# Site Mercury Monitoring Report
# March 20, 2015 and July 8, 2015
# Reliable Relamping Facility
# Saranac, Michigan

Michigan Department of Environmental Quality
Air Quality Division
Toxics Unit, Evaluation Section
P.O. Box 30026
Lansing, Michigan 48909-7760

# Site Monitoring Report
# Reliable Relamping Facility

## Background Information

Reliable Relamping is a facility that crushes old fluorescent lamps and is located in Saranac, Ionia County, Michigan. The facility is located in primarily a rural area. Some residential homes are located very close to the facility, one on the north side and adjacent to the facilities' property line. The lamps are collected from a variety of commercial properties. The purpose of the inspection and air monitoring on March 20, 2015 was to determine the concentrations of elemental mercury (Hg(0)) around the vicinity of this process and to determine if the process was exceeding their air permit limit for Hg(0). Various types of lamps, including fluorescent lamps, can contain Hg(0) ranging between 1-100 mg per lamp (IMERC, 2014). The Hg(0) is included in fluorescent lamps to increase the energy efficiency (over incandescent bulbs) and to extend the life of the lamps. The Hg(0) is present in the lamps in both the phosphor powder and in the vapor (IMERC, 2014). The phosphor powder is transported offsite by Cleanlites Recycling to USA Lamp and Ballast in Cincinnati, Ohio.

The unit that crushes the lamps is located in a delivery truck parked at the stationary facility (see photos below) (#1 on site map, page 5). While the system is permitted to be mobile, the company currently only crushes lamps at the facility's property in Saranac. The facility has been permitted to crush lamps since 2001 when it obtained an Air Quality Division (AQD) Permit to Install (PTI No. 373-00). The Permit to Install requires a fan to maintain negative pressure and a filter system that includes a pre-filter, a HEPA filter to control any particulate matter and two carbon filters to capture Hg(0). The required permit limit for Hg(0) has been set at 0.05 $mg/m^3$. The Permit also limits the facility to process no more than 500,000 lamps per month and requires air monitoring every two weeks. The permittee must demonstrate that the filters are working properly and if the Hg(0) in the exhaust gas is detected at a concentration of 0.01 $mg/m^3$ or greater than the permittee must replace the carbon filters.

This report summarizes the monitoring of atmospheric Hg(0) levels in and surrounding the Reliable Relamping facility on March 20 as well as a follow-up inspection on July 8, 2015.

*Truck with Crusher Inside*

*Facility with Trucks at Bay*

**<u>Summary of Data - March 20, 2015</u>**

A limited set of Hg(0) data was collected on March 20, 2015 from approximately 11:00 am to noon. Air monitoring was conducted with a handheld mercury monitor known as a Lumex RA-915+, which works on spectrophotometric principles (see photo below). The instrument has a wider range and lower detection limit than other known portable mercury vapor monitors. The reported detection limit is 2 ng/m$^3$ with a range of up to 50,000 ng/m$^3$. The monitor is relatively lightweight and battery-operated. The instrument was set up to provide a one-minute average, along with instantaneous readings. All values reported are minute averages reported in Table 2.0. Data was recorded manually based on observed readings.

*Lumex RA-915+*

On March 20, 2015, ambient temperatures ranged between 35-40° F, with a southwest wind of up to approximately 8 mph. The sky was partly cloudy. It should be noted that the ambient temperature was at the low end of the acceptable operating conditions; in the Lumex manual, it lists the operating range of the analyzer as 1° to 40° Celsius (or 34° to 104° F) http://ohiolumex.com/download/manual_RA_915.pdf. Results reported here have been corrected for standard temperature and pressure.[1] The vapor pressure of Hg(0) at 70° F is about 30 times that at 40° F, so there is less volatilized Hg(0) available to be measured than on a 70° F day (Allen, 2015). Therefore, levels of Hg(0) both inside the facility and outside, are expected to increase if the facility is heated and/or if the ambient temperatures increase during the spring and summer seasons.

General protocol in an ambient Hg(0) monitoring effort of this nature is to remain at a particular point long enough to obtain at least one average reading and ideally several readings, before moving on to the next defined point. After running the reliability test for the machine, an upwind reading is typically obtained followed by a downwind reading to see if any influence of the source can be detected. In this case, upwind and downwind readings were obtained prior to the crushing device being turned on, then upwind and downwind readings were obtained when it was operating.

The upwind reading at the southwest corner of the parking lot (#2 on site map) prior to operation ranged from 1-9 ng/m$^3$. When the crusher began operation of crushing the lamps, concentrations upwind ranged 4-8 ng/m$^3$ so no signal upwind from the device was detected. The downwind concentrations (#3 on site map) prior to operation ranged from 1-100 ng/m$^3$; however, it should be noted that the monitor may have picked up a signal from the broken lamps that were around the dumpster located at the southeast corner of the building (#4 on site map) (see photos below). When the device was operating, the downwind signal ranged from 18-41 ng/m$^3$.

