U.S. Department of Justice
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A Review of Federal Prison Industries' Electronic-Waste Recycling Program

Appendix – Volume I

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This appendix presents reports that the OIG technical team members (FOH, NIOSH, and OSHA) prepared following field work at the BOP institutions where UNICOR recycled e-waste. To consolidate this information, the OIG requested that FOH compile and analyze the agencies' findings, as well as information from OIG interviews and documents, address any discrepancies, and provide the OIG with comprehensive health, safety, and environmental reports on conditions from 2003 to 2009 for each of the eight UNICOR e-waste recycling factories that had ongoing operations during the OIG's investigation. These eight FOH reports are presented below and attach reports from OSHA, NIOSH, and U.S. EPA. Each FOH report was peer reviewed by OSHA and NIOSH. U.S. EPA provided comments on the FOH reports for FCIs Elkton and Texarkana, institutions where EPA conducted site inspections.

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DEPARTMENT OF HEALTH & HUMAN SERVICES

Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

EVALUATION OF ENVIRONMENTAL, SAFETY, AND HEALTH INFORMATION RELATED TO UNICOR E-WASTE RECYCLING OPERATIONS AT USP ATWATER

PREPARED FOR THE UNITED STATES DEPARTMENT OF JUSTICE
OFFICE OF THE INSPECTOR GENERAL

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1.0 INTRODUCTION

At the request of the U.S. Department of Justice (DOJ) Office of the Inspector General (OIG), the Federal Occupational Health Service (FOH) coordinated environmental, safety and health (ES&H) assessments of electronics equipment recycling operations at a number of Federal Bureau of Prisons (BOP) facilities around the country. The assessments were conducted as a result of whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium at electronics recycling operations overseen by Federal Prison Industries (UNICOR).[1] The allegations stated that these exposures were occurring from the breaking of cathode ray tubes (CRTs) and other activities associated with the handling, disassembly, recovery, and recycling of electronic components found in equipment such as computers and televisions (i.e., e-waste).[2] It was further alleged that appropriate corrective actions had not yet been taken by BOP and UNICOR officials and that significant risks to human health and the environment remained.

This FOH report consolidates and presents the findings of technical assessments performed at UNICOR's e-waste recycling operations at the United States Penitentiary (USP) in Atwater, California by industrial hygienists and other environmental and safety and health specialists representing federal agencies including FOH; the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH) Division of Applied Research and Technology (DART); and NIOSH Division of Surveillance Hazard Evaluation and Field Studies/Hazard Evaluations and Technical Assistance Branch (DSHEFS/HETAB). Reports and field data from these agencies are presented in the attachments to this report (see references for these reports in Section 7.0). The primary objectives of these assessments were to characterize current UNICOR operations and working conditions at USP Atwater in light of the whistleblower allegations and to identify where worker exposures, environmental contamination/degradation, and violations of governmental regulations and BOP policies may still exist so that prompt corrective actions may be taken where appropriate. In addition, this FOH report also relies upon information from documents assembled by the OIG which were developed by various consultants, regulatory agencies, the BOP and UNICOR staff.

The overall purpose of this report is to characterize current operations and working conditions at USP Atwater (i.e., 2003 to present) especially with respect to the potential for inmate and staff exposures[3] that may result from present day e-waste recycling activities as well as from legacy contamination on building components from e-waste

[1] FPI, (commonly referred to by its trade name UNICOR) is a wholly-owned, Government corporation that operates factories and employs inmates at federal correctional institutions.

[2] E-waste is defined as a waste type consisting of any broken or unwanted electrical or electronic device or component.

[3] In this report, the term "exposure" refers to the airborne concentration of a contaminant (e.g., lead or cadminm) that is measured in the breathing zone of a worker but outside of any respiratory protection devices used. Unless otherwise noted, "exposure" should not be confused with the ingestion, inhalation, absorption, or other bodily uptake of a contaminant. Concentrations reported and discussed in this report are not adjusted based on respirator protection factors. However, when reported, it is indicated whether the exposure was within the protective capacity of the respirator.

recycling operations which took place in the past. This report consolidates findings from those contributing to the OIG investigation and evaluates additional assembled information regarding BOP and UNICOR recycling operations (e.g., consultant reports, programs and procedures, and various records and documents). Conclusions and recommendations presented in this report are based on the entire body of available reports, data, documents, interviews, and other information.

USP Atwater is one of seven BOP institutions that have ongoing e-waste recycling operations for which an assessment report has been prepared by FOH. On October 10, 2008, FOH issued a separate report entitled "*Evaluation of Environmental, Safety, and Health Information Related to Current UNICOR E-Waste Recycling Operations at FCI Elkton*" [FOH 2008a] detailing current exposure conditions at FCI Elkton. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, pertinent regulatory requirements, and other information that provides additional context to this report on USP Atwater. The FOH report on USP Atwater is the last of eight comprehensive assessments that FOH has prepared on individual UNICOR e-waste factories.

Currently, e-waste recycling operations at USP Atwater involve receipt of waste electronics from various locations around the country, disassembly and sorting activities ('breakdown'), and the associated material handling and facilities maintenance required to support these operations. Glass breaking had been performed in the past at USP Atwater but was discontinued in March 2005. In addition, glass breaking was suspended UNICOR-wide in June 2009. USP Atwater facilities and processes are further discussed in Section 2.0, below.

2.0 UNICOR E-WASTE RECYCLING FACILITIES AND OPERATIONS AT USP ATWATER

The UNICOR e-waste recycling program began at USP Atwater in April 2002. Glass breaking was started in the penitentiary factory in a mezzanine area under UNICOR's administrative offices with limited and ineffective hazard controls as part of the initial recycling operations in April 2002. As personal monitoring data were collected showing elevated exposures, additional control measures were slowly implemented that included PPE, respiratory protection, a progression of engineering controls, and relocation of glass breaking operations (GBOs) to a room near the factory loading dock area. These additional control measures were not fully effective in maintaining exposures below occupational exposure limits until after February 2004, nearly two years after start-up. Glass breaking was stopped at USP Atwater in March 2005.

As part of the OIG investigation, NIOSH/HETAB performed a medical surveillance assessment at USP Atwater in October 2008. Glass breaking operations as they occurred from April 2002 to March 2005 were described in the NIOSH/HETAB report (see Attachment 3). In addition, NIOSH/DART with assistance from FOH conducted an on-site industrial hygiene evaluation in April 2007 and prepared a report also describing facilities and operations (see Attachment 1). Based on these reports and other information gathered from the OIG investigation, the glass breaking operations are summarized below.

In April 2002, glass breaking was initiated below the mezzanine area in the penitentiary factory (see Image 1, below) without the benefit of proper respiratory protection or local exhaust ventilation (LEV, an engineering control to prevent or reduce levels of airborne metal dusts from entering the breathing zone of workers). In May 2002, a "3-stage powder booth" (i.e., paint spray booth) was installed and modified by UNICOR staff for CRT glass breaking (see Images 2, 3, and 4). Also, the GBO inmate workers were provided dust masks described by the recycling factory Production Controller at that time as being the "flimsy paper kind and not the N95 type". These dust masks would therefore not have been adequate for the levels of toxic metals exposures found. Also, in May 2002, fit testing of workers or other requirements of the OSHA respiratory protection standard (e.g., medical qualification, training) had not been instituted. GBO continued for about two months and then was suspended pending biological monitoring results for lead and cadmium. Respirator fit testing was conducted in mid-July 2002, and respirators were used for GBO after this time.

A UNICOR consultant developed a written lead and cadmium compliance plan in August 2002, after repeated exposure monitoring indicated exposures above OSHA permissible exposure limits (PEL) for lead and cadmium (exposures also exceeded the protection factor of the respirators in use). However, according to the recycling factory Production Controller at that time, this compliance plan was never implemented due to management concerns over increased costs were they to do so. In December 2002, UNICOR installed what it termed a "ventilation system that exceeded OSHA standards." Although exposures were reduced from levels found in 2002, cadmium exposures remained above the OSHA PELs in early 2003. In June 2003, a glass breaking booth (retrofitted paint spray booth) and GBO were relocated from the main factory into a room near an adjacent loading dock (see Image 5). The exhaust air from the booth was vented to the outdoors. This system was another attempt to improve engineering controls to lower exposures (the third system attempted). The last exposure shown to be above the PEL was for cadmium in February 2004. Glass breaking was stopped in March 2005 although other e-waste disassembly (demanufacturing) operations continued (see Images 6 and 7). Section 4.0 provides additional details on the progression of GBO, associated hazard controls, and exposures. Also see the NIOSH/HETAB report (Attachment 3) for additional information.

Also as part of the OIG investigation, NIOSH/DART, with assistance from FOH, performed an on-site industrial hygiene evaluation in April 2007. Glass breaking had been stopped by this time. Other electronics recycling operations were underway, including disassembly and related activities. The facilities and operations in place during the NIOSH/DART and FOH site visit are described below (see NIOSH/DART report, Attachment 1).

The recycling of electronic components at USP Atwater is done in two separate buildings: the main factory located within the penitentiary, and the warehouse located approximately a quarter mile away on the same property. Diagrams of these work areas are shown in Figures 1 and 2, respectively. These figures provide a general visual description of the layout of the work process, although workers often moved throughout their respective areas in the performance of their tasks. In 2007, the population of the UNICOR facility was approximately 68 workers in the penitentiary factory with an additional 28 in the camp warehouse.

The recycling of electronic components (not including glass breaking) can be organized into three production processes: receiving and sorting; disassembly; and packaging and shipping. In addition to these processes, ancillary facilities which supported the UNICOR operations at the penitentiary factory were in place over various periods of time including a nearby clothing change room for inmate e-waste recycling workers, an eating area, and a food service line (see Images 8, 9, and 10). Incoming materials to be recycled are received at a warehouse where they are examined and sorted. During the 2007 evaluation by NIOSH/DART and FOH, it appeared that the bulk of the materials received were computers, either desktop or notebooks, or related devices such as printers. Some items, notably notebook computers, are upgraded and resold. These items are sorted for that task.

Figure 1: USP Atwater Penitentiary Factory Floor Plan Showing Sample Locations

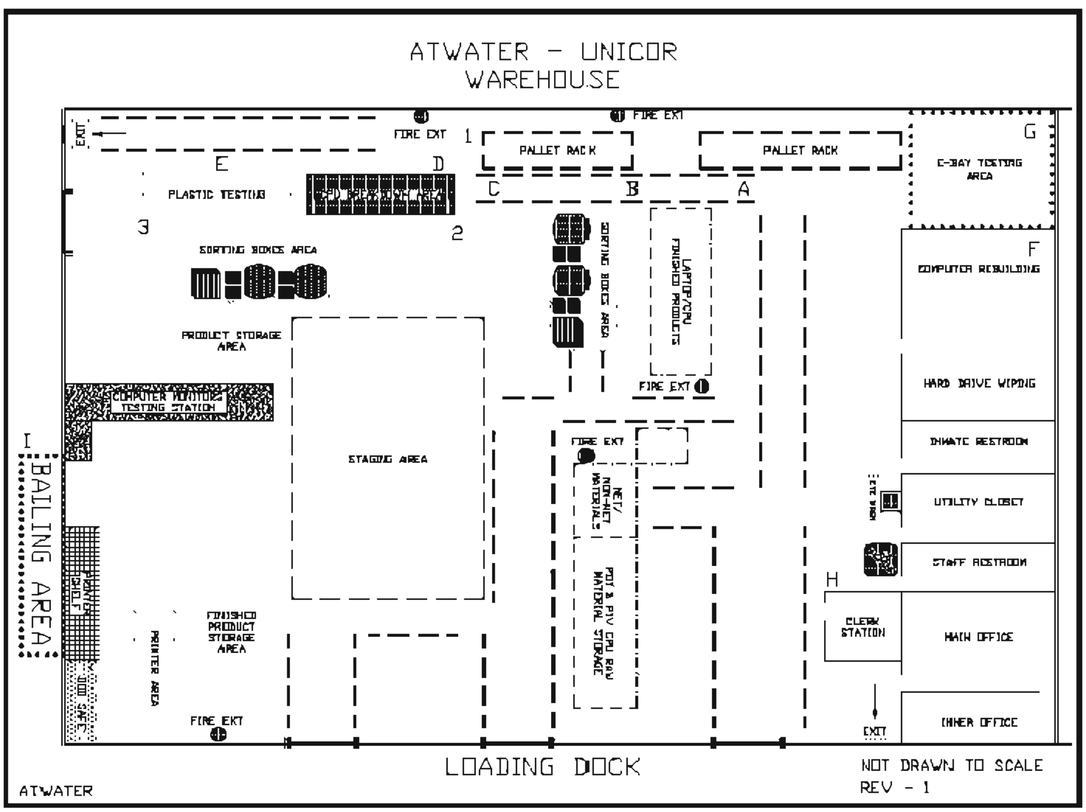

Figure 2: USP Atwater Warehouse Floor Plan Showing Sample Locations

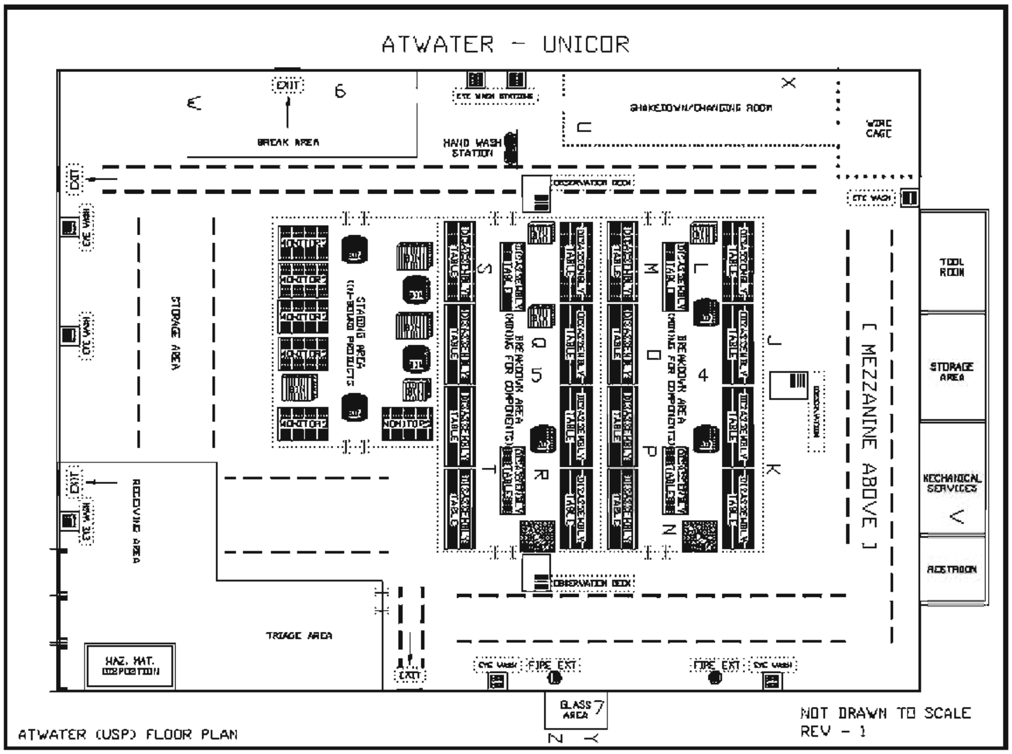

Image 1: Below the mezzanine area in the penitentiary factory [circa 2007]

Image 2: Glass breaking area below the mezzanine (view from the main floor). [circa 2002]

Image 3: Glass filtration booth (view from back wall of glass breaking area).
[circa 2002]

Image 4: Booth in room adjacent to loading dock.
[circa 2003]

Image 5: CRT glass breaking[4]
[circa 2002]

Image 6: Peneteniary demanufacturing area.
[circa 2002]

Image 7: Camp warehouse demanufacturing area.
[circa 2007]

Image 8: Inmate's changing room and bins for soiled coveralls (looking from the food service area).
[circa 2007]

[4] The CRT is held over the grating of the breaking table and dropped onto the grating. The panel glass breaks away from the frit and falls through the grating into the panel glass box. (Note: According to UNICOR, this 2002 image was being staged and no glass was actually being broken; consequently PPE was not being worn).

Image 9: UNICOR food service area (looking from the changing room).
[circa 2007]

Image 10: UNICOR's food service serving line.
[circa 2003]

After electronic memory devices (e.g., hard drives and discs) are removed and degaussed or destroyed, computer central processing units (CPUs), servers, and similar devices are sent for disassembly. Monitors and other devices (e.g., televisions) that contain cathode ray tubes (CRTs), when processed at Atwater, were separated and also sent for disassembly and removal of the CRT. Printers, copy machines, and any devices that potentially contain toner, ink, or other expendables are segregated, and those expendables are removed prior to the device being sent to the disassembly area.

