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# **Industrial Hygiene Survey**

## **Air Cycle Corporation**

### **Polk County Recycling Facility**

**August 2004**

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**Industrial Hygiene Survey**  
**Air Cycle Corporation**  
**Polk County Recycling Facility**

**August 2004**

**Executive Summary**

On August 6, 2004 an industrial hygiene survey was conducted for the Air Cycle Corporation at the Polk County Recycling Facility in Winter Haven, Florida. This survey was conducted as a follow up to an identical survey that was conducted at an Illinois facility on July 9, 2003. The purpose of the survey was to characterize personal exposures to and area concentrations of mercury vapor while an employee crushed fluorescent bulbs that contain mercury, using a privately owned and maintained Air Cycle Corporation Bulb Eater™.

One personal air samples and one area air sample was collected during the survey. The personal air sample was collected from a representative breathing zone of the worker to measure the actual exposures during the task of relatively short duration, which is typical of most workers using a Bulb Eater™. That actual exposure was then characterized as an 8 hour time weighted average to evaluate exposures over the course of the work day. An area air sample was collected to characterize the air concentration of mercury from a worse case location near the source of the emissions.

Of the samples collected, neither exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) 8 Hour threshold limit value (TLV) of 0.025 milligrams per cubic meter (mg/M<sup>3</sup>) or the (Occupational Safety and Health Administration's (OSHA) 8 Hour Permissible Exposure Limit of 0.1 mg/M<sup>3</sup>.

The following recommendations are offered in this report to assure the control of worker exposures and for regulatory compliance:

1. Notify the evaluated employee of the results of this survey.
2. The facility should consider improving the filtration of their older bulb crusher by either cleaning out the blue vacuum housing and sending it to the manufacturer to be sealed, or consider purchasing a new vacuum housing. This is due to the technological improvements made to newer machines by the manufacturer, engineered to further minimize mercury emissions.
3. At this facility, bulbs were stored upright inside a large open cardboard box with dimensions of approximately 4' x 4' x 4'. Workers should resist the temptation to reach inside the bottom of the box to retrieve broken bulb fragments as vapors may linger near the bottom of the box.
4. Continue advising users to operate the machine in ventilated areas.

**Industrial Hygiene Survey**  
**Air Cycle Corporation**  
**Polk County Recycling Facility**  
**August 2004**

**Narrative Report**

**A. Purpose of Sampling**

On August 6, 2004 an industrial hygiene survey was conducted for the Air Cycle Corporation at the Polk County Recycling Facility in Florida. This survey was conducted as a follow up to an identical survey that was conducted at an Illinois facility on July 9, 2003 and a Florida facility on August 5, 2004. The purpose of the survey was to characterize personal exposures to and area concentrations of mercury vapor while an employee crushed fluorescent bulbs that contain mercury, using a privately owned and maintained Air Cycle Corporation Bulb Eater™.

The Objectives of the survey were to:

1. Evaluate potential employee exposures to mercury vapor, by collecting air samples.
2. If applicable, assist the Air Cycle Corporation with their progressive administrative and personal protective equipment recommendations they provide to their customers, that have been designed to minimize the potential for employee exposures while using their privately owned and maintained Bulb Eater™.

**B. Industrial Hygiene Methodology**

All industrial hygiene practices, air sampling, calculations, evaluations, and interpretations were conducted in accordance with the established industrial hygiene practices set forth by the American Board of Industrial Hygiene and OSHA. All personal air samples were collected from representative breathing zones as defined by OSHA, which is within six to nine inches of the worker's nose with the media inlet facing downward. Excess tubing was positioned so as not to kink or interfere with the work of the employee.

Samples were collected using IH sampling pumps with air drawn through a method-specific media based upon the contaminant to be analyzed. Pump flow calibrations were performed before and after each day's sampling period using a factory calibrated BIOS DC\_Lite primary standard flow meter. The flow rate for each pump was measured three times and then averaged, and none of the post or pre-calibrations varied by greater than five percent, which would void the sample. Of the post and pre-calibration flow rates, the lowest average flow rate was used in the air sample volume calculations in order to arrive at the highest contaminant concentration. The basis for this approach is to achieve the higher reported concentration of the chemical in order to quantify the worker's worse case personal exposure.

The pump was placed on the worker and then activated, and the employee did not tamper with the pump and media. The pumps worked properly and were removed at the end of the sampling period.