[1] Conversion to standard temperature and pressure: concentration x (70+460)/(40+460).

*Dumpster with Broken Lamps* *Broken Lamps*

Concentrations ranged from 1-16 ng/m$^3$ when measured from the northwest corner of the building, close to a nearby residence (#5 on site map), walking toward the north side of the building at the center mark (#6 on site map) when the crusher was not operating. When the crusher was running, the concentrations ranged from 7-19 ng/m$^3$.

Before the crusher was operating, the concentrations measured around the outside of the truck (#7 and #8 on site map) ranged from 111-2,681 ng/m$^3$. Once the crusher was operating, the concentrations ranged from 1,252-4,018 ng/m$^3$.

Inside the facility (#9 on site map) when the crusher was operating, the concentrations ranged from 539-3,629 ng/m$^3$ and inside the truck when the crusher was operating, the concentrations ranged from 773->50,000 ng/m$^3$. If 50,000 ng/m$^3$ is exceeded, this is beyond the measuring capabilities of the Lumex RA-915+ monitor. Additionally, 50,000 ng/m$^3$ is the instantaneous concentration limit within the air permit that should not be exceeded. Since the temperature was at the lower end of the acceptable operating conditions for this monitor, a follow-up inspection was scheduled in July that included a Lumex Light monitor with the capability of detecting concentrations up to 200,000 ng/m$^3$.

*SITE MAP (upwind/downwind for March 20, 2015)*

**Discussions of Measured Values**

Ambient Hg(0) concentrations within the vicinity of this facility appear to be above background concentrations. Background concentrations in clean geographic areas not impacted by urban sources, are known to be approximately 1.5 ng/m$^3$ in Michigan and elsewhere (Liu, et al., 2010; Lieu, et al., 2007 and EPA, 1997). Recent published literature are now starting to document that these levels are continuing to decline with time as less mercury is used and emitted into the environment (Zhang, 2016). At the fence line surrounding the facility on the day of monitoring on March 20, 2015, the concentrations did not exceed the applicable acute health benchmarks listed in Table 1.0 (page 8).

Elevated concentrations of Hg(0) are primarily a concern from inhalation. Up to 80% of the inhaled Hg(0) vapor is absorbed through the lungs and then transferred throughout the body through the blood, compared to uptake through the skin, which is only 2% (Hursh et al.,

1989). Hg(0) is a known neurotoxicant and at elevated levels, symptoms can include tremors, mood swings, memory loss, headaches and decreased cognitive function (WHO, 2003; ATSDR 2009). The known health protective regulations and benchmarks are summarized below in Table 1.0.

## Summary of Data - July 8, 2015

The purpose of the inspection and air monitoring on July 8, 2015 was to conduct a follow-up inspection after elevated ambient Hg(0) concentrations were detected when the facility was inspected on March 20, 2015.

For quality assurance purposes, an additional Lumex RA-915+ operated by Michigan Department of Health and Human Services (MDHHS) staff was used as well as a Lumex Light monitor used by Ottawa County Health Department staff that has the capability of detecting concentrations up to 200,000 ng/m$^3$, compared to the Lumex RA-915+, which has a top range of 50,000 ng/m$^3$. MDHHS reported on their findings when inspecting the facility and includes recommendations in their report (MDHHS, 2016).

The owner of the facility also used a Jerome® 431-X mercury vapor analyzer dosimeter monitor that has a detection limit of 3,000 ng/m$^3$ as compared to the Lumex RA-915+ at 2 ng/m$^3$ and the Lumex Light at 100 ng/m$^3$.

A limited set of Hg(0) data was collected on July 8, 2015 from approximately 10:30 am to approximately 12:45 pm.

The concentrations in the trailer were significantly less (as shown in Graph 1.0). The owner of the facility said that they conducted extensive housekeeping within and around the facility. For example, the broken lamps that were scattered in and around their dumpster had been cleaned up and within the truck where the lamps are crushed seemed much cleaner. It appears based on the limited monitoring data collected March 20 and July 8, 2015 that the housekeeping efforts were effective in reducing the Hg(0) concentrations detected in the ambient air. In Table 4.0, Hg(0) values were compared when air monitoring was conducted at similar locations on March 20, 2015 and July 8, 2015. The values were averaged at specific locations that were similar and are compared in Graph 1.0

## Report Summary

Because fluorescent lamps are a mercury-containing product, emissions of some amount of Hg(0) will occur when the lamps are broken. This was evident when air monitoring was conducted around the vicinity of a dumpster that contained broken lamps in and surrounding the dumpster as well as when monitoring within the truck where the lamps are crushed. Without proper housekeeping methods, emissions of Hg(0) are greater than with implementation of these procedures. Housekeeping methods can include, but are not limited to, cleaning up any broken lamps properly and

not allowing broken lamps to remain outside or inside the facility. If the lamps are broken indoors they should be cleaned up properly with a vacuum that is specifically designed for cleaning up mercury waste.

