on the main floor, and in the basement. Mercury concentrations in ambient air outside the house fluctuated between less than 30 ng/m^3 and more than 150 ng/m^3. The instrument readings appeared to stabilize below 30 ng/m^3 when the instrument was held in the shade. Typical mercury concentrations outdoors are less than 10 ng/m^3.

We entered the house through the back door into the kitchen and measured the mercury concentration to be between 1,500 and 3,500 ng/m^3 in the kitchen. The mercury concentration increased on the stairs to the basement. Mercury concentrations in the basement ranged from 20,000 to 51,000 ng/m^3. The Lumex is not thought to be sensitive to ammonia, and readings readings near the kitty litter box were consistent with what was encountered in other areas of the basement. According to the manufacturer, the sensitivity of the Lumex flattens out as mercury concentrations in air approach 50,000 ng/m^3. Therefore, the actual mercury concentrations in air in the basement may have been higher in some areas.

Exposure to mercury concentrations above 6,000 ng/m^3 for a long time (years) has been associated with hand tremor; increases in memory disturbances and other neurological effects. MDH advised Xcel that you, the owner of the house, be temporarily removed from the house until the house was re-cleaned to

Ms. [redacted]
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levels below the EPA Reference Concentration for mercury of 300 ng/m^3. The RfC is considered protective for the general public, including sensitive sub-populations such as children, for life-time exposures. It is my understanding that you were relocated for the duration of most of the cleanup.

According to Xcel Energy, on Wednesday, June 13 contractors experienced in cleaning up mercury spills in basements (Weston, Chicago, IL) began cleanup operations. Cleaning methods included use of a mercury cleanup (amalgamating) kit, washing and scraping. Cleanup continued until all levels of mercury vapor, except those near the floor drain, were below the low-end calibration limit (1,000 ng/m^3) on a Nippon mercury vapor survey meter. On Friday afternoon they sealed the floor with an enamel paint. Friday night the house was sealed up and heated to about 80° F..

On Saturday, June 16, I accompanied you and Xcel on what was to be a final inspection prior to clearance, or approval of reoccupancy. Mercury vapor concentrations on the main floor of your house were between 265 and 589 ng/m^3. Mercury concentrations in the basement ranged from 881 ng/m^3 to 1231 ng/m^3.

Areas of the floor near the bottom of the basement stairs and a small partition on the north side of the eastern wall, as well as the washtub drain, were subsequently identified as areas which may be the source of some mercury vapor. The washtub and partition were removed. Some concrete was also excavated from the floor in areas where high mercury readings were recorded. Concrete patches were put in the floor and clear epoxy was used to seal these and other areas of the floor.

On June 20 Lumex sampling showed mercury vapor levels throughout the house to be below 300 ng/m^3. On June 22, final clearance sampling was conducted by Franklin Dickson, Certified Industrial Hygenist, Applied Environmental Services, Inc.. Following established protocols, the house was heated to between 75 and 80° F. for two hours prior to drawing air samples over a 6 hour period. These sampling protocols were developed by the U.S. Environmental Protection Agency, and the Agency for Toxic Substances and Disease Control, a part of the U.S. Public Health Service.

Mercury concentrations throughout the house were below the identified level-of-concern of 300 ng/m^3. Analytical results (Braun InterTech) are listed in the table below.

Sample #	Location	Mercury Concentration
1.	Living Room	210 ng/m^3
2.	Dining Room	180 ng/m^3
3.	Master Bedroom	140 ng/m^3
4.	Second Bedroom	100 ng/m^3
5.	Basement	270 ng/m^3
6.	Outdoors - back porch	less than 100 ng/m^3

MDH recommends that follow-up sampling be performed in the future to assure that these concentrations decrease over time, as expected.