In the disassembly process, external cabinets, usually plastic, are removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing are removed and sorted by grade for further treatment, if necessary. Components such as circuit boards or chips that could contain precious metals (e.g., gold or silver) or have value are removed and sorted. With few exceptions, each of the workers in the factory performs all tasks associated with the disassembly of a piece of equipment into the aforementioned components using powered and un-powered hand tools (primarily screwdrivers and wrenches). A few workers collect the various parts and place them into the proper collection bin. Work tasks include removing screws and other fasteners from cabinets, unplugging or clipping off electrical cables, removing circuit boards, and using whatever other methods are necessary to break these devices into their component parts. Virtually all components are sold for some type of recycling.

The third process, packing and shipping, involves returning the various materials segregated during the disassembly process to the warehouse where they are packaged and sent to contracted purchasers of those individual materials. To facilitate shipment, some bulky components such as plastic cabinets or metal frames are placed in a hydraulic baler to be compacted for easier shipping. Other materials are boxed or containerized and removed for subsequent sale to a recycling operation.

Glass breaking was not being done at USP Atwater at the time of the NIOSH/DART, NIOSH/HETAB, and FOH evaluations. However, two areas in the penitentiary factory where glass breaking had been performed in the past were observed by NIOSH/DART, NIOSH/HETAB, and FOH. According to sources within the BOP, UNICOR does not plan to resume glass breaking at this facility, and in June 2009, UNICOR suspended glass breaking at all UNICOR factories. Instead, for a period of time in 2009, CRTs were sent by UNICOR to an e-waste recycling company in Mexico where they were processed. Currently, the handling of equipment containing CRTs at Atwater is in transition. Atwater is transitioning from sending whole monitors and TVs to an offsite recycler to, instead, a process that is more consistent with other UNICOR recycling factories. Thus, soon, Atwater will be dismantling all of its monitors and TVs to produce whole, bare CRT tubes, which will then be sent to an off-site recycler for further processing.

The NIOSH/DART and NIOSH/HETAB reports (Attachments 1 and 3) present details on personal protective equipment (PPE), respiratory protection, engineering controls, and work practices used for USP Atwater recycling activities. These controls are summarized in Sections 3.0 and 4.0 of this report.

3.0 BOP/UNICOR SAFETY AND HEALTH PROCEDURES AND PRACTICES AT USP ATWATER

Under 29 CFR 1960 each federal agency is obligated to develop a comprehensive and effective safety and health program. Such programs establish requirements and processes for controlling occupational hazards and meeting federal occupational safety and health regulations. The BOP has established an ES&H policy entitled Occupational Safety, Environmental Compliance, and Fire Protection (BOP Program Statement 1600.09). UNICOR's compliance with this policy will be evaluated in the OIG's final report.

Various OSHA standards require written programs or plans to address occupational hazards or implement hazard control measures. Examples potentially applicable to UNICOR's e-waste recycling activities performed at USP Atwater particularly include:

- 29 CFR 1910.1025: Lead requires a written lead compliance plan;
- 29 CFR 1910.1027: Cadmium requires a written cadmium compliance plan;
- 29 CFR 1910.134: Respiratory Protection requires a written respiratory protection program; and
- 29 CFR 1910.95: Occupational Noise Exposure requires a written hearing conservation program.

In addition to the specific OSHA standards listed above, another hazard that could be associated with USP Atwater recycling operations is heat exposure. Although OSHA does not have a specific standard for heat exposure, it can regulate this hazard under its "General Duty Clause" [OSHA 1970] that requires employers to furnish a workplace that is free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees.

A good practice approach also warrants that an overall safety and health plan should be in place to identify workplace hazards and specify appropriate hazard controls and safe work practices. Such a plan would apply to the factory as a whole.

UNICOR's ES&H practices and programs associated with the e-waste recycling activities conducted at USP Atwater are discussed below.

3.1 Safety and Health Practices and Procedures to Control Toxic Metals Exposure

UNICOR at USP Atwater has several documents that describe safety and health practices and requirements for e-waste recycling activities and define the measures to be taken to control toxic metal exposures. These documents include the following:

- Work Instructions – Glass Breaking Procedures;
- Glass Breaking Area – General Procedures;
- UNICOR Glass Department – Glass Department Procedures;
- Cathode Ray Tube (CRT) Processing Procedures;
- Cathode Ray Tube Recycling & Quality Assurance Procedures for Atwater, California;
- Cadmium and Lead Compliance Program Plan; and
- Computer Monitors (CRT's) Operating Procedures.

These documents are discussed below, along with other documents for related activities such as respiratory protection and job orientation. Overall, while these documents were worthwhile in documenting important policies and procedures, they contained numerous redundancies and were in some respects inconsistent. This was a likely source of confusion which contributed to a lack of proper implementation of requirements by management and supervision.

The Work Instruction entitled "Glass Breaking Procedures" applies to the breaking of CRT glass and support activities in and around the glass breaking room. This document describes mandatory safety equipment (i.e., PPE); practices for removing PPE; hygiene practices; end-of-shift clean-up procedures; respirator cleaning, inspection, and storage procedures; clean-up procedures for accidental CRT breakage; and booth clean-up practices. Staff and inmate workers inside the glass breaking room are required to wear a "reverse air flow hood and HEPA filter system" (presumably a powered-air purifying respirator, PAPR), leather/Kevlar® work gloves, long sleeves, safety boots, and jumpsuit. The type of jumpsuit is not further described. Outside assistants are required to wear safety glasses, leather/Kevlar® work gloves, safety boots and jumpsuits. PAPRs or other respirators are not required for these workers. The use of wet methods and HEPA vacuums is emphasized for clean-up and PPE/respirator decontamination processes, as is hand washing. As discussed further below, FOH notes that the type of respiratory protection reportedly used during glass breaking at this factory (i.e., April 2002 to March 2005) was not consistent with this procedure.

The Glass Breaking Area General Procedures is a compilation of procedures for glass breaking. The specific procedures include Cathode Ray Tube (CRT) Breaking Procedures, Glass Removal and Handling Procedures, Personal Hygiene/Cleanup Procedures, Mandatory Safety Equipment, and Respirator Cleaning and Storage Procedures. The General Procedures document requires that all staff and inmate personnel working in the glass breaking area read and comply with the specific procedures listed above. Combined, these specific procedures define work practices for glass breaking, handling and cleaning procedures using wet methods and HEPA vacuums, hygiene practices including PPE, HEPA vacuuming and hand/skin washing for breaks and lunch and end-of-shift, and respiratory protection use. The types of respiratory protection required in these procedures are a full facepiece respirator inside the booth and a full facepiece or half facepiece respirator outside the booth, which are different from the PAPR specified in the glass breaking procedure discussed above. Respirator cleaning procedures are included, but the type of respirator cartridge is not defined. Other PPE for workers in the glass booth is specified as leather work gloves, Kevlar® sleeves, safety boots, ear protection, and two jumpsuits. PPE outside the booth includes safety glasses, leather or Kevlar® gloves, Kevlar® sleeves, safety boots, and hearing protection.

The UNICOR Glass Department – Glass Department Procedures for USP Atwater defines medical clearance requirements, safety equipment, the progression of the glass booth design including ventilation and LEV systems, and monitor breaking procedures, among other items. It also incorporates some of the same specific procedures described above for cleaning, hygiene, and respirator practices. Medical clearance calls for blood testing and respirator fit testing, but does not provide details on the content of the medical surveillance program. Safety equipment specified is consistent with that defined in the Glass Breaking Area General Procedures, described above. The fabrication of the glass breaking booth and ventilation/LEV systems is described along with upgrades over time. Various drawings and photographs of the booth, LEV systems, and work surfaces are also provided.

The Cathode Ray Tube (CRT) Processing Procedure provides regulatory requirements for the medical surveillance program; a general description of parameters for engineering controls including the glass booth ventilation/LEV system; PPE requirements; operational requirements for the work shift, PPE, hygiene, and cleaning; and testing and monitoring requirements, among others. The specific procedures of the Glass Breaking Area General Procedures are also included. PPE requirements are consistent with the requirements described above. Monitoring and testing includes initial and periodic exposure monitoring, ventilation assessment, and surface wipe sampling. Biological monitoring for lead and cadmium is also further described. Work practices for dismantling and breaking monitors are detailed in this document.

Cathode Ray Tube Recycling & Quality Assurance Procedures for Atwater, California provides recycling procedures for monochrome and color CRTs. This document is a quality assurance procedure and does not focus on safety and health issues. An appendix to this procedure addresses cleanup procedures for accidental CRT breakage.

The Cadmium and Lead Compliance Program Plan dated August 7, 2002 provides information to control cadmium and lead exposures to the "lowest practical levels" and below the OSHA PELs and action levels. The program states that "at no time should any worker be exposed to any chemical above the OSHA Permissible Exposure Limit (PEL) or Action Level" and provides an appropriate hierarchy of controls that include engineering, administrative, and personal protective equipment controls. The program calls for PPE consistent with other procedures (and specifies the type of respirator cartridge), change rooms, showers, housekeeping, prohibiting food and drink in the work place, and waste disposal using TCLP testing criteria. LEV testing and maintenance, exposure monitoring, medical surveillance, and worker training are also addressed, among other content. The plan calls for an annual review and update as necessary. [Note: The OIG found no evidence that this plan was ever purposefully implemented. Exposures to cadmium and/or lead remained above the PEL, at times, through February 2004, about 18 months after this program stated that this level of exposure should occur at no time.]

Correspondence dated February 6, 2003 from the Associate Warden to the Recycling Foreman and titled Computer Monitors (CRTs) Operating Procedures provided information regarding improvements to the recycling operations, directed various actions to be implemented, and attached procedures with which inmates must comply. The correspondence mentioned that analytical data "shows that recent progressive engineering control measures implemented were effective in lowering the exposure to lead, cadmium, barium, beryllium, mercury, brominated flame retardants, hexavalent chromium, and plastics below regulatory limits." The Assistant Warden directed that air monitoring be conducted every six months, the performance of frequent and regular inspections, and the implementation of the "new" Monitor Breaking Work Procedures. These procedures included the Monitor Breaking Procedures, Glass Removal and Handling Procedures, Hygiene Procedures, Housekeeping Procedures, and Personal Protective Equipment. [Note: Despite the exposure reduction claimed in this correspondence, personal or area air samples were above the cadmium PEL and/or action level both before and after this correspondence in January and February 2003. In addition, the LEV system was shown to exhaust elevated cadmium levels on January 21, 2003 when it was operated without filters (see Section 4.1).]

Since UNICOR at USP Atwater required use of respiratory protection during glass breaking, a written respiratory protection program is required by OSHA. The procedure entitled Occupational Safety and Environmental Health, ATW 1600.08C, dated June 14, 2003 contains a Respiratory Protection Program chapter. This chapter specifies that "full face and half face air purifying respirators with HEPA filters" are required for GBO. Fit testing and medical clearance is addressed. Another document entitled Self-contained Breathing Apparatus and Negative Air Purifying Respirators, dated 11/1/2000 was also reviewed. This document generally addresses fit testing, training, and medical clearance. In its assessment of the USP Atwater medical surveillance program, NIOSH/HETAB found that inmates did not receive medical clearance to wear a respirator. This finding indicates deficiencies with the implementation of the respiratory protection program(s), as written and as required by the OSHA respiratory protection standard.

When asked about documents that describe safety and health practices on the general factory floor, such as disassembly and material handling, the USP Atwater Factory Manager provided FOH with the FPI Recycling Business Group Pre-Industrial Manual, dated October 15, 2008. This manual is used for job orientation and addresses general rules of the factory, PPE in general terms, hazard communication, hazardous materials, safety overviews for certain subject matter such as lockout/tagout and flammable and combustible materials, safe operations of certain equipment such as balers and forklifts, and glass breaking procedures. This document is similar to the Pre-Industrial Manual described in FOH reports for other factories. Although useful for job orientation, this document lacks the specific details that describe the safety and health requirements and work practices at the USP Atwater e-waste recycling factory.

For general activities conducted on the factory floor (i.e., disassembly and materials handling), a written safety and health document to define existing workplace hazards and control measures is not in place for UNICOR e-waste recycling conducted specifically at USP Atwater for its recycling activities. The Pre-Industrial Manual provides some information as described above, and a procedure entitled Occupational Safety and Environmental Health, ATW 1600.08C, dated June 14, 2003 contains various ES&H information for the facility as a whole, but neither document details safety and health practices in the recycling factory at USP Atwater. As a "good practice" approach, such a document should be developed and implemented to concisely define the safety and health practices and requirements specific to USP Atwater recycling. The document should address PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping and cleaning practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Non-routine or periodic work activities should also be addressed in the document, particularly those that potentially disturb dusts such as cleaning and handling/disposing of wastes from HEPA vacuums or containers. The document could also specify requirements for periodic site assessments, hazard analyses, inspections, actions for new or changed work activities, monitoring, and regulatory compliance reviews.

In summary, the seven glass breaking documents described above define various work practices, testing requirements, and hazard control measures. The documents are redundant in many ways and are inconsistent in other important respects, such as the type of respiratory protection to be used. In addition, requirements specified in the documents were not promptly implemented, such as the requirement for medical clearance for respirator use and the statements that occupational exposure limits shall not be exceeded or that exposures have been controlled. The redundancies and inconsistencies among the documents are a source of potential confusion to management, oversight staff, ES&H support staff, and staff/workers responsible for implementing, enforcing, assessing, and/or complying with requirements and practices. UNICOR should implement a document control system to eliminate redundancies and inconsistencies, clearly show the status of documents (e.g., operable, superseded, or expired), define required review dates, and issue revisions when needed. UNICOR should also implement a system to verify effective implementation of document requirements and objectives.

3.2 Safety and Health Practices and Procedures to Control Noise Exposure

Two noise surveys were conducted for USP Atwater's recycling operations in 2009. Both studies also included ventilation testing and one included a lighting evaluation. Findings are discussed below regarding the need for a hearing conservation program.

The first survey was conducted on March 25, 2009 by a BOP consultant. Numerous "instantaneous" noise measurements were taken throughout the penitentiary, but most were not associated with UNICOR operations. No UNICOR readings were found to exceed the OSHA PEL or action level. The consultant stated that based on levels not exceeding 85 dBA, the areas surveyed were not subject to a hearing conservation program. The Factory Manager and Safety Specialist confirmed that a hearing conservation program is not required nor in place, but also stated that hearing protection is required and made available as an added precaution. The consultant readings were very limited with respect to UNICOR operations (see Section 4.3) and did not represent a complete survey.

In April 2009, a UNICOR consultant conducted noise dosimetry as part of UNICOR's recently implemented annual monitoring program at all UNICOR factories. This consultant found that the metal baling operation resulted in exposures above the OSHA action level and that a hearing conservation program is required for inmates performing this activity. UNICOR has not been in compliance with 29 CFR 1910.95, Occupational noise exposure for this operation, because it does not have a hearing conservation program at USP Atwater.

UNICOR should have performed a hazard evaluation for noise exposure at USP Atwater much earlier than 2009. Noise monitoring at UNICOR e-waste recycling factories and, in addition, at other UNICOR factories have shown levels above the OSHA action level and/or PEL for such operations as baling, glass breaking, pallet manufacturing, sanding, and use of other powered tools, among others. This is further indication that UNICOR does not apply results and lessons learned from specific factories to others on a UNICOR-wide basis. See Section 4.3 for additional details on these two surveys and NIOSH/DART noise monitoring results.

3.3 Other Safety and Health Practices and Procedures

UNICOR has prepared a document titled "Heat Stress Program" dated 09/26/2008. The USP Atwater Factory Manager stated that UNICOR is reviewing this procedure at this time. A heat hazard evaluation has not been performed to date, but the Factory Manager stated that work is not performed if conditions are too hot.

As part of an overall safety and health program, UNICOR should develop a thorough hazard analysis program. This program should include baseline hazard analysis for current operations and job (activity-specific) hazard analyses for routine activities, activities performed under an operations and maintenance (O&M) plan, non-routine activities, and new or modified activities. This applies to all UNICOR recycling factories.

4.0 FIELD INVESTIGATIONS AND MONITORING RESULTS

Several field investigations of USP Atwater e-waste recycling operations have been conducted since 2002. These investigations are listed below:

- UNICOR consulting firms and a BOP industrial hygienist conducted a series of exposure monitoring episodes from 2002 through 2005. Personal breathing zone, area air samples, and surface wipe samples were collected. These results are discussed in Section 4.1.1.

- OSHA received complaints regarding UNICOR's e-waste recycling operations at USP Atwater in 2003 and 2005 and made inquiries regarding these complaints. OSHA conducted an inspection of USP Atwater's recycling operations in March 2005. The results are discussed in Section 4.1.2.