The atmospheric Hg(0) levels measured around the facility were elevated beyond typical background levels in Michigan's environment. The levels also exceeded a couple of the known acute and 8-hour health benchmarks on the first day of monitoring noted in Table 1.0. The available acute health benchmarks have averaging times of 1 hour, 8 hours, or 24 hours. However, the Lumex readings are one minute averages and the two visits to this facility encompassed mobile readings for only about 1-2 hours. Therefore, comparison of the readings to the acute benchmarks is done under an assumption that the readings are representative estimates of ambient air levels and exposures that may occur for several hours or longer. This is a reasonable assumption because facility activities and emissions can take place over several hours and meteorological conditions can be fairly consistent over this time range.

It is critical for the protection of public health and the environment that facilities such as this manage their mercury-containing product waste and follow mandatory housekeeping protocols and maintains required air pollution control devices to ensure that any Hg(0) emissions are minimized to levels below the available health protective mercury inhalation benchmarks.

## Table 1.0 - Available Health Protective Mercury Inhalation Benchmarks

| Source | Benchmark Value ($ng/m^3$) | Average Time | Hg Species | Basis |
|---|---|---|---|---|
| EPA (1995) IRIS[7] | 300 | Not specified *(inferred as chronic)* | Elemental (metallic) mercury (Hg(0)) | Neurological effects, hand tremor; human occ. Inhalation studies; LOAEL[1] (TWA) = 25,000 $ng/m^3$; LOAEL(adj)=9,000 $ng/m^3$; UF[3] = 30 (10 for combined $UF_H$[4] and $UF_L$[5]; 3 for $UF_{db}$[6]); (Fawer et al., 1983, etc.) |
| MDEQ – Air Quality Division 2015 | 300<br><br>1,000 | Annual averaging time for protection of chronic exposure<br>24-hour averaging time for acute exposure | Elemental (metallic) mercury (Hg(0)) | Neurological effects, hand tremor; human occ. Inhalation studies; LOAEL[1] (TWA) = 25,000 $ng/m^3$; LOAEL(adj)=9,000 $ng/m^3$; UF[3] = 30 (10 for combined $UF_H$[4] and $UF_L$[5]; 3 for $UF_{db}$[6]); (Fawer et al., 1983, etc.)<br><br>Bush (2015); ATSDR (2012) |
| ATSDR[8] (1999) Toxicological Profile | 200 | Chronic (1 year or longer) (MRL min. risk level) | Hg(0) | Occupational study of mercury exposed workers and neurological effects. (Fawer et al., 1983) |
| OSHA[9] | 100,000 | Ceiling | Hg(0) | Occupational study of mercury exposed workers and neurological effects. |
| MIOSHA[10] | 50,000 | 8-hr. Time Weighted Average (TWA) | Hg(0) | LARA 2014 |
| NIOSH[11] | 10,000,000 | IDLH 30 minutes | Hg(0) | Immediately Dangerous to Life and Health (IDLH), NIOSH, 2013 |
| ATSDR (2012) | 10,000 | Not specified *(inferred as chronic)* | Hg(0) | The lowest toxic concentration level for humans (TCLo). Level where urinary levels of mercury begin to increase. |
| ATSDR (2012) | 3,000-6,000 | Short-term exposure in vehicles | Hg(0) | Exposure is shorter-term than in home and therefore level is higher than 1,000 $ng/m^3$; "ceiling" of range is based on presumption that Hg(0) may still be present but not yet discovered. |
| Bush (2015); ATSDR (2012) | <1,000 | Level for recommending acceptability of home occupancy | Hg(0) | Applied to scenarios where attenuation over time may be assumed (e.g., indoor spill situations). |
| ACGIH[12] (2014) | 25,000 | 8-hr. TWA | Elemental & inorganic mercury forms | CNS impairment, kidney damage |
| Cal OEHHA[13] (2008) | 600 | Acute (1-hour) | Mercury and inorganic mercury compounds | Rat 1 hr/d inhalation developmental study LOAEL = 1.8 $mg/m^3$ Hg(0) to pregnant rats, for effects on motor activity of offspring (Danielsson et al., 1993) |
| Cal OEHHA (2008) | 60 | 8-hour | Mercury and inorganic mercury compounds | Neurological effects, human occ. Inhalation studies; LOAEL (TWA) = 25,000 $ng/m^3$; LOAEL(adj) = 18,000 $ng/m^3$ (for 8-hr) or 9,000 $ng/m^3$ (for chronic); UF = 300 (10 for $UF_L$; 30 for $UF_H$); (Fawer et al., 1983; etc.) |
| Cal OEHHA (2008) | 30 | Chronic | Mercury and inorganic mercury compounds | Neurological effects, human occ. Inhalation studies; LOAEL (TWA) = 25,000 UF = 300 (10 for $UF_L$; 30 for $UF_H$); (Fawer et al., 1983; etc.) |