The date of the sampling is usually our sample number. For example, sample number 08050401 represents the eighth month and fifth day of year 04; with specific sample number 01 collected that day. In this specific case, in order to avoid sending two separate analysis requests, these samples were numbered with an 0805 identifier because multiple facilities were evaluated independently. The different sample days have been identified in the air sample data collection sheets found in Appendix B. The sample number, the calculated sample volume, contaminant to be analyzed, and chain-of-custody signature were recorded onto the specific lab analysis request form. The sorbent tubes were refrigerated until being sent to the laboratory for analysis.

Employee chemical exposures were compared to the OSHA 8 hour Permissible Exposure Limits (PELs) and the American Conference of Governmental Industrial Hygienists (ACGIH) 8 hour Threshold Limit Values (TLVs). A PEL is a regulatory limit and represents the maximum allowable concentration of a contaminant to which an employee can be exposed during the workday. A PEL can be established as a full-shift time weighted average (TWA) exposure, short-term exposure level (STEL), or ceiling limit. Mercury is only regulated as an 8 hour exposure by OSHA. A TLV is a recommended exposure limit and represents the time-weighted average concentration for a conventional 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. Like the PEL, the TLV can be established as a full-shift time weighted average (TWA) exposure, short-term exposure level (STEL), or ceiling limit. As with OSHA, the ACGIH has only an 8 hour recommended TLV for mercury. However, when assessing agents that have only an 8 hour TLV, the ACGIH provides that a worker may be exposed to up to three times the TLV for a task of thirty minute duration, or 0.075 mg/M<sup>3</sup> mercury.

The results were reported both as an actual concentration found plus as a time-weighted average. The basis for reporting results as an actual exposure is to characterize the employee's actual exposure during the time period the pump was worn by the employee. The basis for time weighting the data in this specific survey is because bulb crushing is performed only a few times per year after enough bulbs have been amassed that the storage space becomes filled; then, the task of crushing bulbs is typically one of short duration, usually less than two hours. Thus, it is appropriate to time weight the data in this case in order to characterize potential exposures over the course of the entire work shift.

### **C. Analytical Methodology**

An independent lab accredited by the American Industrial Hygiene Association performed analysis of the air sample collection media. Laboratory staff, based upon the air sample volume reported on the lab analytical request form, performed calculations converting the detected analyte to milligrams per cubic meter. The specific analytical method used to evaluate potential employee exposures was OSHA ID 140, with the air drawn through an SKC 226-17-1A sorbent tube,

Anasorb C300, 6 X 70 mm size, 1-section, 200 mg sorbent, with GS ends, WW separators, A tube cover.

The laboratory report is contained in Appendix C and the lab request is in Appendix D.

#### **D. Monitoring Rationale**

Most fluorescent tubes contain elemental mercury, phosphorus powder and an inert gas, typically argon, kept under very low pressure. Mercury is an essential ingredient for most energy efficient lamps. Fluorescent lamps and high intensity discharge (HID) lamps are the two most common types of lamps that utilize mercury. Because of this, the disposal of most fluorescent tubes is regulated. (Manufacturers have responded by designing green tipped “environmentally friendly” tubes that do not contain as much mercury. However, because only 6 of the tubes crushed during this survey were of that design, it is not relevant to this survey.)

OSHA regulates worker exposures to airborne mercury vapor. According to actual worker interviews from a similar survey conducted for Air Cycle in 2003 and those interviewed during this survey, bulbs are typically crushed for a time-period of approximately one hour or less. In this case, this facility was asked to amass enough bulbs to allow for a sampling period of at least one hour. The rationale for crushing for such a short time period is due to how quickly the bulbs can be crushed. In other words, it takes roughly one second to crush a 4' fluorescent lamp and a fraction of a second longer for 8' lamps. The amount of storage space that would be needed to store enough bulbs for crushing over an eight-hour work shift would be prohibitive in most cases, and could create safety hazards from the accidental breakage of stored bulbs. In general, the employee crushes bulbs when enough have been collected to fill the dedicated storage area.

Tube nomenclature is as follows: for an F32T8TL735 for example, the F stands for fluorescent; the 32 indicates the wattage, and the T number represents that it is tubular with a diameter in eighths of an inch (T12 = 12/8ths = 1½ inches, T8 = 8/8ths = 1 inch).