- NIOSH/DART with the assistance of FOH conducted an industrial hygiene evaluation in April 2007. This was a qualitative survey and not a comprehensive evaluation. Observations were made regarding work practices and hazard controls related to metals exposure and surface contamination. The NIOSH/DART survey report is provided as Attachment 1, additional data are provided as Attachment 2, and all data are discussed in Section 4.1.3.

- As part of a recently initiated annual monitoring program at all factories, a UNICOR consultant performed air monitoring and surface sampling for lead, cadmium, and beryllium; a noise survey; and a limited ventilation evaluation in 2009. This work was performed during general disassembly operations (all glass breaking operations had been previously discontinued in 2005). Results are discussed in Section 4.1.4.

- Also, as part of the DOJ OIG investigation, NIOSH/HETAB conducted an assessment of the medical surveillance program in October 2008. NIOSH/HETAB also reviewed past exposure monitoring reports prepared by UNICOR consultants and a BOP industrial hygienist. The NIOSH/HETAB report is provided as Attachment 3 and discussed in Section 4.2.

Results of the UNICOR consultant studies, BOP industrial hygienist studies, OSHA inspection, NIOSH/DART and FOH evaluation, and NIOSH/HETAB medical surveillance assessment are summarized and discussed in this section[5].

Toxic metals of greatest interest for occupational exposures related to e-waste recycling include lead, cadmium, and barium. Beryllium can also be associated with e-waste materials and is also of interest because of its adverse health effects and low exposure limit. These metals were the focus of the field investigations. See the FCI Elkton report referenced in Section 1.0 for details regarding e-waste hazards.

Results of monitoring for airborne exposures are compared to permissible exposure limits (PELs) and action levels established by OSHA. In addition, non-mandatory ACGIH Threshold Limit Values (TLVs, an exposure limit guideline) and NIOSH recommended exposure limits (RELs) are also available for reference. Permissible exposure limits are often based on 8-hour time weighted average (TWA) exposures and the TWAs are applicable to the exposures discussed in this report. Table 1 provides exposure limits for lead, cadmium, barium, and beryllium. PELs, action levels, and TLVs for other hazards can be found in OSHA standards (29 CFR 1910) and the 2009 ACGIH TLVs. [ACGIH 2009]

Table 1
Occupational Exposure Limits[1]

	LEAD ($\mu g/m^3$)	CADMIUM ($\mu g/m^3$)	BARIUM ($\mu g/m^3$)	BERYLLIUM ($\mu g/m^3$)
OSHA PEL	50	5.0	500	2[5]
OSHA ACTION LEVEL[2]	30	2.5	N/A	N/A
ACGIH TLV (Total Exposure)	50	10.0	500	0.05[4]
ACGIH TLV (Respirable Fraction)	N/A	2.0	N/A	N/A
NIOSH REL	50	*Ca*[3]	500	0.5

Notes:

1. All limits are based on an 8-hour time weighted average (TWA) exposure. NIOSH RELs are based on TWA concentrations of up to a 10-hour workday during a 40-hour workweek.
2. The action level is an exposure level (often around half of the PEL) that triggers certain actions, such as controls, monitoring, and/or medical surveillance under various OSHA standards.
3. *Ca* (Potential Occupational Carcinogen). NIOSH RELs for carcinogens are based on lowest levels that can be feasibly achieved through the use of engineering controls and measured by analytical techniques. [NIOSH 2005]
4. ACGIH TLV 2009 adoption.
5. OSHA also has 5 $\mu g/m^3$ ceiling and 25 $\mu g/m^3$ peak exposure limits.

[5] Given the many variables that may impact air sampling and exposure monitoring, testing data and findings can vary from one period to the next. Also, the findings, interpretations, conclusions and recommendations in this report may in part be based on representations by others which have not been independently verified by FOH.

PELs, TLVs, and RELs are used to evaluate airborne exposures (inhalation) as determined through air sampling. Test results from surface samples (i.e., wipe and bulk samples) are also used to assess potential exposures. Wipe and bulk samples are collected and analyzed for toxic metals to provide insight into the potential for ingestion as a route of exposure and also as a measure of the potential for settled dusts to contribute to inhalation exposures if dusts are disturbed and become airborne. In addition, surface testing provides insight into the effectiveness of dust capture and filtration mechanisms, as well as other engineering controls such as containment structures. Results of surface sample tests conducted by NIOSH/DART and FOH are also summarized and discussed below. See the Appendix for 'Guidance for Evaluating Surface Samples'.

Exposure standards for noise and heat are discussed in the sections below where results of the investigations are presented.

4.1 Investigations for Exposure to Toxic Metals

Given the various materials and components in e-waste, recycling activities have the potential to result in worker exposure to toxic metals including, in particular, lead and cadmium. The magnitude and potential health consequences of exposures are dependent on a number of factors such as workplace ventilation, work practices, protective equipment utilized (e.g., respirators, protective clothing, gloves, etc.), duration of exposures, and others. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, their relative toxicities, pertinent regulatory requirements, and other information.

Investigations that included evaluation of toxic metals exposure during USP Atwater's e-waste recycling operations are discussed below in chronological order of the studies. These investigations were conducted by UNICOR consultants, a UNICOR industrial hygienist, and NIOSH/DART with support from FOH. As part of the OIG investigation, FOH and NIOSH/HETAB reviewed and evaluated UNICOR consultant reports. Commentary provided on these reports in Sections 4.1.1 consolidates both FOH and NIOSH/HETAB reviews.

4.1.1 UNICOR and UNICOR Consultant Monitoring from 2002 through 2005

UNICOR consulting firms and a BOP industrial hygienist conducted evaluations for worker exposure to metals during glass breaking and other recycling operations at USP Atwater e-waste recycling facilities from 2002 through 2005. FOH and NIOSH/HETAB reviewed 13 evaluation reports prepared during this period. Two evaluations were conducted by a BOP industrial hygienist and 11 were conducted by UNICOR consultants. This section consolidates commentary from both the FOH and NIOSH/HETAB reviews (also see Attachment 3 for the NIOSH/HETAB report for additional analysis of these evaluations and reports).

Much of the exposure monitoring evaluations were for glass breaking operations. The following provides information regarding the evolution of glass breaking operations at

USP Atwater, which is summarized from the NIOSH/HETAB report (Attachment 3). This information provides pertinent context within which to evaluate the 13 exposure monitoring episodes.

- April 2002: Recycling begins with little or no hazard controls;

- May 2002: Glass breaking is conducted using a "3-stage powder booth," but is suspended after two months for a brief period pending results of biological testing for lead, cadmium, and barium. Glass breaking then continues;

- August 2002: A consultant prepares a written lead and cadmium compliance plan because air sampling indicates that lead and cadmium exposures exceed OSHA PELs, but this plan is not implemented;

- December 2002: Glass breaking is conducted using what UNICOR termed a "ventilation system that exceeded OSHA standards." In January 2003, this system is operated for at least five days without the filters in place that are essential to capture lead and cadmium dusts;

- June 2003: The glass breaking booth is relocated to a room near the loading dock area and GBO is resumed with the booth air now exhausted to the outside; GBO continue until March 2005 with the exception of several periods of reported suspension;

- March 2005: All glass breaking operations are stopped;

- Present Day: Disassembly and related recycling activities continue, but glass breaking had not resumed.

Discussion of the UNICOR and UNICOR consultant exposure evaluations are organized below within the time periods shown above.

4.1.1.1 Exposure Evaluations between May 2002 and December 2002

From the start of glass breaking in April 2002 up to the implementation of the "improved" ventilation system in December 2002, UNICOR consultants performed three exposure evaluations, and the BOP industrial hygienist performed one study. Personal exposure monitoring and area air sampling were performed during glass breaking. Samples were analyzed for lead and cadmium. Some studies also included additional metals analyses, dust analyses, and surface wipe testing. Results are summarized below.

- June 20, 2002: A UNICOR consultant found that personal breathing zone exposure to cadmium was 50 $\mu g/m^3$ for a 65 minute sample and stated that if representative of the 8-hour period, then the 8-hour TWA exposure would be same. If the result represents an 8-hour TWA, then it is 10 times the OSHA cadmium PEL of 5 $\mu g/m^3$. Lead exposure was 99 $\mu g/m^3$ which is almost twice the OSHA PEL of 50 $\mu g/m^3$. The consultant recommended that respiratory protection be provided to inmates performing glass breaking until exposures are reduced to below the action levels. The consultant also recommended the review of personal hygiene procedures related to hand washing. NIOSH/HETAB observed that "the report contains no other information regarding the work environment, work practices, engineering controls, or personal protective equipment." FOH also notes that no mention is made of the requirements of the OSHA lead and cadmium standards when exposures exceed the action levels and/or PELs. Most importantly, the OSHA standards require control of lead and cadmium at levels below the PELs through the use of engineering and work practice controls, not simply respiratory protection.

- July 24, 2002: The same UNICOR consultant collected seven full-shift (approximately 6.5 hours) personal breathing zone samples. Cadmium exposure was reported to be "270 $\mu g/m^3$ or less" (i.e., as high as 270 $\mu g/m^3$). This is up to 54 times higher than the OSHA PEL. The consultant stated that four personal samples exceeded the cadmium PEL, and that five exceeded the action level. Lead was as high as 58 $\mu g/m^3$, which is above the OSHA PEL of 50 $\mu g/m^3$. The consultant reported that one personal sample exceeded the lead PEL, with three exceeding the action level. The report does not state whether results are for the sampling period or as 8-hour TWAs. Results for surface wipe and skin wipe samples were also reported, but the consultant did not offer any interpretation of the results. The consultant again recommended that respiratory protection should be provided, but did not indicate whether it was in use based on the recommendation of June 2002, and no mention of work practices or hazard controls was made. The consultant also recommended that material handling and personal hygiene procedures be reviewed and incorporated into a "Lead and Cadmium Exposure Control Plan," but again did not mention the importance on controlling lead and cadmium hazards through the use of engineering and work practice controls, as required by OSHA.

- September 4-5, 2002: A BOP industrial hygienist conducted a technical assistance visit that included an evaluation of the glass breaking operations including exposure monitoring and other testing. This study included evaluating two scenarios of work practices/engineering controls involving various misting practices and worker positioning during glass breaking to determine if these measures would be effective in reducing exposures. Of 11 breathing zone samples, five exceeded the cadmium PEL as 8-hour TWAs, with the highest at 90.8 $\mu g/m^3$ (18 times higher than the PEL). One other sample exceeded the cadmium action level, but not the PEL. Of the six samples that did not exceed the cadmium PEL, five were collected outside the glass breaking booth. One of 11 samples exceeded the lead PEL with a result of 89.1 $\mu g/m^3$ versus the PEL of 50 $\mu g/m^3$. Two other samples exceeded the lead action level but not the PEL. [Note: The highest result for both lead and cadmium was for "breaking panel glass about 5 feet outside the booth." According to the BOP industrial hygienist, this operation was within the area partially contained by strip curtains, but FOH notes that the existing exhaust system would likely not be as effective in capturing dust generated in this location since it was outside the confines of the booth. The industrial hygienist noted that the panel glass operation is "exceptionally high for cadmium and lead exposure" and concluded that "neither misting nor repositioning workers and operations in the booth were effective in lowering exposures below regulatory limits." Recommendations included adopting less aggressive glass breaking techniques, reconfiguring work stations, misting, creating a vented box for electron gun breaking, and HEPA vacuum cleaning. This study was an improvement over previous consultant studies since it evaluated and recommended possible control measures including engineering and work practice controls. Nevertheless, this study did not seem to contribute to a reduction in exposures, work was allowed to proceed, and key information was lacking in the report such as information on any PPE (including respiratory protection) that was used. [Note: Other documents indicate that half facepiece APRs with HEPA filters were used after mid-July 2002. These respirators have a protection factor of 10; therefore, some cadmium exposures were beyond the protective capacity of this type of respirator.]

- November 4, 2002: The UNICOR consultant collected six full-shift (about 6 hours) personal breathing zone samples during glass breaking. Five of the six exceeded the cadmium PEL, with the highest exposure at 300 $\mu g/m^3$ (60 times the cadmium PEL of 5 $\mu g/m^3$). Two personal samples exceeded the lead PEL, with the highest exposure at 210 $\mu g/m^3$ (over four times the lead PEL of 50 $\mu g/m^3$). The narrative report does not mention the use of respirators, but the sample data sheets state that "half-faced HEPA respirators" were worn (i.e., half facepiece APRs with HEPA cartridges). As reported by NIOSH/HETAB, both glass breakers were exposed to cadmium at levels that greatly exceeded the assigned protection factor of 10 for these respirators. The consultant's report made no mention of this exceedance and did not provide any recommendations. Again, no mention was made of the fact that OSHA lead and cadmium standards require the control of lead and cadmium to levels at or below the PEL through the use of engineering and work practice controls.

In summary, the results between May 2002 and November 2002 prior to the implementation of "improved" glass breaking ventilation (as stated by UNICOR), showed that inmates were exposed to cadmium and lead during glass breaking at levels that exceeded OSHA PELs. Every sampling episode showed elevated exposures; therefore, it is likely that these levels of exposure were typical of daily glass breaking operations. NIOSH/HETAB reports that "it appears that inmates worked without adequate respiratory protection from April 2002 until July 2002." FOH concurs with this statement and adds that even through November 2002, exposure monitoring indicates that the type of respirators worn were not adequate to protect workers against the level of cadmium exposures found.

During this period, engineering and work practice controls were not adequate to maintain exposures at or below the OSHA lead and cadmium PELs. OSHA standards explicitly require that lead and cadmium exposure be controlled using engineering and work practice controls.

Given both the frequency and magnitude of lead and cadmium exposures, UNICOR should have taken prompt and effective action to remedy these conditions and implement effective controls for glass breaking not only at USP Atwater, but at all other UNICOR factories performing glass breaking. These actions should have included stoppage of glass breaking work at USP Atwater and other factories by July 2002 until additional monitoring could be completed; official notification of other factories of these exposures with directives for analysis and corrective action at all applicable factories; retaining qualified professionals such as industrial ventilation engineers and certified industrial hygienists to design and assist in implementation and verification of effective engineering and work practice controls; and, after implementation of controls, restarting GBO with appropriate ES&H oversight, monitoring, and other support until verification of effective exposure control. In general, over the course of e-waste recycling operations from start-up to the present, UNICOR communication and information sharing with other factories was lacking or not effective based on exposures also found at other factories such as FCI Elkton [FOH 2008a] and FCI Texarkana [FOH 2009c]. In addition, UNICOR appeared to slowly implement hazard control and improvement measures at USP Atwater more through a process of "trial and error" rather than a systematic process of hazard analysis, work planning with hazard control design and implementation, and work performance with hazard control verification. Support of qualified ES&H professionals should have been applied at all stages.

In correspondence dated July 19, 2002, the USP Atwater Safety Manager informed the Associate Warden of elevated personal exposure results and hazardous waste disposal issues, and provided a "roadmap" to address these issues. The Safety Manager stated that at least four other UNICOR factories have similar activities, but have not conducted hazard/risk analyses. BOP and UNICOR did not implement prompt hazard analyses and corrective actions at the other factories based on the USP Atwater findings and deficiencies.

UNICOR consultant reports stated that OSHA PELs were exceeded, but did not provide appropriate recommendations to reduce these exposures that are consistent with OSHA lead and cadmium standards. For instance, one consultant recommended respiratory protection, hygiene practices, and some other actions, but did not provide recommendations for engineering and work practice controls to reduce exposures, as required by OSHA. Other important information was not provided in consultant reports, such as alerting UNICOR to the fact that cadmium exposures exceeded the protective capacity of the respirators in use.

4.1.1.2 Exposure Evaluations between December 2002 and June 2003

Between December 2002 and June 2003, glass breaking was conducted using what UNICOR termed as a "ventilation system that exceeded OSHA standards." Two episodes of personal exposure monitoring and area air sampling were performed during glass breaking in January and February 2003. Samples were analyzed for lead, cadmium, barium, and beryllium. Surface wipe testing was also performed. During late January 2003, the LEV system was reported by the USP Atwater Safety Manager to be operating without filters in place. Results from the consultant reports and information regarding the LEV system are summarized below for this period.

- January 21, 2003: The UNICOR consultant reported that three personal breathing zone samples exceeded the cadmium action level, but not the PEL. The highest cadmium exposure result was 3.7 $\mu g/m^3$ relative to the PEL of 5 $\mu g/m^3$ and action level of 2.5 $\mu g/m^3$. None of the personal exposures to lead exceeded the PEL or action level. Barium was very low and beryllium was not detected. The report states that the airborne concentration near the "exhaust outlet of the booth" exceeded the cadmium PEL. This cadmium area result was 8.8 $\mu g/m^3$. The report does not describe the location of the outlet. NIOSH/HETAB reports that skin wipe samples were reported incorrectly for barium and beryllium (see Attachment 3).