[1] LOAEL = lowest observed adverse effect level
[2] HEC = human equivalent concentration
[3] UF = uncertainty factor
[4] $UF_H$ = UF to account for intrahuman variability in sensitivity
[5] $UF_L$ = UF for extrapolating from an LOAEL to a no-observed-adverse-effect level (NOAEL)
[6] $UF_{db}$ = UF to account for database deficiencies
[7] IRIS = Integrated Risk Information System
[8] ATSDR = Agency for Toxic Substances Disease Registry
[9] OSHA = Occupational Safety and Health Administration
[10] MIOSHA = Michigan Occupational Safety and Health Administration
[11] NIOSH = National Institute of Occupational Safety and Health
[12] ACGIH = American Conference of Industrial Hygienists
[13] OEHHA = Office of Environmental Hazard Assessment - California

# Record of Use

| | |
|---|---|
| Date: | March 20, 2015 |
| Instrument Operator: | Amy Robinson, AQD with Joy Taylor Morgan, AQD and Eric Grinstern, AQD Grand Rapids district staff |
| Reliability Test: | Test cell check: (R%) = 8,9<br>R% is relative deviation of measured value of Hg(0) concentrations in test cell from tabulated values. If R value = or <25%, the device is ready for operation. |
| Lumex RA-915+: | Unit serial number: 251 |
| Last Calibration Date: | June 2014 |
| Error Messages: | None |
| Facility Name: | Reliable Relamping |
| Address: | 6459 Nash Highway, Saranac, MI 48881 |
| Geocoordinates: | Lat 42.894264<br>Long -85.242889 |
| Type of Mercury Source: | Fluorescent lamp crusher |
| Site Description: | Dusty within the trailer where crusher is housed. |
| Meteorological Conditions: | Cool, 35-40°F, SW wind 8 mph, 59% humidity, UV index: moderate. |

**Table 2.0 - Monitoring Results – March 20, 2015**

| Time | Location | Concentration Hg(0) ($ng/m^3$) Average | Notes |
|---|---|---|---|
| 10:51 AM | SW corner of parking lot (upwind) | 10 | Upwind test |
| 10:52 | SW corner of parking lot (upwind) | 1-4 | Upwind |
| 10:53 | SW of truck in parking lot | 2 | ~ 40 yards SW from truck (where lamps are crushed) |
| 10:54 | SE corner of building (bldg.) | 3 | ~ 40 yards away |
| 10:56 | SE corner of bldg. by dumpster | 829 | By dumpster, significant broken lamps under and around dumpster (see photos). |
| 10:57 | Closer to bldg's SE corner, by dumpster and boxes of new lamps | 400-950 | SE area of building by dumpster, ~ 10 yards from corner of building. |
| 10:58 | E of bldg. | 389 | |
| 10:59 | Downwind | 106 | Downwind NE corner of bldg. |
| 11:00 | Downwind | 85 | Downwind NE corner of bldg. |
| 11:02 | NE side of bldg. | 1-5 | Downwind |
| 11:03 | N of bldg. 1/3 of the way west of NE corner | 11 | 42°F, wind SW at 10 mph |
| 11:04 | N side of bldg., in center of bldg. | 17 | |
| 11:05 | N side of bldg. | 1 | Residence next to property, ~ 100 yards from house (can see two dogs in kennel) |