Ms. [redacted]
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MDH has concluded:

- Xcel and Weston have certified that the cleanup was conducted using the best methods currently employed in mercury cleanups;
- Applied Environmental Services and Braun Intertech certified that clearance data was acquired and analyzed according to protocols established by the EPA and ATSDR
- The cleanup was successful in reducing potential exposures to mercury in air to levels below health concern.

In the next month, I will be writing a larger technical report on this incident. If I can be of further assistance, please let me know.

Sincerely,

Carl Herbrandson, Ph.D.
Site Assessment and Counsultation Unit

cc: Judy Grant, Xcel Energy
Edward Swain, Ph.D., MPCA
Carol Hubbard, MPCA

CH:rlk

Final Clearance Sampling Protocol
for
Mercury Within a Residential Home

This protocol is designed to be implemented once the on-site remediation service feels that the environment has been adequately cleaned and for the sole purpose of gathering valid data to be further assessed by _____ _____ and applicable governmental authorities.

Quantitative Sampling:

1. Prior to sampling period, the indoor temperature of home environment should be determined and documented. Temperature should be at least 75-80° F for a minimum of 60 minutes prior to commencing sampling.

2. Following the heating and venting period, the house should be closed up (windows, doors shut) for a minimum of 60 minutes after desired temperature of 75-80° F to allow for equilibrium temperatures to be achieved. Screen test area using screening protocol prior to final clearance. If there are readings above 0.0003 mg/m^{3} with continuous reading instruments, identify areas requiring recleaning, including additional ventilation. Record all readings on log sheet.

3. The hopcalite test (sample attached)(SKC HYDRAR), or other approved method, will be used to provide final clearance if the detected mercury vapors were confined and there were no detectable levels in living areas prior to cleanup.

4. If instrument testing is not used, final clearance sampling shall be performed utilizing USEPA Response Team SOP #1827 with a modified NIOSH 6009 method, 5/13/99 or OSHA ID-140. The pump will be calibrated to 0.5 liters/min. or less, or as defined by the method. The media utilized will be hopcalite or approved equivalent (e.g. Hydrar).

5. One (1) field blank (opened in field and handled with samples) shall be taken for each home sampled. In addition, two (2) unopened blanks from the same lot shall be retained and submitted with the corresponding field blank.

6. A minimum of five (5) samples should be taken throughout the home. All children's bedrooms and play areas shall be tested. In addition, one (1) outdoor reference sample shall be taken outside.

7. A floor map of the home shall be drawn to document the locations selected for sampling. The floor map shall include occupancy information identifying the rooms sampled (i.e., children's bedrooms, play areas, etc.)

8. The sample media shall be set at a height of between three to four (3-4) feet from ground level to represent a breathing zone sample.

9. The sample time should be approximately eight (8) hours or as necessary to obtain a detection limit less than 0.0003 mg/m^3. Periodic pump flow checks shall be performed and documented throughout the sampling period (minimum of 2).

10. Upon completion of the sampling, samples shall be handled and submitted to an AIHA accredited laboratory for analysis utilizing proper chain of custody procedures. Sample turnaround time will be determined in advance by _____.

11. The analytical method to be utilized should be USEPA Response Team SOP #1827 with a modified NIOSH 6009 method, 5/13/99 or OSHA ID-140.

12. Upon completion of the final clearance test and receipt of results, the sampling firm will prepare a clearance sampling report and submit to _____ for further review and follow-up action. The report shall consist of, at a minimum:

    a. Floor map documenting the locations of samples taken and corresponding results, including a description of the occupancy of the rooms tested.
    b. Sample data sheets documenting either the instrument readings or the media number, sample location, pump flow (with checks), final volume sampled, sample duration and any remarkable field notes.
    c. Sample results as submitted by the laboratory corresponding to provided sample data sheets, as applicable.
    d. Copy of this sampling protocol.

13. The clearance sampling report will be submitted to USEPA, ATSDR and the IDPH for their review and determination of the effectiveness of the cleanup. A letter from IDPH to the residents will provide the final result of the consultation between USEPA, ATSDR and IDPH.