- January 2003: During late January 2003, the USP Atwater Safety Manager wrote memoranda documenting discussions with BOP and UNICOR management and staff regarding operation of the LEV system for at least five days during glass breaking without filters that are essential for trapping lead and cadmium contaminated dust emissions. According to these documents, the Safety Manager directed that glass breaking cease when he identified this condition, but it apparently continued without the Safety Manager's authorization.

- January 2003: Based on the elevated LEV exhaust level found by the consultant on January 21, 2003, this sampling episode apparently confirms that the LEV system was not operating adequately (i.e., the LEV filters were not in place to scrub metal dusts from the air). Although personal exposures for glass breakers were below the PEL, but above the action level, the LEV system was simply redistributing cadmium-bearing dusts from the immediate breathing zone of glass breakers to other areas of the GBO and/or factory. The Safety Manager's memorandum of January 28, 2003 mentioned that UNICOR staff asked whether the consultant's monitoring results (presumably the January 21, 2003 results) were received. The Safety Manager reiterated that glass breaking should be suspended. UNICOR should not have needed the consultant's results to determine that work should be stopped when an engineering control is not operating as designed. Work stoppage followed by corrective action should not have been delayed pending receipt of sampling results.

- February 27, 2003: During this sampling, the LEV filters were presumably in place. The UNICOR consultant found that one glass breaker personal exposure exceeded the cadmium PEL with a result of 8.7 $\mu g/m^3$, and the other exceeded the cadmium action level. Lead exposures were less than the PEL and action level. One personal beryllium exposure also exceeded the PEL. This exposure was reported as 2.2 $\mu g/m^3$ versus a 2003 OSHA PEL of 2 $\mu g/m^3$. NIOSH/HETAB questioned this beryllium result stating that no supporting documentation such as laboratory analysis reports was provided to substantiate the finding. NIOSH/HETAB noted that NIOSH/DART data at other UNICOR facilities do not show significant beryllium exposures, and that some data errors were found in previous UNICOR consultant reports (see Attachment 3). At this time, sample data sheets identified respiratory protection as "full-faced HEPA respirators" (i.e., full facepiece APRs with HEPA cartridges). These respirators have an assigned protection factor of 50. As in previous consultant reports, no recommendations were provided.

In summary, the results between December 2002 and June 2003 after the implementation of "improved" glass breaking ventilation (as stated by UNICOR) and before relocating the glass breaking booth and operations to a room near the outside loading dock, showed that inmates were still exposed to cadmium during glass breaking at levels that exceeded the OSHA PEL and/or action level. Both sampling episodes during this period showed either elevated personal exposures to cadmium or elevated area levels near the LEV exhaust. Although the January 21, 2003 data was representative of the LEV system being operated without filters in place, the February data still showed one of two cadmium exposures for glass breakers above the PEL even with the LEV filters in place.

During this period, respirators were upgraded to full facepiece APRs with an assigned protection factor of 50, and exposures were reduced below those reported in 2002. Therefore, exposures for glass breakers were within the protective capacity of the respirators worn. Nevertheless, OSHA requires that exposures be maintained at levels at or below the lead and cadmium PELs through the use of engineering and work practice controls. UNICOR was not in compliance with this requirement.

The same deficiencies as described in Section 4.1.1.1, above for 2002 applied to UNICOR during 2003. These included failure to take prompt and effective action, failure to bring in ES&H and industrial engineering experts to evaluate hazards and design and implement effective controls, use of trial and error approaches rather than systematic hazard analysis and control processes, lack of communication across factories, and others.

Critical programmatic deficiencies were also evident when the LEV system was operated without necessary filters. Specifically, BOP policy PS1600.08 grants the Safety Manager stop-work authority when conditions or practices exist that could reasonably be expected to cause death or serious physical harm (i.e., create an "imminent hazard.").[6] The policy also states that "reactivation of the work or process shall be contingent upon the Safety Manager's re-inspection and written approval." The USP Atwater Safety Manager ordered work stopped upon identifying the LEV filter deficiency, but UNICOR

[6] This stop-work authority also exists in the October 2007 revision of this document (i.e., PS 1600.09, Occupational Safety, Environmental Compliance, and Fire Protection).

apparently continued work without installing the filters and without the Safety Manager's re-inspection and written approval.[7]

In addition to this instance where operations continued without the LEV filters, according to OIG interviews, the Safety Manager indicated that he invoked his authority to shut down operations several times in 2002-2003 following tests showing excessive contamination only to find that the operation had restarted several days or weeks later without his permission. In this regard, UNICOR violated BOP policy.

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[7] It is the opinion of FOH and the other agencies that assisted the OIG with health and safety issues (i.e., the technical team) that the Safety Manager was correct to attempt to shut down glass breaking operations once he learned that they were being conducted without the LEV filters, and that BOP stop-work policies should have been in place to clearly provide him authority to do so. FOH recognizes that the Imminent Hazard section of Program Statement 1600.08 may not have technically provided this authority since, although the deficiency was serious, the criteria referenced by the policy may not have been satisfied. However, in general, whenever a necessary primary hazard control such as an engineering control is not used properly or is not being operated as designed, it is appropriate and essential to stop work until operability is restored. The continuation of operations absent installation of the filters and without the Safety Manager's approval appears to be a violation of OSHA regulations (e.g., 1910.1027 (k) states that "all surfaces shall be maintained as free as practicable of accumulations of cadmium") in-so-far as it allowed the uncontrolled release of lead and cadmium-laden dusts into the glass breaking area as well as the general factory environment. The Safety Manager did not authorize the continuation of the operation and FOH is not aware of any sound, documented rationale used by UNICOR management at the time to contravene the Safety Manager's decision. The lack of LEV filtration could reasonably be expected by the Safety Manager to result in, at a minimum, elevated exposures at the time (if not cause "serious physical harm" as required by the BOP Imminent Hazard policy) based on a number of factors including the visually apparent release of dust; the fact that the dust was known to contain significant concentrations of toxic metals, including cadmium, a carcinogen; the knowledge that the OSHA PEL for cadmium had been exceeded in the past when glass breaking operations were performed without the benefit of adequate engineering controls; and the realization that general factory workers were not protected by respirators. Unlike the Imminent Danger section in the current (revised) Program Statement, 1600.09, the language in 1600.08 did not require an immediacy of adverse health effects and did not specify that the Chief of the OSHA Area Office be consulted should there be technical disagreements associated with imminent hazard determinations. Moreover, the revision to 1600.08 that the BOP made in 1600.09, which we believe reflected BOP's prior interpretation of 1600.08, was detrimental to worker safety in that it further restricted the circumstances in which the Safety Manager could halt work to those situations where the harm from the hazardous condition itself was "imminent." The BOP's revision therefore deprives the Safety Managers of authority to stop work where a latency period may exist for the harm to become apparent. In addition, FOH notes that the definition of "emergency situation" in the OSHA respiratory protection standard (29 CFR 1910.134) can be interpreted as pertaining to "running the booth without the filters". According to the OSHA definition, an 'emergency situation' means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that may or does result in an uncontrolled significant release of an airborne contaminant. As such, the BOP stop work policy would not cover all "emergency situations."

While there may be some disagreement among safety and health professionals about to what extent the missing filters could result in worker exposures to toxic metals that could "reasonably be expected to cause death or serious physical harm" on an immediate ("imminent") basis, the OIG technical team finds that the Safety Manager was in the best position to make these determinations and should not have been second-guessed by UNICOR management. Furthermore, according to FOH's discussions with representatives of OSHA's Office of Federal Agency Programs, Division of Enforcement and Technical Guidance, it cannot be ruled out that the occurrence would have qualified as an "Imminent Danger" as defined by OSHA (see Section 13a of the OSH Act of 1970), however a lack of exposure data precludes a definitive determination at this time. Included in the OSHA definition of Imminent Hazard is the requirement that "For a health hazard there must be a reasonable expectation that toxic substances or other health hazards are present and exposure to them will shorten life or cause substantial reduction in physical or mental efficiency. The harm caused by the health hazard does not have to happen immediately." See the Conclusions and Recommendations sections of this report for additional considerations. Additional discussion of the ineffectiveness of the BOP 'stop-work' policy and apparent violation of the Imminent Hazard section of Program Statement 1600.08 will be found in the OIG report.

As in 2002, the UNICOR consultant reports stated exposure status versus OSHA PELs, but did not provide recommendations to reduce these exposures that are consistent with OSHA lead and cadmium standards. No mention was made that UNICOR was not in compliance with these standards. Even though a sample was taken at the exhaust of the LEV system, no mention was made of the status of the LEV system; that is, were filters in place as required or not. The consultant did not provide recommendations regarding the result that showed that cadmium dusts were distributed from the LEV exhaust to occupied areas of the GBO and/or factory.

4.1.1.3 Exposure Evaluations between June 2003 and March 2005

The glass breaking booth and operations were relocated in June 2003 to a room adjacent to the outside loading dock. Operations continued in that area until March 2005 with the exception of several periods of reported suspensions. All glass breaking operations were permanently stopped in March 2005. During this time period, six evaluations were performed by a second UNICOR consultant. Also, the BOP industrial hygienist performed one evaluation. Personal exposure monitoring and area air sampling were conducted and samples were analyzed for lead, cadmium, barium, and beryllium. Surface wipe sampling and other testing were also performed during some of these evaluations. Results are summarized below.

- January 7, 2004: The consultant collected five personal exposure samples, with three for glass breakers. All results were below the lead and cadmium PELs and action levels. Breaker cadmium exposures ranged from <0.4 $\mu g/m^3$ to 0.93 $\mu g/m^3$, and breaker lead exposures were all less than the limit of detection (LOD). Curiously, the only personal sample with detectable lead exposure (2 $\mu g/m^3$) was an inmate on "kitchen duty" near the on-going glass breaking operations. All beryllium results were also less than the limit of detection (LOD), and barium exposures were low (well below the PEL). No information was provided regarding work practices and hazard controls, and no recommendations were provided.

- February 9, 2004: The consultant collected five personal exposure samples, with three for glass breakers. The panel glass breaker had an exposure to cadmium at 17 $\mu g/m^3$ as an 8-hour TWA (assuming no exposure for the remainder of the work shift). This exposure is 3.4 times the PEL for cadmium. His lead exposure was 1.9 $\mu g/m^3$, well below the lead PEL and action level. The cadmium exposure of the funnel glass breaker was 0.73 $\mu g/m^3$ and lead exposure was 0.6 $\mu g/m^3$, both well below the PELs and action levels. A worker supporting glass breaking had cadmium and lead exposures less than the LOD. The feeder had cadmium exposure less than the LOD and lead exposure at 0.4 $\mu g/m^3$. The "kitchen helper" also had cadmium and lead exposures less than the LOD. All beryllium results were also less than the LOD, and barium exposures were low (well below the PEL).

The consultant issued three reports for this sampling episode, with dates of February 17, February 23, and March 23, 2004. The first report was a cover letter with the data which pointed out the one elevated cadmium exposure, but also stated that "full-face negative pressure respirators and HEPA filters" were used, and that "therefore the PEL for cadmium has been increased to 250." This is an erroneous statement in that the protection factor of a respirator does not increase the PEL, and it is inaccurate to suggest that the PEL was not exceeded for the cadmium exposure. The second report pointed out the one cadmium exposure above the PEL, but did not describe PPE or respiratory protection or other hazard controls and work practices that were employed. No context or explanation for the exposure was discussed, and no possible causes or corrective actions were provided. The consultant did recommend "that the panel breaking activity be re-evaluated for any deviations or changes in the activity." Follow-up monitoring was also recommended. In the third report, the consultant added information that described the PPE as disposable suits and full-face respirators with HEPA filters and stated that the protection factor for this respirator is 50 and that the maximum use level (MUL) for cadmium is 250 $\mu g/m^3$. In discussing these reports, NIOSH/HETAB mentions that "the erroneous statements in the report are another example of incorrect or incomplete information that has been provided to UNICOR by environmental consultants." (See Attachment 3.)

- March 10 and 18, 2004: The UNICOR consultant collected four personal exposure samples on both March 10 and 18, 2004 for inmate workers performing glass breaking or supporting activities. On March 10, all exposure results were below the LOD. On March 18, cadmium exposures ranged from <0.4 $\mu g/m^3$ to 1.4 $\mu g/m^3$, which are below the OSHA PEL and action level. As opposed to the February 2004 result, the panel glass exposure was less than the LOD while the funnel glass exposure was higher at 1.4 $\mu g/m^3$. The consultant reported that similar PPE and respiratory protection were worn as in February 2004. The consultant's report offered no explanation for the reduced cadmium exposure from its monitoring episode in February 2004. The only recommendations were to periodically re-evaluate activities and to re-evaluate exposures if any changes are implemented.

- September 28-30, 2004: The BOP industrial hygienist performed a technical assistance visit to conduct testing and evaluation for general factory activities, not including glass breaking. Personal exposure monitoring and area air sampling were performed for disassembly and related activities. All 17 personal and area air samples were below the LOD for lead, cadmium, barium, and beryllium. Eighteen surface wipe and 10 hand wipe samples were also collected. Lead concentrations for three work table top samples collected in factory areas ranged from 2,200 $\mu g/ft^2$ to 3,760 $\mu g/ft^2$. These samples show significant contamination, and the industrial hygienist recommended measures to prevent and control dust accumulation, including using disposable surface covers and HEPA vacuuming, as well as glove use and hand washing by inmates to prevent skin contamination and possible ingestion. Although at much lower levels than the factory area, lead, cadmium, and barium were detected in the food service area. The industrial hygienist recommended that based on these "low levels" the food service area should be isolated from the factory area via physical separation (e.g., addition of walls, doors, and ceilings), including isolation of the ventilation systems.

- March 18 and 28, 2005: The UNICOR consultant performed exposure monitoring and surface wipe sampling on both dates, and a ventilation assessment on March 18. Six personal samples were collected for breakers and assistants during GBO. All were below the OSHA PELs and action levels for cadmium and lead. All barium and beryllium results were below the LOD. The most notable result was for a glass breaking assistant on March 18, whose exposure to cadmium was 3 $\mu g/m^3$ during a 206 minute sampling period (1.3 $\mu g/m^3$ as an 8-hour TWA assuming no exposure for the remainder of the shift). This is still less than the cadmium action level as an 8-hour TWA. All five personal samples for inmates performing disassembly activities in the factory area (not glass breaking) were all well below the lead and cadmium action levels, with many below the LOD. Surface wipe sample results were difficult to understand as reported. Results were reported in quantifiable micrograms (µg), but then converted to $\mu g/cm^2$, most of which were reported as "<" (less than) results. Generally, these results seemed far lower than typical results from other UNICOR factories and far lower than results obtained by the BOP industrial hygienist in September 2004. The consultant offered no interpretation of these data. Regarding the ventilation evaluation, the consultant concluded "that the ventilation system is more than adequate to trap the heavy metals evolving from the glass breaking operations." Overall, the consultant concluded that exposures "are below any level that could be considered significant on an occupational level." Recommendations were not provided.

In summary, the 2004 and 2005 studies after relocating the glass breaking operations to a paint spray booth in a room located adjacent to the loading dock showed that exposures were much better controlled. With the one exception for cadmium on February 9, 2004, all personal breaking zone samples were less than the cadmium and lead PELs and action levels. Inmates performing glass breaking wore full facepiece APRs with a protection factor of 50, and more importantly, since February 2004, exposures were controlled through the use of engineering and work practice controls as required by the OSHA lead and cadmium standards. Exposures for disassembly and related activities in the factory (not including glass breaking) were all well below OSHA lead and cadmium action levels.

UNICOR consultant reports stated exposure status versus OSHA PELs and, after February 2004, the reports documented the PPE and respiratory protection used. The studies did not include a critical evaluation of work practices and did not provide recommendations for continued improvement.

4.1.1.4 Summary of UNICOR and Consultant Evaluations-2002 through 2005

A summary of exposures found to be above the action level or PEL at USP Atwater as determined by BOP and UNICOR consultants and industrial hygienists is provided in Table 2.