**Table 2.0 - March 20, 2015, continued.**

| Time | Location | Concentration Hg(0) (ng/m$^3$) Average | Notes |
|---|---|---|---|
| 11:06 | NW corner of bldg. | 2 | ~ 50 yards from house and kennel |
| 11:07 | NW corner of bldg. | 3 | ~ 10 yards away from bldg. |
| 11:21 | Outside SW of truck | 3 | Upwind of truck where lamps are crushed, crusher not yet operating. |
| 11:22 | West of truck | 1,811 | Monitoring where truck enters bldg., crusher not yet operating. |
| 11:24 | Between two trucks (east side of truck that was to operate) | 125-2,682 | Between two trucks that crush lamps (outside), crusher not yet operating. |
| 11:27 | | 2,842 | Between two trucks that crush lamps (outside), crusher not yet operating. |
| 11:30 | Moved upwind of trucks | | Crusher begins operation. |
| 11:31 | Upwind of truck | 4 | Crusher is operating. |
| 11:35 | Upwind of truck | 7 | Crusher is operating. |
| 11:36 | SW of bldg., outside | 9 | Crusher is operating. |
| 11:37 | SW corner | 7 | Moving around west side of facility toward house. |
| 11:37 | NW side of bldg. | 7 | ~ 50 yards from house, crusher continues to operate. |
| 11:38 | NW side of bldg. | 11 | 36°F, wind SW at 10 mph, crusher operating. |
| 11:39 | N side of bldg., in center of bldg. | 20 | Crusher operating. |
| 11:41 | NE corner (side) of bldg. | 19-25 | Crusher operating. |
| 11:42 | NE downwind signal | 44 | Downwind. Crusher operating. |
| 11:45 | Back at west side of truck | 1,327 | Crusher operating. |
| 11:47 | At bay door for truck, east side of truck with crusher operating inside | 4,259 | Crusher operating. |
| 11:48 | Top of truck at exhaust port | 67-138 | On ladder with Lumex to monitor at top of truck. Crusher operating. |
| 11:51 | At door of bldg. | | Entering inside facility. |
| 11:52 | Walking inside facility | 2,187 | Just inside facility, crusher operating. |
| 11:52 | Just outside truck inside facility | 571 | Crusher operating |
| 11:53 | Inside truck, where bulbs are fed into crusher | 804-2,808 | Crusher operating, 50°F |
| 11:54 | Inside truck, where bulbs are fed into crusher | 23,431 | Crusher operating |
| 11:55 | Inside truck by drums where broken glass is collected | 40,560 | Crusher operating |
| 11:56 | Inside truck by filters | 53,000-54,000 | Noticed HEPA filter gauge pegged out. Exceeded maximum capacity for this Lumex model. Crusher operating. |

**Table 2.0 - March 20, 2015, continued.**

| Time | Location | Concentration Hg(0) ($ng/m^3$) Average | Notes |
|---|---|---|---|
| 11:57 | Inside truck, next to crusher where glass exits the crusher | 44,728 | Crusher operating |
| 11:58 | Walking outside of truck, inside facility | 1,489 | Crusher operating |
| 11:59 | Inside facility at doorway to truck where crusher is operating | 3,774 | Crusher operating |
| 12:00 | Walked outside of facility | | |
| 12:02 | On top of ladder, west side of truck | 13,038 | Crusher operating |
| | On top of ladder, west side of truck | 67-76 | Crusher operating |
| 12:03 | Stopped monitoring | | |

## Record of Use

### Table 3.0 - Reliable Relamping Monitoring Results - July 8, 2015

| | | | | |
|---|---|---|---|---|
| **Date of Analysis:** | July 8, 2015 | | | |
| **Operator of Instruments:** | Amy Robinson, DEQ-AQD with Joy Taylor Morgan, DEQ-AQD and Eric Grinstern, , DEQ-AQD GR district staff<br>Chris Bush, MDHHS; Jason Peterson, Jenifer Proto and Mark Novak, Ingham County Health Department; Stew Whitney, Ottawa County Environmental Health; Ken Bowen, Ionia County Environmental Health, Eric Pessell; Kent County Environmental Health; and Dan Schmidt, President Reliable Relamping | | | |
| **Reliability Test** | AQD Lumex:<br>R% = 0 | MDHHS Lumex:<br>R% = 16 | Lumex Light:<br>R% = 4 | |
| | Serial # 251 | # 242 | #1155 | |
| **Last Calibration Date** | AQD Lumex: | MDHHS Lumex: | Lumex Light: | Jerome: |
| | June 17, 2015 | June 2015 | October 2014 | Obtained new unit from Jerome April 2015 |
| **Error Messages** | None | None | None | None |
| **Detection Limit** | 2 ng/m3 | 2 ng/m3 | 100 ng/m3 | 3, 000 ng/m3 |

### Location Information

| | |
|---|---|
| Facility Name | Reliable Relamping |
| Address | 6459 Nash Highway<br>Saranac, MI 48881<br>Ionia County |
| Geocoordinates<br>(if known) | Lat 42.894264<br>Long -85.242889 |
| Type of Mercury Source | Fluorescent lamp crusher |
| Site Description<br>(dusty, steam, etc.) | Warm and somewhat dusty within the trailer where the lamps are crushed. |
| Meteorological Conditions | Warm 60-75 F, NE 3-4 mph wind, 77% humidity, UV Index - low<br>Rained the day before |