The Bulb Eater™ is a machine that processes, or crushes, spent fluorescent lamps into small fragments. The crushed glass is compacted into a 55-gallon container by the workers who feed the bulbs into a bulb-specific tube on top of the machine that has a diameter only slightly greater than that of the tube being crushed. The Model 55 VRS crushes over 1350 T8 4' lamps into one 55-gallon drum. The Model 55 VRS-U crushes straight fluorescent lamps of any length and u-shaped fluorescent lamps as well. As tubes enter the drum, air is emitted from the machine's vent. This air has been filtered through a High Efficiency Particulate Air filter to capture dust, then through a carbon filter designed to neutralize the mercury vapor. This facility uses an early version of Model 55 VRS-U.

The Polk County recycling facility in Winter Haven, Florida accepts tubes from homeowners so the bulbs are stored according to length, not type, making it unfeasible to count them by manufacturer during this survey. Thus, the approximate count of bulbs crushed over a 75 minute time period was as follows:

- 40 Sylvania 8' tubes
- 6 GE F32T8SPX35-U-6 large diameter U-Tubes
- 109 GE, Phillips and Sylvania 4' tubes
- Several broken in the bottom of a box open to atmosphere

## **E. Air Sample Results**

- The area sample collected from a **worse case** location on top of the drum at the source of the emissions was 0.15 mg/M<sup>3</sup>. Time weighted as an 8 hour exposure, the concentration equates to 0.0234 mg/M<sup>3</sup>, below the OSHA PEL and the ACGIH TLV. The results from the personal sample were 0.046 mg/M<sup>3</sup>, or 0.0068 mg/M<sup>3</sup> as an 8 hour time weighted average.

## **F. Conclusions**

The sample results indicate that employee exposures to mercury vapor were controlled at the time of the survey. This can likely be attributed to the engineering controls utilized by the Air Cycle Corporation on the Bulb Eater™ Machine, and from using the machine in a well-ventilated area. While these task samples (for 71 minutes) exceeded the ACGIH TLV for mercury, when time weighting the data the TLV was not exceeded. The concentrations of mercury vapor for these particular short term samples could be due to several variables, such as the older model of the machine at the facility and that broken bulbs were stored in a larger container (as opposed to boxes provided by the bulb manufacturer.) In any event, employees use the machine in a well-ventilated area with a floor fan positioned to move air away from the worker's breathing zone. It should be noted that in this case, the floor fans were turned off during the air sampling survey in order to characterize *worse case* exposures. Elemental mercury has a vapor density of 6.93, meaning the vapors are almost seven times heavier than air and may be of higher concentration near the ground. This is important to consider because it is not uncommon for bulbs to be broken inside boxes while in storage, and workers may be tempted to reach inside large boxes to retrieve broken pieces of the bulb by hand, allowing lingering mercury vapor to enter their breathing zone. The worker at the Winter Haven Facility spent a significant portion of the sampling period sorting through the tubes contained in the box, some of which were broken. Nonetheless, the air samples collected at the Winter Haven Facility may be indicative of a need to have the older model machine serviced by the manufacturer.

## **G. Recommendations**

The following recommendations are offered in this report to assure the control of worker exposures and for regulatory compliance:

1. Notify the evaluated employee of the results of this survey.
2. The facility should consider improving the filtration of their older bulb crusher by either cleaning out the blue vacuum housing and sending it to the manufacturer to be sealed, or consider purchasing a new vacuum housing. This is due to the technological improvements

made to newer machines by the manufacturer, engineered to further minimize mercury emissions.

3. At this facility, bulbs were stored upright inside a large open cardboard box with dimensions of approximately 4' x 4' x 4'. Workers should resist the temptation to reach inside the bottom of the box to retrieve broken bulb fragments as vapors may linger near the bottom of the box.
4. Continue advising users to operate the machine in ventilated areas.

#### **H. Confidentiality**

All aspects of this study were and will be treated by HSE Solutions, Inc., as strictly confidential. No information, recommendations, or results have been released to outside parties, including federal agencies or other government bodies.

Results of this assessment are based on conditions observed while on location performing the industrial hygiene survey. Any operational or equipment changes which are not "in kind" may change conditions and air concentrations identified in this industrial hygiene survey. If you have any questions concerning this survey, please feel free to contact me at (217) 345-2725.

Respectfully submitted,

Bob Borman, CIH  
HSE Solutions, Inc.