Table 2
Exposures Above the Action Level or Permissible Exposure Limit at USP Atwater
as Determined by BOP and UNICOR Consultants and Industrial Hygienists*
Time Period: 2002 through February 2004

Date of Test	Tester	Parameter	Description	Exposure as 8-hour TWA (μg/m³)
June 2002	Consultant	Cadmium	Personal Sample in Glass Breaking Booth	6.8 to 41**
		Lead	Personal Sample in Glass Breaking Booth	13 to 80**
July 2002	Consultant	Cadmium	7 Personal Samples in Glass Breaking Booth	Up to 270 [4 of 7 >PEL; 5 of 7 >AL]
		Lead	7 Personal Samples in Glass Breaking Booth	Up to 58 [1 of 7 >PEL; 3 of 7 >AL]
Sept 2002	BOP IH	Cadmium	Worker Breaking Panel Glass	6.63
		Lead	Worker Breaking Panel Glass	43.3
		Cadmium	Worker Breaking Funnel Glass	17.7
		Cadmium	Worker Breaking Panel Glass	90.8
		Lead	Worker Breaking Panel Glass	89.1
		Cadmium	Worker in Glass Breaking Booth	34.0
		Lead	Worker in Glass Breaking Booth	38.2
		Cadmium	Worker Breaking off Electron Guns	5.79
		Cadmium	Worker Loading Monitors to Electron Gun Breaking Table, Outside of Booth	2.98
Nov 2002	Consultant	Cadmium	5 Personal Samples in Glass Breaking Booth	14 to 300
		Lead	2 Personal Samples in Glass Breaking Booth	130 and 210
		Cadmium	1 Personal Sample in Glass Breaking Booth	2.8
Jan 2003	Consultant	Cadmium	3 Personal Samples in Glass Breaking Booth	Up to 3.7 [3 samples >AL]
Feb 2003	Consultant	Cadmium	Sample in Glass Breaking Booth	8.7
		Cadmium	Sample in Glass Breaking Booth	4
		Beryllium	Personal Sample in Glass Breaking Booth	2.2
Feb 2004	Consultant	Cadmium	Worker Breaking Glass	17

*The OSHA Action Level and PEL for Cadmium are 2.5 μg/m³ and 5.0 μg/m³, respectively. The OSHA Action Level and PEL for Lead are 30 μg/m³ and 50 μg/m³, respectively. The OSHA PEL for Beryllium is 2 μg/m³.
** Larger value assumes 6.5 hours of work; smaller value based on 65 minute sampling duration.

FOH and NIOSH/HETAB findings concerning these elevated exposure results as well as regarding others characterizations performed from June 2002 through March 2005 are summarized below along with conclusions regarding UNICOR's work practices and responses to the exposure results.

- Inmate workers were routinely exposed to cadmium above the OSHA PELs during glass breaking in 2002 and early 2003 and to lead above the OSHA PEL in 2002.

- UNICOR did not have effective engineering and work practice controls in place during 2002 and 2003 as required by OSHA. In addition, UNICOR allowed inmates to perform glass breaking operation without adequate respiratory protection in 2002.

- UNICOR conducted exposure monitoring associated with glass breaking operations from 2002 to 2005, but was slow to take action as required by OSHA to reduce employee exposures to levels at or below the lead and cadmium PELs. Exposures were above the cadmium PEL for almost two years before UNICOR was finally successful in maintaining exposures below those levels. Lead exposures were above the PEL throughout most of 2002.

- UNICOR exhibited numerous systemic deficiencies in its failure to promptly evaluate and control exposures during glass breaking at USP Atwater and other recycling factories. Work planning with appropriate hazard analysis, control design, and control implementation with control verification were lacking. Work was not stopped at USP Atwater and other factories when elevated exposures were repeatedly identified. Elevated exposure results were not shared with other factories, and instructions to stop work pending evaluation and control of exposures at all factories were not provided. ES&H experts were not retained to evaluate hazards and controls, design engineering and work practice controls, assist in implementation of controls, and verify effectiveness of controls. It appeared that UNICOR took a "trial and error" approach to hazard analysis and control that took nearly two years before effective exposure control was achieved.

- A clear indication of UNICOR's lack of hazard analysis and implementation of controls is the 2002 glass breaking operations where UNICOR failed to initially implement effective engineering, work practice, and respiratory protection controls, and then later in 2002 implemented inadequate respiratory protection controls.

- The January 2003 incident of UNICOR operating the LEV system without the necessary filters exemplified UNICOR's slowness to respond to known hazards and slowness to correct failed engineering controls. As discussed above in an earlier section of this report, FOH believes that the BOP and UNICOR violated the BOP stop-work policy (PS 1600.08) by continuing work in contravention of the Safety Manager's instructions.

- With the exception of one cadmium exposure, worker exposures to lead and cadmium in 2004 and 2005 were reduced to below the OSHA PELs through the use of engineering and work practice controls, as required by OSHA. In addition, adequate respiratory protection was provided during this period to achieve further worker protection.

- The usefulness of many consultant evaluations was limited by the lack of analysis and discussion of work practices and hazard controls, along with the lack of substantive conclusions and recommendations that could have contributed to reductions in exposures. In addition, some reports contained erroneous information or statements.

- Discussion of the significance of surface contamination results was particularly lacking in consultant reports.

- The reports prepared by the BOP industrial hygienist were more substantive and contained recommendations for exposure and contaminant control.

UNICOR should ensure that as part of exposure monitoring episodes, its consultants also evaluate and report on work practices and hazard controls and provide appropriate conclusions and recommendations related to the findings. UNICOR should implement an effective and pro-active approach to hazard analysis and controls utilizing ES&H experts, as appropriate, to evaluate hazards, design controls, and support their effective implementation.

4.1.2 OSHA Complaints, Inquiries, and Inspection of 2003 - 2005

FOH reviewed a series of documents dealing with complaints made to OSHA of worker safety and health violations associated with e-waste recycling operations at USP Atwater. The documents included two "OSHA Notice of Alleged Safety or Health Hazard" that described the complaints; one dated April 14, 2003 and the other dated January 24, 2005. In addition, FOH reviewed an OSHA inspection report for a March 2005 inspection pertaining to the January 2005 complaint, as well as various related emails and correspondence.

The first complaint was documented by correspondence from Director of Enforcement and Investigations, OSHA-Honolulu, to the USP Atwater Safety Manager, [redacted]. The complaint alleged that USP Atwater inmates involved in UNICOR e-waste disassembly operations were being exposed to known carcinogenic heavy metals without protective clothing or respirators and that several correctional officers refused to go back to work after high levels of cadmium were detected in their blood. The complaint also alleged that inmates were not being tested for cadmium or lead poisoning despite continuing exposures. In addition, the complaint alleged that workers were being x-rayed daily upon leaving the UNICOR facility posing a health concern due to excessive radiation exposure. Other than this OSHA correspondence, no other documents related to these 2003 allegations were available for FOH review.

In 2005, a second complaint was documented in correspondence to USP Atwater from OSHA-San Francisco. In the "Notice of Alleged Safety or Health Hazard," seven alleged OSHA violations were described in the UNICOR warehouse where e-waste recycling operations occurred. A summary of these allegations is provided below.

- Staff members and inmate employees are required to consume food in a contaminated lunchroom area that is not sealed off from the workroom area. [1910.141(g)(2)]

- Food service operations are not being conducted in a hygienic manner in-so-far as food is being contaminated with toxic metals resulting from activities like the use of compressed air for cleaning of surfaces in the e-waste factory. [1910.141(h)]

- Warehouse work and storage areas are not being kept adequately clean resulting in contaminated surfaces. Use of compressed air exacerbates the spread of this contamination. [1910.141(a)(3)(i)]

- Exposed staff members and inmate employees are experiencing skin and eye irritation and have not been provided the PPE previously identified in the UNICOR hazard assessment. [1910.132(d)(1)(i)]

- Workers are exposed to compressed air utilized for cleaning that exceeds 30 pounds per square inch. [1910.242(b)]

- Staff members and inmate employees have not received training on cadmium and barium as required by hazard communication regulations. [1910.1200(h)(2) and (3)]

- Staff members and inmate employees have not been informed about the existence, location, and availability or records such as air/wipe sampling tests nor of their right to access these records. [1910.1020(g)(1)]

In response to these allegations, a letter signed by the USP Atwater warden was issued on February 11, 2005 which outlined USP Atwater's investigation into the allegations and provided details about any workplace modifications or corrective actions which had been instituted as a result. The letter indicated that USP Atwater's review of each complaint found that operations were currently in compliance with all referenced regulatory requirements and pointed to a number of considerations to justify this position, including the following:

- Low or non-existent contamination on dining area surfaces and workers hands, as reflected by wipe samples collected by USP Atwater in September 2004;

- Delivery of food to the factory in enclosed containers which do not allow contamination by dusts;

- Thorough cleaning of the dining area and food service equipment on a daily basis;
- On-going cleaning and maintenance of the computer recycling factory and warehouse;
- Completion by USP Atwater of a PPE assessment which reflected that appropriate PPE (safety glasses, work gloves, safety shoes) is being used by inmate workers who disassemble computers;
- Lack of medical or industrial hygiene information to support the contention that exposure to lead, cadmium and barium is causing eye and skin irritations; and
- The results of a UNICOR review which indicated that staff and inmates receive adequate work place training on lead, cadmium, and barium.

In addition, the warden's letter indicated that a number of new policies or workplace modifications had been or will be implemented, including:

- Adoption of a new policy prohibiting the use of compressed air for cleaning purposes in the computer recycling factory and warehouse;
- Adoption of a new policy whereby the Factory Manager will ensure that staff and inmates are initially and annually notified of the existence, location, and availability of any records pertaining to workplace exposures via inmate orientations, staff-issued packets, etc.

Following receipt of the warden's February 11, 2005 letter, OSHA deployed inspectors to USP Atwater on March 29-30, 2005 to assess exposures at the UNICOR e-waste recycling operations. As described in a report dated April 11, 2005, OSHA performed walkthrough inspections of operations including warehouse receiving operations, e-waste disassembly, and CRT glass breaking being performed in an area equipped with a commercial spray paint booth as an engineering control. Based on sampling strategies formulated during the first day of the site visit, area air sampling and wipe sampling were conducted to determine the extent of exposure in these work areas. In addition, a qualitative assessment of the commercial spray paint booth ventilation system was performed.

On March 30, 2005, OSHA collected air samples from three factory locations in the penitentiary where e-waste disassembly occurred to assess air exposures for 13 metals, including lead, cadmium, and beryllium. In addition, area samples were collected from inside the glass breaking area and in the warehouse. All area air samples were described as 'negative' with the exception of three air samples collected inside the glass breaking booth (i.e., the converted spray paint booth). These three samples showed cadmium air concentrations approaching but not exceeding 50% of the OSHA PEL for cadmium (the action level). The report indicated that all three workers in the glass breaking booth were fitted with full face piece negative pressure respirators. In addition to the area samples, OSHA collected one personal sample from the breathing zone of a guard monitoring the glass breaking activities who was stationed on the loading dock outside the glass breaking room. This sample was described as 'negative'. No information was provided regarding the numbers or types of CRTs being broken during the sampling.

In addition to the air samples, OSHA collected wipe and surface samples throughout the UNICOR work areas (factory management areas/disassembly tables, glass breaking area, and warehouse) to identify the presence of dusts containing metal contamination. According to OSHA's report, "assessment of exposure to toxic heavy metals such as lead and cadmium must also consider surface and skin contamination because ingestion or re-entrainment of dusts from clothing can be a major source of exposure." Based on data collected from a portable x-ray fluorescence analyzer, the OSHA report indicated that "some" lead contamination was found on various building surfaces inside the disassembly factory and on a disassembly table which was "probably from the solder used in the electronic boards." In addition, the report indicated that lead and barium contamination was found on working surfaces inside the glass breaking room and that this was "not surprising". Wipe samples from the hands of inmate employees working in the glass breaking room showed "appreciable" amounts cadmium contamination which, on at least one glass breaker, was not effectively removed through hand washing (based on a post-hand washing sample). The amount of lead contamination was reported to be similar on the hands of glass breaking workers as compared to factory floor inmate workers.

Overall, the OSHA report concluded that area air sampling data indicated that aerosols generated by the glass breaking operations were adequately contained inside the enclosure and that the modified spray paint booth provided sufficient negative air movement. The report also concluded that, in general, work practices and ventilation design provided good control of potential exposures to heavy metal contamination but that wipe samples indicated the need to improve hand washing/hygiene practices.

Following the completion of the March 2005 OSHA inspection at USP Atwater, the Director of Enforcement and Investigations for OSHA-San Francisco provided identical letters to USP Atwater's Safety Manager, [redacted] and the UNICOR Recycling Business Group in which each of the seven original complaints (summarized above) were addressed in light of the inspection's findings. In this letter, dated May 23, 2005, OSHA indicated that it was unable to substantiate any of the complaints. Furthermore, OSHA indicated that no violations of other OSHA safety and health standards were identified based on a review of work practices, industrial hygiene sampling, assessment of the ventilation system, and evaluation of the Safety and Health Program.

4.1.3 NIOSH/DART and FOH Evaluation of April 2007

In April 2007, NIOSH/DART with assistance from FOH conducted an industrial hygiene evaluation at USP Atwater to evaluate exposures to metals and other occupational hazards associated with the recycling of electronic components. This evaluation was a qualitative assessment with some surface sampling, but was not a comprehensive evaluation. Operations conducted at the time of this evaluation included receiving and sorting, disassembly, and packaging and shipping. Glass breaking was stopped in March 2005 and was, therefore, not part of the NIOSH/DART evaluation. The NIOSH/DART evaluation included observations of work practices and PPE use, surface wipe and bulk dust sampling and analysis, and limited noise monitoring. The bulk dust and surface wipe samples were analyzed for lead, cadmium, barium, beryllium, and nickel. Personal exposure monitoring was not performed. Results of the evaluation are summarized below and are provided in detail in Attachments 1 and 2. Also see the Appendix for guidance to assist in evaluating surface wipe and bulk dust samples.

- Wipe samples were collected from 26 work area surfaces (see Attachment 2a for results). Most samples were below the 200 $\mu g/ft^2$ OSHA guideline for lead that applies to clean areas such as change rooms, but not active lead work areas. Therefore, most surfaces were adequately clean. Three surface samples that were above the 200 $\mu g/ft^2$ OSHA lead guideline for clean areas were from two wooden table tops (240 and 420 $\mu g/ft^2$ lead) and the top of an electrical power box (350 $\mu g/ft^2$ lead). The top of the power box had the highest cadmium contamination at 330 $\mu g/ft^2$. Consistent with other UNICOR factories, this sample indicates that metal dusts can accumulate on non-work surfaces that are not subject to regular cleaning. Nevertheless, these levels were less than other surface criteria that apply to work areas such as the Lange guidance that was developed for commercial buildings. [Lange 2001] Overall, the data showed that factory areas were kept reasonably clean.

- The highest lead measurement of 850 $\mu g/ft^2$ was collected on a surface inside the exhaust hood that served the former GBO. Cadmium was present at 84 $\mu g/ft^2$ on this surface. This result indicates that systems associated with the former GBO should be tested and decontaminated.

- Beryllium was not detected on the surfaces tested.

- Seven bulk dust samples were collected; three from the warehouse and four from the UNICOR recycling factory at the penitentiary (see Attachment 2b for results). Three of the four factory samples had the highest levels of lead and cadmium ranging from 1,100 µg/g to 9,100 µg/g lead and 110 µg/g to 810 µg/g cadmium. Two of these samples were floor sweepings and the other was from the top of the former GBO exhaust system. The latter result again indicates the need to decontaminate systems and areas associated with the former GBO. Dust samples from warehouse disassembly tables ranged from 150 µg/g to 430 µg/g for lead and from 11 µg/g to 110 µg/g for cadmium.

- Seven additional bulk samples were collected in the factory from the top of the ventilation duct and other high horizontal surfaces (see Attachment 2c). These samples showed lead contamination in the range of 44 µg/g to 1,100 µg/g and cadmium in the range of 12 µg/g to 250 µg/g. [Note: These samples were collected by FOH and are not presented in the NIOSH/DART report in Attachment 1.]

- NIOSH/DART noted that the work areas were kept reasonably clean, primarily by the use of brooms and brushes. NIOSH/DART also stated that these cleaning techniques are a potential source of airborne metal dust and the use of HEPA vacuums and wet cleaning are better techniques to clean dust contamination from surfaces. FOH also notes that dry sweeping and brushing is explicitly prohibited by OSHA lead and cadmium standards.

- Regarding PPE, NIOSH/DART reported that safety glasses were used in most operations, hearing protection was available where needed (primarily near the baler) and disposable respirators were available for voluntary use.

- Spot noise measurements were taken in the warehouse using a sound pressure meter. Noise measurements were not taken in the USP factory because work was not being conducted due to a lockdown. Occasional transient noise measurements up to 90 dBA were found in the warehouse, but most were well below that level. NIOSH/DART was of the opinion that occupational noise exposures were below the OSHA 90 dBA PEL and NIOSH 85 dBA criteria (which is also the OSHA action level that triggers the need for a hearing conservation program). However, NIOSH/DART recommended that further noise evaluations be conducted. The NIOSH/DART readings were limited and were not intended to represent a complete noise survey of all noise producing sources.