**Table 3.0 - July 8, 2015, continued**

| Time | Location | Concentration Hg(0) (ng/m$^3$) Average | | | | Notes: Upwind/Downwind, Event Specific, etc. |
|---|---|---|---|---|---|---|
| | | AQD Lumex | MDHHS Lumex | Lumex Light | Jerome | |
| 10:37 am | NE corner of building (upwind) | 2 | 11 | ND | ND | Upwind test 60F |
| 10:39 | NE corner of building (upwind) | 1 | 12, 15 | ND | ND | Upwind |
| 10:40, 10:41, 10:42 | SW of truck in parking lot | 1,1,1 | 12,15,16 | ND | ND | Upwind |
| 10:44, 10:45, 10:46, 10:47, 10:48 | N of building | 0,0,0, 1,0 | 13,17,16,16,19 | ND | ND | N side of building, at center of building 63F |
| 10:49, 10:50, 10:51, 10:52, 10:53 | NW corner of building (by residential home) | 1,1,1, 1,1 | 17,18,19,19,20 | ND | ND | NW corner of building 64F |
| 10:54, 10:55, 10:56, 10:57, 10:58 | SW Corner of Building (in parking lot) | 7,10,5, 5,9 | 24,33,22,25,25 | ND | ND | Downwind site – although currently no wind 65F |
| 10:59, 11:00, 11:01, 11:02, 11:03 | SW of Building - Downwind area in parking lot where cars are parked although little wind | 4,0,1, 1,1 | 23,22,21,22,23 | ND | ND | Wind 2 mph NE 65F |
| 11:04, 11:05, 11:06, 11:07, 11:08 | W side of trailer where crusher is housed by bay doors | 12,21,18,32,20 | 35,41,45,56,44 | ND | ND | No wind |
| 11:09, 11:10, 11:11, 11:12, 11:13 | At Bay Doors, W side of trailer | 40,22,106,31,23 | 48,45,193,43,40 | ND | ND | 70F |
| 11:14, 11:15, 11:16 | At entrance of warehouse, door mat | 20,22,25 | 42,34,47 | ND | ND | 70F |
| 11:17, 11:18, 11:19, 11:20, 11:21 | Inside facility, main door, inside office hallway | 149, 155, 132, 163, 188, | 234, 171, 236, 175, 224 | 200, 200, 200, 200, 300 | ND | 74-76F<br>No wind |

**Table 3.0 - July 8, 2015, continued**

| Time | Location | Concentration Hg(0) (ng/m$^3$) Average | | | | Notes: Upwind/Downwind, Event Specific, etc. |
|---|---|---|---|---|---|---|
| | | AQD Lumex | MDHHS Lumex | Lumex Light | Jerome | |
| 11:22 | Indoor mat, front entrance | 165 | 225 | 200 | ND | 74F |
| 11:23 | Bathroom | 408 | NA | 400 | ND | 74F |
| 11:26, 11:27, 11:28, 11:29, 11:30 | Inside warehouse, just outside trailer where crusher is housed by fan | 245, 171, 104, 196, 188 | 282, 187, 168, 291, 257 | 200, 200, 200, 300, 200 | ND | 70F – not yet operating |
| 11:31, 11:32, 11:33, 11:34, 11:35 | Inside trailer, not yet operating | 1,373, 3,226, 837, 1,065, 635 | 1,995, 1,378, 635, 538, 404 | 800, 600, 500, 500, 400 | ND | 70F |
| 11:46, 11:47, 11:48, 11:49, 11:50 | Moved back to the upwind site, NE of facility | 3,5,4, 6,7 | 30,31, 30, 30, 31 | ND | ND | Started Crushing Lamps until monitoring was completed<br>4 mph NE wind<br>64F |
| 11:51, 11:52, 11:53, 11:54, 11:55 | N of building | 7,7,7, 4,7 | 31,22,2 3,33,35, 22 | ND | ND | N side of building, at center of building<br>68F – sun came out |
| 11:56, 11:57, 11:58, 11:59, 12:00 | NW corner of building (by residential home) | 9,9,10, 11,10 | 32,32,3 2,34,36 | ND | ND | 66F |
| 12:01, 12:02, 12:03, 12:04, 12:05 | SW Corner of Building (in parking lot) | 4,10,12 ,12, 13 | 41,35,3 3,34,33 | ND | ND | 67F<br>Downwind – crusher operational<br>4 mph |
| 12:06, 12:07, 12:08, 12:09, 12:10 | SW of Building - Downwind area in parking lot where cars are parked | 15,15,1 5,15,16 | 35,35,3 5,37,36 | ND | ND | Sun came out - 67F<br>Downwind where cars are parked SW of building |
| 12:11, 12:12, 12:13, 12:14, 12:15 | W side of trailer where crusher is housed by bay doors | 42,4,7, 12,62 | 91,47,5 2,71,88 | ND | ND | No Wind 69F |