NIOSH/DART provided several recommendations including training in the use of PPE and dust suppression techniques, evaluation of hazards associated with tasks that are biomechanically taxing, evaluation of the heat stress hazard during summer months, performance of health and safety evaluations, vigilance in hygiene practices including hand washing, use of HEPA vacuuming and wet cleaning methods for surface decontamination, and performance of a noise survey (see Attachment 1).

4.1.4 UNICOR Consultant Exposure Evaluation of 2009

In April, 2009, a UNICOR consultant performed air monitoring, ventilation testing, surface sampling, and noise monitoring of e-waste recycling operations at USP Atwater. The consultant evaluated disassembly and materials handling operations at the penitentiary factory and warehouse. As stated in the consultant's report, the purposes of this evaluation were to determine worker exposures to lead, cadmium, beryllium, and noise during the recycling operations underway at the time; to evaluate lead, cadmium, and beryllium surface concentrations; and to determine the necessity of additional controls and/or work practices. These evaluations were conducted as part of UNICOR's annual monitoring program implemented in 2009 for its factories. This monitoring did not include an evaluation of glass breaking, because all GBO at USP Atwater were suspended in 2005.

At the disassembly factory in the penitentiary, air monitoring consisted of the collection of 10 personal samples for workers involved with various e-waste disassembly operations being performed on factory tables. At the outside camp, the consultant collected an additional seven personal air samples for workers stationed at disassembly tables and at the baler. The consultant's report stated that no lead, cadmium, or beryllium was found in any of the 17 air samples, and that worker exposures were all below well below allowable OSHA limits.

The consultant also measured the volumetric air flow of the disassembly factory's swamp coolers used for air conditioning. Testing was performed using a velometer and smoke tubes. The consultant reported that at the time of the testing, only one of the four swamp coolers was running due to cooler outdoor temperatures and indicated that the "amount of flow per swamp cooler averaged 1,852 cubic feet per minute." Regarding the camp, the report indicated that no ventilation system was present with the exception of local floor fans. No conclusions or recommendations were provided concerning the ventilation evaluations at the two locations. [Note: FOH notes that OSHA issued a citation to UNICOR at USP Lewisburg, in part, for using pedestal fans that can disturb surface contamination and increase inhalation exposures in disassembly areas. UNICOR should evaluate the fan types and their locations relative to the USP Lewisburg violation and determine if the fans are appropriate for use.]

Based on these evaluations, the consultant recommended that several types of disposable dust masks (N-95 or better) be made available to workers based on their personal preference, and that Appendix D of the OSHA Respiratory Protection standard be provided to the workers voluntarily using the masks. The consultant further recommended that use of the dust masks should not be made mandatory and advised that the results of his testing be communicated to workers within 15 days of receipt. No comments were provided dealing with the use or effectiveness of other PPE (e.g., gloves, eye protection, and protective footwear) or other controls such as to limit ingestion as a route of exposure, ergonomic hazards, or heat stress exposures during hot weather.

The consultant also performed surface wipe sampling in the disassembly factory (penitentiary) and camp. At the disassembly factory, samples were collected from 13 surfaces including floors, beams, ventilation ducts, table tops, and walls. All 13 were analyzed for lead, while four samples were analyzed for cadmium and beryllium. Seven of the 13 lead measurements exceeded the OSHA guidance level for clean areas (i.e., 200 $\mu g/ft^2$ for clean areas such as lunch room and change rooms but not active work areas, see Appendix for more information), although only one of these samples was taken from a work surface. The other six lead results, ranging from 588 to 2,890 $\mu g/ft^2$, were from factory beams and ventilation ducts. Of the four samples tested for cadmium, two had detectible concentrations (i.e., 482 and 544 $\mu g/ft^2$ taken from a beam and ventilation duct, respectively). The consultant's report notes that these cadmium surface concentrations exceeded the U.S. EPA's Health Benchmark for cadmium of 144 $\mu g/ft^2$ established as a guidance level for residential dust clean-up following the September 11, 2001 attacks. In addition, the report indicates that OSHA requires that surfaces be maintained "as free as practicable" of cadmium contamination. The remaining two samples (from a floor surface and a table top) showed no cadmium contamination. None of the four surfaces tested had detectible beryllium contamination.

At the camp, 10 surface wipe samples were collected from floors, tables, a beam, and the top of a locker. All 10 were tested for lead and four were tested for cadmium and beryllium. Of the 10 locations tested for lead, four (three table samples and one floor sample) exceeded the OSHA guidance level for lead of 200 $\mu g/ft^2$ for clean areas. Of the four samples tested for cadmium, one floor sample slightly exceeded the EPA Health Benchmark for residences. None of the four samples had detectible beryllium surface contamination.

Overall, based on the evaluations performed, the consultant's report concluded that dust on beams, lights, and ventilation ducting does not appear to contribute significantly to employee exposure and that although UNICOR personnel were vigilant about cleaning their workstations, "more will need to be done in light of wipe sample results reported for work surfaces." The consultant recommended that that floors be HEPA vacuumed and mopped, that workstations be HEPA vacuumed and wet wiped more frequently, and that dry sweeping in the disassembly factories be limited to the collection of larger parts. [Note: In other reports, NIOSH/HETAB recommended use of wet misting and squeegees for clean-up of larger debris.] No recommendations were provided dealing with the contamination on the elevated surfaces.

Other than indicating some "variability in the use of dust masks", the consultant did not provide additional documentation of PPE or work practices. The consultant conducted noise monitoring, and these results are reported in Section 4.3.

In summary, the 2009 consultant report provided certain conclusions and recommendations regarding current operations and facilities and was an improvement over previous evaluations. However, the report did not provide an interpretation of the ventilation measurements and was not comprehensive in terms of documenting existing work practices and controls or determining the necessity for worker protection improvements as originally stated in the purposes of his report. In addition, given the limited numbers of samples collected, the surface sampling performed should not be construed as a comprehensive delineation of contamination such as would be the basis for a detailed operations and maintenance plan to control exposures to contamination on various factory surfaces. That is, unless a suspect surface, building component, or piece of equipment is assumed to be contaminated and treated as such, sampling should be performed to ascertain its status. This may require multiple samples from dispersed locations and sampling in hidden or inaccessible locations (that may be accessed at times by workers or otherwise contribute to personal exposures or environmental releases). It is recommended that UNICOR utilize sampling regimens that are informed by guidance documents such as the U.S. EPA's *Lead Sampling Technician Field Guide* [EPA 2000] and *Managing Asbestos in Place, A Building Owners Guide to Operations and Maintenance Programs for Asbestos-Containing Buildings* [EPA 1990].

FOH recommends that UNICOR discontinue use of dry sweeping and develop an operations and maintenance plan to deal with contamination on elevated and other surfaces not subject to regular cleaning. FOH also recommends that UNICOR evaluate the appropriateness of the factory fans relative to the USP Lewisburg OSHA violation for pedestal fan use. OSHA issued this violation for both dry sweeping and pedestal fan use in the disassembly areas even though exposures were less than the action levels.

4.2 Assessment of the Medical Surveillance Program

As part of the DOJ/OIG investigation, NIOSH/HETAB assessed the existing medical surveillance program for inmates and staff exposed to lead and cadmium during e-waste recycling at USP Atwater. NIOSH/HETAB conducted a site visit in October 2008 to conduct this assessment. Results are summarized below and are presented in detail in the NIOSH/HETAB report provided in Attachment 3.

- NIOSH/HETAB reported that inmates were exposed to cadmium and lead above occupational exposure limits during glass breaking from 2002 to 2003. During this period, it appears that inmates worked without adequate respiratory protection from April 2002 to July 2002. Exposures seemed to have been better controlled with the relocation of the GBO to the spray booth, however, one exposure monitoring result showed significant exposure to cadmium.

- Biological monitoring is performed by the USP clinic and consists of blood lead levels (BLL), blood cadmium (CdB), urine cadmium (CdU), urine beta-2-microglobulin (B-2-M), and serum barium. Not all tests are done for each inmate. The tests are reviewed by a physician. Paper copies of results are maintained in the inmate's personal medical record. No physical examinations are performed and inmates did not receive medical clearance to wear a respirator.

- Preplacement test results from March 2002 were available for 10 inmates who performed glass breaking. These 10 inmates were retested in early July 2002 prior to respirator use but about one week after temporary shutdown of the GBO. The BLLs of these 10 inmates increased. In July, the mean BLL was 4.6 µg/dL (range of 2-9 µg/dL). In March, the BLLs ranged from below the LOD of 2 µg/dL for six inmates to 3 µg/dL. In contrast, CdBs decreased for these 10 inmates in July relative to March 2002. Mean serum barium in May was 76.3 µg/L and was 105.5 µg/L in July. NIOSH/HETAB noted that these test results are the best indication of inmate exposure during the time frame when glass breaking was performed without controls or respiratory protection. NIOSH/HETAB concluded that the slightly increased BLLs indicate exposure to lead, and the decreased CdB results likely represent an inability to leave the work area to smoke (smoking is known to increase CdB levels, sometimes dramatically).

- In July 2002, an additional eight inmates were tested for the first time. The mean BLL was 3.8 µg/dL (range of 2-8 µg/dL), comparable to but slightly lower than the previously discussed 10 inmates. CdB levels were below the LOD for four inmates and the mean was 1.4 µg/L for the other four.

- Ten inmates were tested between one and four times from May 2003 to November 2004. NIOSH/HETAB found that biological monitoring results were unremarkable with regard to potential for occupational exposure to lead, cadmium, and barium (see Attachment 3 for the results and discussion).

- Records were reviewed from seven staff members who filed workers' compensation claims for exposures from recycling. These staff members were seen by an occupational medicine physician and a toxicologist. Two reported no symptoms and five reported cough and nasal problems. Biological monitoring and other medical tests were performed for these staff members. The toxicologist determined that none of the individuals evaluated had any occupational medical problems. (See Attachment 3 for further details.)

- NIOSH/HETAB also reviewed results of medical surveillance that 10 UNICOR staff received from private physicians between 2007 and 2008. Eight BLLs were all below the LOD. Of nine CdBs, eight were below the LOD and one was 0.8 µg/L. Of nine CdUs, six were below the LOD and three ranged from 0.3 to 0.4 µg/L. Eight B-2-M results were within the normal range.

Overall, NIOSH/HETAB concluded that the results of biological monitoring for both staff and inmates were unremarkable with regard to potential occupational exposure to lead, cadmium, and barium. No inmates or employees had blood or urine levels of lead or cadmium which exceeded occupational standards. NIOSH/HETAB also concluded that medical surveillance was not in compliance with the OSHA lead and cadmium standards, and medical clearance was not performed for respirator use in the GBO which is a violation of the OSHA respiratory protection standard. NIOSH/HETAB stated that there is no need to perform any further medical surveillance if the GBO remains closed.

4.3 Investigations for Noise Exposure

In April 2007, NIOSH/DART took a limited number of spot measurements for noise in the camp warehouse only, because the penitentiary factory was not operating at the time of the evaluation. NIOSH/DART did not find exposures likely to be above the OSHA action level as 8-hour TWAs (see Section 4.1.3), but NIOSH/DART recommended that a complete noise survey be performed for all operations that could potentially have a noise exposure. BOP and UNICOR consultants performed two noise surveys in 2009, as reported below.

A BOP consultant conducted a noise survey at USP Atwater in March 2009. "Instantaneous" noise measurements were taken throughout the penitentiary, including many areas not associated with UNICOR operations, such as housing units. These "instantaneous" types of readings are point-in-time readings rather than dosimetry that measures exposures as 8-hour TWAs, which can then be compared to OSHA exposure limits.

Over 200 noise readings were taken, but only nine were in UNICOR areas. Of the nine, only three were in potentially noise producing areas, which were identified as demanufacturing areas and a drilling area. None of the three readings were found to exceed the OSHA PEL or action level. The consultant survey is very limited relative to UNICOR e-waste recycling. The consultant report does not mention if specific areas/activities of potential noise sources were monitored, except for one "drilling" reading (e.g., areas and activities involving balers, powered hand tools, or other powered tools and equipment were apparently not tested). FOH notes that other UNICOR disassembly factories showed noise exposures above the OSHA action level and/or PEL for a limited number of specific activities and areas.

The consultant stated that based on levels not exceeding 85 dBA (the OSHA action level), areas surveyed are not subject to a hearing conservation program. The Factory Manager and Safety Specialist confirmed that a hearing conservation program is not required nor in place, but also stated that hearing protection is required and made available as an added precaution.

In April 2009, a UNICOR consultant conducted personal noise dosimetry to evaluate noise exposures during various e-waste recycling operations taking place at USP Atwater. This work was performed as part of UNICOR's annual monitoring program implemented in 2009 for its factories and was conducted at both the penitentiary disassembly factory and camp.

Noise doses were obtained over monitoring periods of approximately two to seven hours from 10 different workers involved in various activities judged by the consultant to have the potential to exceed OSHA action levels. Work activities included disassembly, copper recovery, breaking up of microwaves, and operating balers. Calculated as 8-hour TWAs, doses ranged from 13 to 53% of the OSHA PEL with only one worker recording a dose in excess of the OSHA hearing conservation action level (i.e., 50 percent of the PEL or 85 dBA as an 8-hour TWA). The worker whose exposure (53%) exceeded the OSHA hearing conservation action level was described as operating a baler located outdoors at the camp. Based on these results, the consultant recommended that all balers be included in a hearing conservation program following OSHA requirements of 29 CFR 1910.95, Occupational noise exposure, and including annual training and audiometric testing.

In summary, the limited amount of noise monitoring for the e-waste recycling operations conducted in March 2009 was not adequate to properly determine noise exposures. The April 2009 survey applied proper techniques. UNICOR should have performed a hazard analysis of its recycling activities at USP Atwater, including noise hazard evaluations, prior to and then shortly after start-up of recycling activities in 2002. Additional noise surveys should have been performed as activities were planned and initiated or modified over time. Inmates performing baling should have been enrolled in a hearing conservation program at the start of baling operations. This is further indication that UNICOR lacks an effective hazard analysis program for its recycling factories.

4.4 Environmental Issues

FOH conducted a review of available documents pertaining to environmental issues associated with e-waste recycling operations conducted by UNICOR at USP Atwater since 2002. Most notable were documents which reflected how, despite recommendations from the Safety Manager at USP Atwater, wastes generated by the UNICOR glass breaking operations (GBO) were not initially characterized in accordance with governmental regulations and that, as a result, GBO-related wastes (e.g., air filters) were not initially disposed of in an appropriate manner (i.e., as hazardous waste). In addition, documents pertaining to a fire at the USP Atwater e-waste facilities reflected a lack of preparedness and communication which likely contributed to an uncontrolled release of hazardous materials.

Overall, the reviewed documents reflect that, from the standpoint of compliance with environmental regulations, USP Atwater and BOP had not adequately prepared for initiating e-waste recycling operations, and even after being advised of the need for necessary testing and other actions, prompt implementation of these recommendations did not occur. Also, important information and lessons learned were not effectively communicated to other e-waste recycling operations at other BOP institutions.

FOH reviewed correspondence regarding concerns that the Safety Manager raised shortly before and soon after recycling was initiated at USP Atwater. These concerns included the need for CRT glass and other wastes to be analyzed to determine whether the materials would be required to be treated as hazardous waste. In a memo to the Associate Warden dated March 2002 (one month before computer recycling operations began at USP Atwater), the Safety Manager indicated that Toxicity Characteristic Leaching Procedure (TCLP) tests needed to be performed on the CRT glass "to identify the material content as hazardous or non-hazardous for shipping, handling and recycling purposes" and to "ensure that lead, cadmium, and barium levels are below the EPA hazardous waste guidelines" (see Table 3, Maximum Concentration of Selected Contaminants for the Toxicity Characteristic).

The need for an environmental risk/health assessment for the e-waste recycling operations had been previously identified in a November 28, 2001 memo from the Safety Manager to the Factory Manager.

Table 3
Maximum Concentration of Selected Contaminants
for the Toxicity Characteristic[1]

Contaminant	TCLP Regulatory Level
Arsenic	5.0 mg/L
Barium	100.0 mg/L
Cadmium	1.0 mg/L
Chromium	5.0 mg/L
Lead	5.0 mg/L
Mercury	0.2 mg/L

[1][40 CFR 261.24]

In June 2002, three months after the start of GBO at USP Atwater, TCLP testing of exhaust air filters from the glass breaking area was performed. Test results identified concentrations of lead which, according to a July 1, 2002 memorandum from the Safety Manager, "far exceeded" EPA Resource Conservation and Recovery Act (RCRA) standards. Based on these results, the Safety Manager indicated that, effective immediately, the glass breaking primary and secondary exhaust filters will need to be removed and handled as hazardous waste. The memo also specified a number of other requirements that needed to be fulfilled including: provide 40-hour HAZWOPER training to UNICOR staff; provide staff and inmates proper procedures and PPE for replacing, handling and disposing the filters; identify the temporary satellite storage site for the hazardous waste; and identify a certified hazardous waste disposal company. According to OIG interviews of USP Atwater inmates and staff, no special precautions were initially afforded these filters and they were disposed of in unlabeled plastic bags (i.e., not as hazardous waste).

Later in July 2002, a memo by the Warden to the BOP Regional Director reflected "deep concerns" about the UNICOR computer recycling program in regard to hazardous metals. The memo pointed to two main issues: that the residual metals collected in the air filtering system were not handled and disposed as hazardous waste in accordance with EPA standards; and that the glass breaking operation resulted in the release of hazardous metals into the air, exposing staff and inmates to "higher than allowed levels of lead, cadmium, barium and other dangerous metals." The memo pointed out the broader implication that four similar glass breaking operations were underway in the BOP which have not conducted any initial hazard assessments and also outlined a number of corrective measures that USP Atwater would be taking to further characterize and control risks. The memo concludes by stating that the UNICOR glass breaking operation at USP Atwater has been temporarily suspended pending the implementation of the corrective measures, and by recommending that UNICOR should be responsible for funding and developing a lead management plan so that operations Bureau-wide can meet governmental requirements. Subsequent to this memo, a "Cadmium and Lead Compliance Program Plan" dated August 7, 2002 was prepared for USP Atwater by a consultant which detailed a number of safety and health measures and identified wastes from the glass breaking area, including air filters, as hazardous waste. However, the OIG found no evidence that this plan was ever put into practice as intended.

In addition to learning that its glass booth filters could constitute hazardous waste, UNICOR also was aware from dealing with California regulators that its glass booth emissions could subject it to California EPA air regulations. In a letter dated June 2, 2003, USP Atwater's Associate Warden of Industries requested a permit waiver from the San Joaquin Central Valley Air Pollution Control District in order that reprocessed air from the CRT glass breaking booth could be vented to the outside. The letter explained that the CRT glass breaking booth, which had been in operation since April 1, 2002, had previously vented its filtered air back into the inside of the factory work area but that it had been recently shut down as a precautionary measure pending relocation to another location where air could be vented to the outside. The letter indicated that based on the design ventilation rating of the booth (i.e., 8000 cubic feet per minute), quantitative measurements of respirable dust in the CRT breaking area (i.e., 1.3 mg/m^3) and a 'worst case' shift duration (6.5 hours), a maximum theoretical total of 0.250 pounds of particulates per day would be released, not factoring in the filtering processes being employed (which was described as having a manufacturer rating of 100% for particles down to 2 microns in size). The letter was accompanied by a San Joaquin Valley Air Pollution Control District Permit Application for Authority to Construct a New Emission Unit and a Supplemental Application Form describing the baghouse/dust collector being proposed to collect materials described as containing "lead, cadmium, barium and beryllium". Ultimately, it was determined that UNICOR qualified for an exemption from air permitting requirements.

Environmental issues at USP Atwater also were raised in the context of a fire which occurred at USP Atwater on November 10, 2003. The fire reportedly involved about 1,000 televisions and computer monitors stacked outside the warehouse and awaiting processing at the UNICOR e-waste recycling factory. Due to the presence of heavy metals in the materials, a hazardous waste contractor was immediately called in to contain the contamination. As a follow-up to the containment, local environmental regulators expressed the immediate need for further remediation (i.e., removal of debris and underlying soil) before forecast rain showers occurred. Correspondence a week after the fire occurred (i.e., November 17, 2003) from the BOP Central Office reflected that remediation had still not occurred and that officials were concerned over the fire's ramifications in light of hazardous waste, clean air, and clean water regulations and possible regulatory fines.

Environmental reports and correspondence were reviewed dealing with the 2005 testing of UNICOR roof filters which constitute part of the factory's general air ventilation system (as opposed to the LEV filters associated directly with the GBO). Specifically, a cover memo from the Safety Manager at that time indicated that all "TCLP and RCRA 13" tests showed data "below the EPA hazardous waste reporting requirements" (i.e., the filters would not be considered hazardous waste based on EPA criteria). The memo goes on to indicate that "all 250 filters on the UNICOR roof will need to be changed out every 90 days to stay below the EPA threshold," and makes the suggestion to place this task on the facility's computerized maintenance tracking system. However, a memo dated November 9, 2005 from the Acting BOP National Safety Administrator indicated that although the EPA toxic characteristic threshold was not reached, the California hazardous waste regulations are more stringent, and two additional analytical tests were required: a Waste Extraction Test (WET); and a 'total metal concentration' determination. The memo indicated that a WET analysis of the filters would "almost certainly" yield a sample result exceeding the 250 mg/l California hazardous waste limit for soluble zinc and recommended that the filters be stored, manifested and disposed as California non-RCRA hazardous waste. Based on the Acting BOP National Safety Administrator's memo, correspondence was sent on November 10, 2005 to all recycling group factory managers requiring that baseline testing of recycling factory ventilation air filters be done and results evaluated in accordance with the various state hazardous waste regulations. FOH found no evidence that this baseline testing of recycling factory general ventilation air filters was done at other UNICOR e-waste recycling facilities until USP Lewisburg performed very limited air filter testing in April 2006 (one sample was tested and found not to exceed the RCRA limit for lead). HVAC filters from other UNICOR e-waste recycling factories (FCI Elkton, FCI Ft. Dix) were not analyzed until tested in conjunction with the OIG investigation (i.e., 2007) at which time at least some samples were found to contain accumulated dust with high lead and/or cadmium levels which failed or would be expected to fail the TCLP RCRA limit for lead. [8]

Regarding the current environmental status of e-waste recycling operations at USP Atwater, based on discussions held in August 2009 with the current UNICOR Factory Manager and Safety Manager, these filters are currently being changed on an annual basis. The Factory Manager also confirmed that the CRT glass breaking had been halted, was not expected to re-start, and the current e-waste recycling operations at USP Atwater are not currently subject to any special environmental permits dealing with air emissions or hazardous waste.

4.5 Summary

Overall, documents from the start-up and initial operation of the UNICOR electronics recycling activities at USP Atwater reflect that, despite the Safety Manager's recommendations to better characterize wastes and airborne dust concentrations and temporarily suspend glass breaking operations until corrective measures could be completed, hazardous waste (e.g., filters) was not properly identified, handled, or disposed and airborne releases within the factory occurred which resulted in hazardous personal exposures. Also, it is evident that similar issues should have been addressed at other UNICOR facilities involved in e-waste recycling operations at the time (e.g., FCI Elkton, FCI Texarkana), and that communication between these organizations was lacking. The documents reviewed concerning the fire which occurred in 2003 reflect a lack of prompt notification of appropriate BOP and UNICOR decision-makers, and a need for more effective emergency action plans and contingencies.

[8] See FOH individual institution reports for additional details.

5.0 CONCLUSIONS

Conclusions concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at USP Atwater are provided below under the following subsections:

- Heavy Metals Exposures;
- Noise Exposure and Other Hazards;
- Health and Safety Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

Various conclusions may be applicable to all UNICOR recycling factories with similar operations and activities. These conclusions are supported by the results, findings, and analyses presented and discussed in Sections 3.0 and 4.0 of this report, as well as the documents assembled by the OIG. These conclusions, in part, are consolidated from the various federal agency reports, and are also supplemented by FOH based on the entire body of information assembled and reviewed. See Attachments 1 and 3 for additional conclusions from the individual contributing federal agencies, NIOSH/DART and NIOSH/HETAB, respectively.

5.1 Heavy Metals Exposures

1. Based on monitoring results from 2002 through 2003 performed by UNICOR consultants and a BOP industrial hygienist, NIOSH/HETAB concluded that some inmates were exposed to cadmium and lead above occupational exposure limits during glass breaking occurring over this period of time [Note: GBO was conducted in the penitentiary factory at this time]. Also, during this period, NIOSH/HETAB concluded that it appears that inmates worked without adequate respiratory protection from April 2002 to July 2002. FOH adds that respiratory protection was also not adequate at least through November 2002, based on some exposures being above the protection factor of respirators in use between July and December 2002. Exposures were better controlled as a result of the relocation of the GBO to the paint spray booth in 2004; however, one exposure monitoring result showed exposure to cadmium above the PEL in 2004.

2. In January 2003, glass breaking was conducted for approximately a week without the LEV system filters in place. These filters are essential for the removal of metal containing dusts from the air. The LEV system was therefore ineffective in controlling exposures during this period, and UNICOR operated this crucial system outside of its design and operating parameters. The system simply redistributed metal contamination to areas of the factory where the system was exhausted. Visible dust emissions were observed during this period according to the USP Atwater Safety Manager and UNICOR staff. BOP and UNICOR did not take prompt corrective action despite a stop-work order by the Safety Manager, and continued work contrary to the Safety Manager's instructions in violation we believe of the BOP's stop-work policy.

3. Personal exposures for glass breakers were repeatedly found to be above the cadmium PEL during repeated exposure monitoring episodes from startup of the GBO in mid-2002 through early to mid 2003, and above the lead PEL through 2002. During this period, cadmium exposures for glass breakers from 10 to 60 times higher than the cadmium PEL were not unusual. The last personal exposure above the PEL was for cadmium in February 2004 (3.4 times higher than the PEL). For a period of 22 months, UNICOR at USP Atwater did not control inmate worker exposure to levels at or below the cadmium and/or lead PELs through the use of engineering and work practice controls, as required by the OSHA lead and cadmium standards. Based on exposures above the PEL for almost two years, UNICOR was slow to bring exposures into compliance with OSHA lead and cadmium standards. In addition, UNICOR did not take positive actions at its other glass breaking operations, based on the USP Atwater findings, experiences, and deficiencies.

4. During glass breaking, the last exposure above the PEL was found in February 2004 for cadmium. Since that time, breaker and feeder exposure monitoring during glass breaking operations showed that lead, cadmium, and other metals exposures were below the OSHA PELs and action levels when calculated as 8-hour TWA exposures.

5. Given both the frequency and extent of lead and cadmium exposures, UNICOR did not take prompt and effective action to remedy these conditions and implement effective controls for glass breaking not only at USP Atwater, but at all other UNICOR factories performing glass breaking. UNICOR should have taken the following actions: stoppage of glass breaking work at USP Atwater and all other glass breaking factories by July 2002; official notification of other factories of USP Atwater exposures with instructions for analysis and corrective actions at each factory; retaining qualified professionals such as industrial ventilation engineers and certified industrial hygienists to design and assist in implementation and verification of effective engineering and work practice controls; and, after implementation of controls, restarting GBO with appropriate ES&H oversight, monitoring, and other support until verification of effective exposure control.

6. UNICOR communication and information sharing with other factories was lacking or not effective based on exposures also found at other factories such as FCI Elkton [FOH 2008a] and FCI Texarkana [FOH 2009c]. This lack of information sharing was evident despite the USP Atwater Safety Manager notifying the Assistant Warden in 2002 that at least four other factories had not performed hazard analysis for similar operations. In addition, UNICOR appeared to slowly implement control and improvement measures at USP Atwater more through a process of "trial and error" and use of make-shift systems rather than a systematic process of hazard analysis, work planning that includes hazard control design and implementation, and work performance with hazard control verification. Support of qualified ES&H professionals should have been applied

at all stages not just to take exposure samples, but to contribute to design, implementation, and verification of controls.

7. Monitoring of operations on the general factory floor (e.g., disassembly, not including glass breaking) was conducted in 2004. Based on these results, exposures were maintained below the lead and cadmium PELs and action levels, which is consistent with results from other UNICOR factories. From March 2005 to April 2009, no exposure monitoring was performed. In April 2009, UNICOR resumed exposure monitoring at USP Atwater as part of its recently implemented annual monitoring program. Current routine e-waste recycling operations conducted in the general factory areas have minimal inhalation exposure potential to lead, cadmium, and other metals. Lead and cadmium exposures were well below OSHA action levels.

8. While glass breaking was performed, exposure monitoring was not conducted for the cleaning and change-out of LEV systems and HEPA filters. These activities have potential for higher lead and cadmium exposures.

9. During an inspection in 2005, OSHA could not substantiate any of the complaints of violation that it received in both 2003 and 2005. During glass breaking, OSHA found cadmium exposures near but below the OSHA action level. By this time, UNICOR had achieved exposure control during glass breaking (i.e., the last exposure recorded above the cadmium PEL was in February 2004). UNICOR shut down glass breaking at USP Atwater shortly after the OSHA inspection.

10. NIOSH/DART found that surfaces associated with past GBO, such as inside an exhaust duct and at the top of the former GBO exhaust system, were contaminated with lead and cadmium. Further testing and decontamination should be performed as part of the decommissioning of former GBO systems and areas.

11. NIOSH/DART found that most samples from other surfaces were below the OSHA lead guideline for "clean" areas. Three samples above the criteria were from wooden table tops and the top of an electrical power box.

12. Surface testing results at USP Atwater as well as other UNICOR factories show that disassembly activities result in metal dust contamination of work surfaces, as well as elevated or other surfaces that are not subject to regular cleaning. In addition to existing and improved housekeeping practices, implementation of an operations and maintenance (O&M) plan will serve to control potential exposure from existing and recurring contamination. An element of the O&M plan could include periodic clean-up of surfaces (such as elevated or other surfaces not subject to regular cleaning) by inmate workers; however, this would have to be performed using proper hazard controls, work practices, and training.

13. NIOSH/DART noted that the work areas were kept reasonably clean, primarily by the use of brooms and brushes. NIOSH/DART also stated that these cleaning

techniques are a potential source of airborne dust, and the use of HEPA vacuums and wet cleaning are better techniques to clean dust contamination from surfaces. FOH also notes that dry sweeping and brushing is explicitly prohibited by OSHA lead and cadmium standards. OSHA issued a violation to UNICOR at USP Lewisburg for dry sweeping in 2007.

14. NIOSH/HETAB concluded that the results of biological monitoring for both staff and inmates were unremarkable with regard to potential occupational exposure to lead, cadmium, and barium. No inmates or employees had blood or urine levels of lead or cadmium which exceeded occupational standards. NIOSH/HETAB also concluded that medical surveillance was not in compliance with the OSHA lead and cadmium standards, and medical clearance was not performed for respirator use which is a violation of the OSHA respiratory protection standard. NIOSH/HETAB stated that there is no need to perform any further medical surveillance if the GBO remains closed.

15. FOH considers the performance of initial and follow-up exposure monitoring conducted between 2002 and 2005 at USP Atwater to be important in establishing exposure levels and indicating where continuing improvements are needed to reduce exposures. FOH encourages continuation of this practice even for general factory operations, not including glass breaking. However, in reviewing UNICOR consultant exposure assessment reports during this period for USP Atwater, both FOH and NIOSH/HETAB found that the reports lacked substantive evaluation of work practices and hazard controls. Interpretation, perspective, and analysis of results were often lacking. In addition, recommendations were generally not provided to contribute to continuing improvement of work processes and reduction in personal exposures. An important example is that no recommendations were provided when January 2003 results showed that cadmium dusts from the LEV system were being distributed to the factory area, because LEV filters were not in place. This is in contrast to the noteworthy practice found to be in place at USP Lewisburg that provided for comprehensive annual exposure assessments that included critical review, assessment, and recommendations.

16. The UNICOR consultant evaluation of 2009 was an improvement over the reports of the 2002 through 2005 period. However, some useful information was lacking, such as the type of PPE used during disassembly and whether hearing protection was in use for the noise exposure. In addition, the consultant did not address all the stated objectives for the evaluation.

5.2 Noise Exposure and Other Hazards

17. NIOSH/DART took a limited number of "spot" sound pressure readings in the warehouse in April 2007 and was of the opinion that noise exposures were below the OSHA 90 dBA PEL and NIOSH 85 dBA criteria. The penitentiary factory was not tested because work was not being conducted at the time. Based on the

limitations of these spot readings and no factory testing, NIOSH recommended further noise evaluations (see Attachment 1).

18. UNICOR did not conduct a noise survey at USP Atwater until March 2009. Results of the March 2009 survey showed noise exposures below the OSHA PEL and action level. The Factory Manager stated that a hearing conservation program is not required based on these results. However, only three "instantaneous" readings were taken in UNICOR "demanufacturing" and "drilling" areas. These limited tests do not represent a complete noise survey.

19. In April 2009, a UNICOR consultant found that inmates performing baling were exposed to noise above the OSHA action level that requires a hearing conservation program. UNICOR at USP Atwater has not implemented a hearing conservation program, as required by 29 CFR 1910.95, Occupational noise exposure.