**Table 3.0 - July 8, 2015, continued**

| Time | Location | Concentration Hg(0) (ng/m$^3$) Average | | | | Notes: Upwind/Downwind, Event Specific, etc. |
|---|---|---|---|---|---|---|
| | | AQD Lumex | MDHHS Lumex | Lumex Light | Jerome | |
| 12:16, 12:17, 12:18, 12:19, 12:20 | Inside facility, main door, inside office hallway | 339, 355, 394, 407, 379 | 277, 297, 347, 391, 413 | 300, 200, 200, 300, 300 | ND | 75F |
| 12:21, 12:22, 12:23, 12:24, 12:25 | Inside facility by back cubicles next to warehouse with 4 female working in cubicles | 489, 515, 495, 495, 495 | 526, 549, 532, 531, 533 | 400, 400, 400, 400, 400 | ND | 76F<br>Crusher operating |
| 12:26, 12:27, 12:28, 12:29, 12:30 | Inside warehouse, just outside trailer where crusher is operating | 129,102, 70, 38, 108 | 234, 221, 170, 149 (battery ran out at 12:29) | 400, 200, 100, 100, 100 | ND | 74F |
| 12:31, 12:32, 12:33, 12:34 | Inside warehouse, just outside trailer where crusher is housed by fan | 870, 569, 522, 1,284, 546 | NA | 400, 600, 500, 400, 500 | ND | |
| 12:35 | Back floor mat by warehouse employee bathroom | 348 | NA | NA | ND | |
| 12:36, 12:37 | Inside employee bathroom in warehouse | 221, 230 | NA | NA | ND | |
| 12:38 | Broom | 238 | NA | NA | ND | |
| 12:39, 12:40, 12:41, 12:42 | Inside trailer where lamps are being crushed | 4,734, 1,638, 4,485, 5,123 | NA | NA | ND | |

NA= not available (not sampled)
ND = non detect (value was below the monitors detection limit)
n= the number of readings

The DEQ Lumex was set up to provide a one-minute average, along with instantaneous readings. All values reported for the AQD Lumex are minute averages reported in Table 3.0. The MDHHS Lumex was set up to provide 10 second averages, along with instantaneous readings, the Ottawa County Lumex Light was also set up to provide 10 second averages. Data was recorded manually based on observed readings.

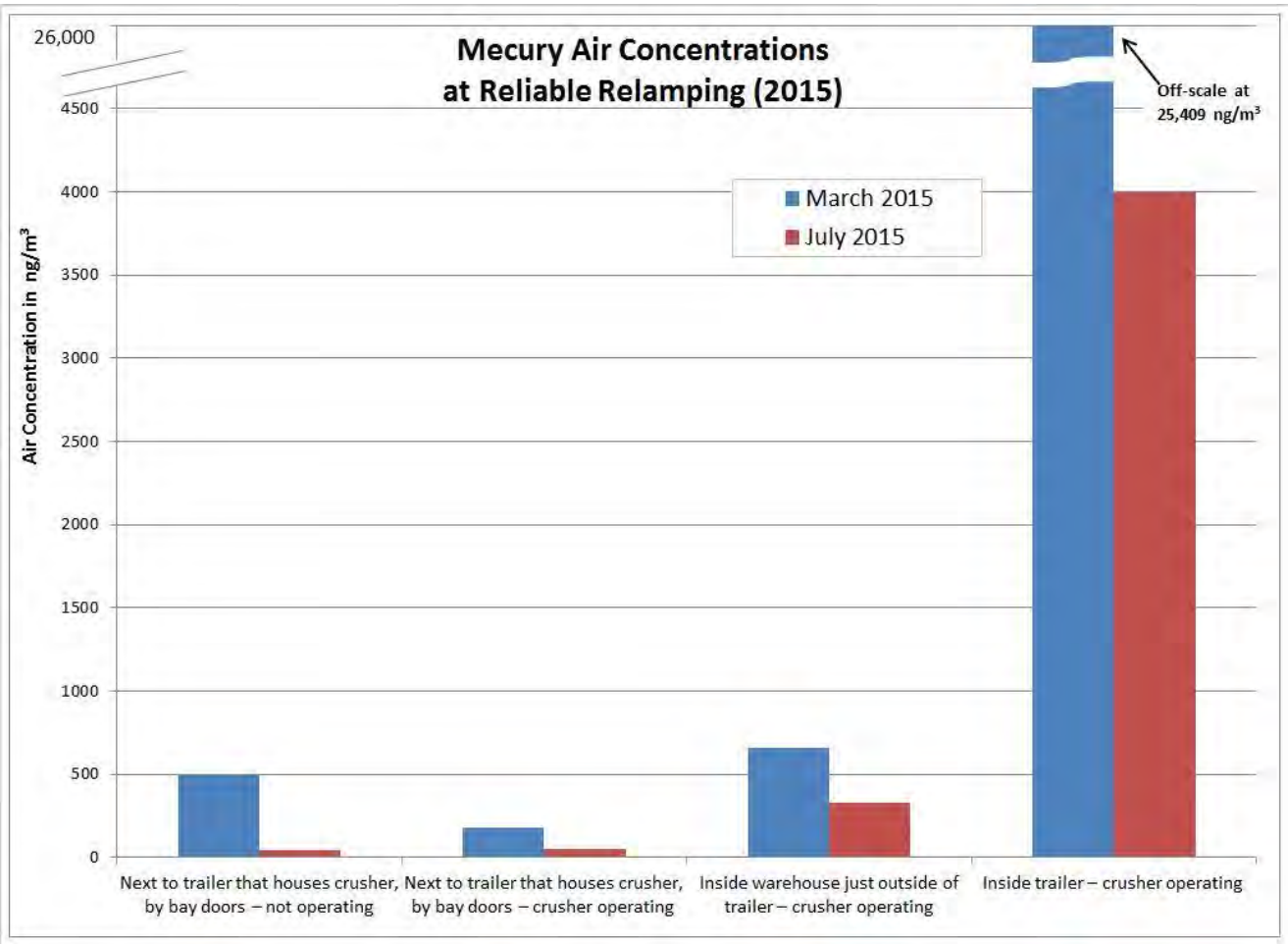
**July 8, 2015 Inspection**

*Monitoring at upwind site, July 8, 2015*

*Monitoring inside trailer*

*Air pollution controls inside truck*

**Graph 1.0**
**Comparison of Concentrations at Similar Locations**
**Before and After Housekeeping Efforts**



## Table 4.0 - Comparison of Hg(0) Concentrations at Similar Locations on Two Separate Days

| LOCATION | MARCH 20, 2015 - AQD Lumex Average of Readings | JULY 8, 2015 - AQD Lumex Average of Readings |
|---|---|---|
| Upwind site – not operating | 1-10 n=3<br>(1,4,10) | 1-15 n=5<br>(1,2,11,12,15) |
| Downwind site – not operating | 85-106 n=2<br>(85, 106) | 1-33 n=19<br>(1,1,1,4,5,5,7,9,10,21,22,22,22,23,23,24, 25,25,33) |
| Upwind site – crusher operating | 4-7 n=2<br>(4,7) | 3-30 n=10<br>(3,4,5,6,7,30,30,30,31,31) |
| Downwind site – crusher operating | 44 n=1 | 15-37 n=10<br>(15,15,15,15,16,35,35,35,36,37) |
| N. side of the building – not operating | 1-17 n=2<br>(1,17) | 1-19 n=6<br>(1,13,16,16,17,19) |
| N. side of building – crusher operating | 20 n=1 | 4-35 n=11<br>(4,7,7,7,7,22,22,23,31,33,35) |
| NW corner of building by resident – not operating | 1-2 n=2<br>(1,2) | 1-20 n=10<br>(1,1,1,1,1,17,18,19,19,20) |
| NW corner of building by resident – crusher operating | 11 n=1 | 9-36 n=10<br>(9,9,10,10,11,32,32,32,34,36) |
| Next to trailer that houses crusher, by bay doors – not operating * | 1-842 n=5<br>(1,125,811,2682,2842) | 12-193 n=20<br>(12,18,21,20,22,23,31, 32,35,40,40,41,43,44,45,45,48,56,106,193) |
| Next to trailer that houses crusher, by bay doors – crusher operating * | 1,327-4,259 n=2<br>(1327,4259) | 4-91 n=10<br>(4,7,12,42,47,52,62,71,88,91) |
| Inside warehouse just outside of trailer – crusher operating * | 571-3774 n=4<br>(571,1489,2187,3774) | 2-1284 n=25<br>(2,10,38,70,100,100,100,108,129,149,170, 200,221,234,400, 400,400,500,500,522,546,569,600,870,1284) |
| Inside trailer – crusher operating * | 804-54,080 n=6<br>(804,2808,23431,44728,50,000,50,000) | 1,638-5,123 n=4<br>(1638,4485,4734,5123) |

* = Data included in Graph 1.0.

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