20. The long period of time from start-up of operations at USP Atwater to the performance of a noise survey showing that a hearing conservation program is required for certain operations is further indication that UNICOR has been deficient in its hazard analysis practices.

21. A heat exposure assessment has not yet been performed at USP Atwater.

22. Although not specifically reviewed at USP Atwater, tasks that are potentially biomechanically taxing were observed by NIOSH at other UNICOR factories. Similar tasks are performed at USP Atwater.

5.3 Health and Safety Programs, Plans, and Practices

23. UNICOR's work instructions, procedures, and cadmium and lead compliance plan for glass breaking and CRT processing contain worker protection practices and requirements to control lead and cadmium hazards, such as PPE, respiratory protection, and cleaning practices, among others. The written documents generally reflect the controls and practices implemented during the work processes; however, aspects of the worker protection requirements are not consistent between the documents and actual work practices. Redundancies also exist. In other cases, the documents do not provide specific information on the type of PPE used. Even though glass breaking is no longer performed at USP Atwater, UNICOR should ensure that safety and health and work control documents reflect actual practice and are consistent with each other in all respects. Redundant documents should be consolidated (also see Conclusion 24).

24. The Cadmium and Lead Compliance Plan dated August 7, 2002 states that lead and cadmium exposures are to be controlled to the "lowest practical levels" and that "at no time should any worker be exposed to any chemical above the OSHA Permissible Exposure Limit (PEL or Action Level)." Cadmium and/or lead

worker exposures associated with glass breaking were found to be above the PELs through February 2004, 18 months after the effective date of this plan. According to the recycling factory Production Controller at that time, this compliance plan was never implemented due to management concerns over increased costs were they to do so. UNICOR was slow to implement necessary engineering and work practice controls as specified in its programs, procedures, and practices to achieve exposure levels at or below the lead and cadmium PELs.

25. In February 2003, correspondence from the Associate Warden stated that "recent progressive engineering control measures implemented were effective in lowering the exposure" to lead and cadmium. Although exposures were lower than in 2002, monitoring results immediately before and after the date of this correspondence showed various cadmium personal exposures and area exhaust levels to above the PEL and/or action level. Exposures were not demonstrated to be consistently below the cadmium PEL until March 2004. This correspondence incorrectly implied effective exposure control practices. [Note: FOH noted the same correspondence issued at another factory.]

26. UNICOR at USP Atwater has a written respiratory protection program and this program is supplemented by practices specified in glass breaking procedures and instructions. However, NIOSH/HETAB found that medical clearance for use of respirators was not performed, even though it was required by UNICOR programs and procedures. This brings into question the effectiveness of implementation of other written respiratory protection practices and requirements.

27. For general activities conducted on the factory floor (i.e., disassembly and materials handling), a written safety and health document to define existing workplace hazards and control measures is not in place for UNICOR recycling conducted specifically at USP Atwater. As a "good practice" approach, such a document should be developed and implemented and would serve to concisely define the safety and health practices and requirements specific to USP Atwater recycling, such as PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping and cleaning practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Non-routine or periodic work activities should also be addressed in the document, particularly those that potentially disturb dusts such as cleaning and handling/disposing of wastes from HEPA vacuums or containers. The document could also specify requirements for periodic site assessments, hazard analyses, inspections, actions for new or changed processes, and regulatory compliance reviews.

28. At USP Atwater, UNICOR had seven documents that addressed glass breaking work instructions, procedures, and plans. Based on the numerous glass breaking documents, including both their redundancies and inconsistencies, UNICOR does not have an effective document control system to prevent document redundancies

and conflicts and to provide review and revision cycles for work instructions and procedures.

29. The frequent and recurring elevated exposures to cadmium and lead from April 2002 thru February 2004 and the slow and ineffective action taken to control these exposures indicate a number of systemic deficiencies in UNICOR operations including: lack of work planning and hazard analysis; failure to retain qualified professionals to design, assist in implementation, and verify adequacy of engineering and work practice controls; lack of information sharing, communication, notification, and lessons learned processes across recycling factories; and lack of a clearly defined stop-work policy which also requires follow-up assessment and corrective action prior to restart.

30. In January 2003, the USP Atwater Safety Manager exercised his stop-work authority for glass breaking because essential LEV system filters were not in place. UNICOR continued glass breaking without the required Safety Manager's re-inspection and written authorization in apparent violation of the BOP stop-work policy in PS 1600.08. According to the Safety Manager, BOP's stop-work policy was repeatedly ignored at other times as well in the 2002-2003 time period.

31. UNICOR has not implemented a hearing conservation program as required by 29 CFR 1910.95, Occupational noise exposure. A recent 2009 consultant evaluation found that this program is required for the baling activity based on exposures. UNICOR has operated without such a program since the start of its operations at USP Atwater in 2002.

32. UNICOR does not have an adequate hazard analysis program in place at USP Atwater and many of its other factories.

5.4 Health and Safety Regulatory Compliance

33. From the start of glass breaking operations in April 2002 through February of 2004, UNICOR was not in compliance with the OSHA lead and cadmium standards. Exposures were consistently above the cadmium and lead PEL in 2002 and frequently above the cadmium PEL through February 2004. Exposures were not reduced below the cadmium PEL through the use of engineering and work practice controls throughout this period, and even with the implementation of respiratory protection (half facepiece APRs in mid to late 2002), exposures were, at times, above the protective capacity of the respirators used in 2002. UNICOR was not in compliance with 29 CFR 1910.1025, Lead; 29 CFR 1910.1027, Cadmium; and 29 CFR 1910.134, Respiratory protection.

34. The LEV system (an engineering control) that is essential to control lead and cadmium exposures was operated for about a week in January 2003 without the filters in place which are essential to remove dust emissions, despite a stop-work order by the USP Atwater Safety Manager. According to memoranda of the Safety Manager, BOP and UNICOR management and staff were aware of this unacceptable condition.

35. Between March 2004 and suspension of glass breaking in March 2005, personal exposures during glass breaking operations were maintained at levels less than the OSHA lead and cadmium PELs as 8-hour TWAs; therefore, USP Atwater operations for glass breaking were in compliance during this period with the aspect of the OSHA lead and cadmium standards regarding control of employee exposure below the PELs.

36. NIOSH/HETAB found that medical clearance for respirator use during glass breaking was not performed as required by the OSHA respiratory protection standard.

37. NIOSH/HETAB found that UNICOR glass breaking operations at USP Atwater were not in compliance with OSHA lead and cadmium standards regarding medical surveillance.

38. Based on available monitoring data, personal exposures to lead and cadmium for general recycling operations on the factory floor, such as disassembly and associated activities (not including glass breaking), have been maintained at levels below the OSHA PELs and action levels. However, exposure monitoring was not performed to verify this between March 2005 and April 2009.

39. NIOSH/DART reported cleaning practices involved use of brooms and brushes. Dry sweeping is explicitly prohibited by OSHA lead and cadmium standards, and was performed despite the OSHA violation issued for dry sweeping to USP Lewisburg in 2007. In 2009, the UNICOR consultant reported the continued use of dry sweeping during disassembly and related activities.

40. The combination of dry sweeping and use of pedestal fans was the cause of the OSHA violation issued to UNICOR at USP Lewisburg in 2007. UNICOR performs dry sweeping and uses fans located at the working level at USP Atwater.

41. UNICOR did not conduct an adequate noise survey until April 2009, even though noise sources are present that have potential for exposure above the OSHA action level. In 2009, the UNICOR consultant found exposure during baling to be above the OSHA action level that triggers the requirement for a hearing conservation program. Past operations such as glass breaking have also been shown to be above the noise action level at other UNICOR factories. The Factory Manager stated that UNICOR does not have a hearing conservation program in place at

USP Atwater. UNICOR has not been in compliance with 29 CFR 1910.95, Occupational noise exposure at USP Atwater.

5.5 Environmental Compliance

42. Experiences at USP Atwater concerning both its GBO and general factory (rooftop) air filters put UNICOR on notice that these filters could be subject to hazardous waste regulations. Contrary to the 2005 memo to all recycling group factory managers requiring that baseline testing of recycling factory ventilation air filters be performed and evaluated in accordance with the varying state hazardous waste regulations, this testing was not done in a prompt or sufficient manner.

43. Despite the Safety Manager's recommendations to better characterize wastes and airborne dust concentrations and temporarily suspend glass breaking operations until corrective measures could be completed, hazardous waste (e.g., air filters) was not properly identified, handled, or disposed at the outset of operations.

44. It is evident that similar environmental issues associated with contaminated air filters should have been addressed at other the UNICOR facilities involved in e-waste recycling operations at the time (e.g., FCI Elkton, FCI Texarkana), and that communication between these organizations was significantly lacking.

6.0 RECOMMENDATIONS

Recommendations concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at USP Atwater are provided below under the following subdivisions:

- Heavy Metals Exposures;
- Noise Exposure and Other Hazards;
- Health and Safety Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

These recommendations relate to the conclusions presented in Section 5.0, above. Some recommendations are taken from supporting documents, including the NIOSH/DART and NIOSH/HETAB reports (Attachments 1 and 3, respectively). See these reports for additional recommendations. Other recommendations are developed by FOH from the body of data and documents reviewed to prepare this report. Various recommendations may apply to all UNICOR recycling factories where similar e-waste recycling activities are performed.

Glass breaking operations were permanently suspended at USP Atwater in March 2005, and glass breaking at other UNICOR factories was suspended in June 2009, pending a status review later in 2009. Therefore, recommendations that apply to glass breaking in this report are only provided for future reference.

As a global recommendation, BOP and UNICOR should ensure that it has and allocates the appropriate level of staff as well as other personnel and material resources in order to effectively implement these recommendations and sustain an effective ES&H program over time.

6.1 Heavy Metals Exposures

1. UNICOR should operate its recycling factories in an integrated fashion. Across its factories, UNICOR should share information such as exposure data, controls, corrective actions, accidents and incidents, regulatory violations, successes, adverse events, lessons learned, and stop-work directives. UNICOR should accompany any directed actions that are required across the factories with commensurate opportunities for sharing information related to their implementation. UNICOR should develop management systems to address this recommendation.

2. BOP and UNICOR should clarify its stop-work policy and lessen the technical threshold for its use (see Section 6.3). In particular, FOH recommends that stop-work authority under BOP and UNICOR policies not be reserved for just "imminent hazards that could reasonably and immediately be expected to cause death or serious physical harm" but relaxed somewhat to allow for an expanded applicability to "emergency situations" as defined in OSHA's respiratory protection standard (29 CFR 1910.134) and other safety and health hazards that, although significant, may fall short of the "imminent hazard" definition. Also, stop-work authority should be expanded to others besides just the Occupational Safety staff members. For example, another federal organization has adopted stop-work policies (see Attachment 4) to ensure that 'all employees are given the responsibility and authority to stop work when employees believe that a situation exists that places them, their coworker(s), contracted personnel, or the public at risk or in danger; could adversely affect the safe operation or cause damage to the facility; or result in a release of chemicals to the environment above regulatory requirements or approvals; and provides a method to resolve the issue…' In general, potential ambiguities in any stop-work policy should be clarified so that terms like 'imminent,' 'danger,' and 'serious physical harm' can be properly and consistently understood in the context of the UNICOR work environment (see Section 6.3).

3. UNICOR should conduct an exposure monitoring program at USP Atwater and other factories even if glass breaking remains suspended. This monitoring will serve to document continued control of the lead and cadmium hazards for disassembly and related activities, as well as glass breaking if resumed. This recommendation, which goes beyond the requirements of the OSHA lead and cadmium standards, would provide important documentation to establish

consistently low exposures and provide benchmarks for continued improvements. Also see Recommendations 1 and 2 of the NIOSH/HETAB report in Attachment 3.

4. UNICOR should ensure that non-routine practices are included as part of its monitoring program. These non-routine practices could include maintenance activities and cleaning performed under an O&M plan, among others.

5. As required by OSHA lead and cadmium standards, UNICOR should promptly conduct exposure monitoring for any future changes that could result in an increased level of exposure, such as changes in work operations, work processes/practices, quantities or types of materials processed, new activities, and non-routine activities. Periodic monitoring should be conducted to evaluate any existing or newly developed engineering controls to make sure that the controls are operating at the design parameters.

6. In addition to personal exposure monitoring, the UNICOR exposure assessment program should continue to evaluate surface contamination levels. UNICOR should establish surface contamination criteria that it intends to use to evaluate results and plan any clean-up or O&M actions.

7. UNICOR should scope the work activities of its exposure assessment consultants to include a critical review and evaluation of work practices and hazard controls. The consultants should evaluate exposure results in the context of its evaluation of such practices and controls and provide recommendations for continued improvements. For example, as consultants provide data and results regarding metal exposures, noise exposures, effectiveness of engineering controls, and surface contamination levels, they should also offer expert interpretation of results with any recommendations for improvements of controls, practices, and systems. [Note: Recent consultant reports for USP Lewisburg could serve as an example of the scope of the consultants' evaluations and content of reports.]

8. Based on a limited number of bulk dust samples collected by NIOSH/DART and FOH from areas in proximity to where CRT glass had been broken in the past (e.g., the warehouse and GBO-associated exhaust systems), UNICOR should further delineate contamination in these former GBO locations and compare results with applicable surface contamination assessment guidelines and criteria. UNICOR should address any contamination found through an O&M plan, clean-up, and/or remediation activities, depending on the results of the evaluation. UNICOR should ensure that the work is performed with the benefit of sound planning, hazard analysis, training, preparation, development and implementation of effective work practices and hazard controls, exposure monitoring, hazardous waste testing and disposal, and clearance sampling. Depending upon the results of the hazard analysis, this work could be performed by a remediation contractor or inmate workers under an O&M plan. If the latter option is chosen, UNICOR

should ensure the preparations described above are in place and that inmate workers are trained and qualified to perform their assigned duties.

9. UNICOR should develop and implement an operations and maintenance (O&M) plan to ensure that surface contamination is minimized and that existing contamination is not released that could result in inhalation or ingestion exposures. Elements of this plan could include:

    - Identification of activities that could disturb contamination (e.g., HVAC maintenance, periodic or non-routine cleaning of elevated or other surfaces, access to areas where significant levels of surface contamination are present, and various building maintenance functions);

    - Processes to identify and control hazards for routine and non-routine activities (e.g., job hazard analysis process prior to conducting certain work activities with identification of mitigating actions);

    - Mitigating techniques and procedures during activities of concern (e.g., dust suppression and/or clean-up and capture, filter removal and bagging processes, and use of PPE and respiratory protection);

    - Training and hazard communication;

    - Disposal of cleanup debris and other contaminated materials based on testing data such as TCLP tests; and

    - Periodic inspection, monitoring and evaluation of existing conditions, as appropriate. Exposure monitoring is particularly recommended for activities that can disturb surface dust. [Note: Follow-up surface sampling is important to ensure that surface contamination does not build up and to take preventive and corrective action, if it does.]

    At UNICOR's discretion, the O&M plan could also include periodic clean-up of surfaces by inmate or other workers; that is, surfaces that are not subject to routine clean-up and housekeeping activities. If this element were adopted, however, UNICOR should ensure that practices to control exposures are included in the plan and implemented, such as appropriate worker training, PPE, respiratory protection, exposure monitoring, clean-up methods (e.g., HEPA vacuuming and wet methods), waste disposal, hygiene practices, and others deemed appropriate by UNICOR. Initial exposure monitoring should be conducted to determine whether exposure during clean-up is above the action levels for lead and cadmium. TCLP testing should also be conducted on waste materials generated to ensure proper disposal. Controls for future clean-up activities should then be based on exposure results. [Note: See FOH report for USP Lewisburg [FOH 2009a] that describes the preparation, hazard analysis, training, controls, work practices, and performance of a clean-up activity conducted for warehouse elevated surfaces. This is a noteworthy practice that could serve as a model for other activities conducted under an O&M plan.]

10. As prohibited by the OSHA lead and cadmium standards and per NIOSH/DART recommendations, UNICOR should discontinue dry sweeping and brushing. NIOSH/DART recommends the use of wet methods and HEPA vacuums. (See NIOSH/DART report in Attachment 1, Recommendation 6.) For larger debris co-located with contaminated dusts, NIOSH/HETAB recommends the use of wet misting and squeegees. Also see Section 6.4 regarding use of dry sweeping and fans.

11. NIOSH/HETAB states that there is no need to perform any further medical surveillance if the GBO remains closed.

6.2 Noise Exposure and Other Hazards

12. UNICOR should implement a hearing conservation program for inmates performing baling operations, based on consultant evaluations that demonstrate this program is required. Baling operations have been shown to have noise exposures at levels that require a hearing conservation program at other UNICOR factories, as well. In addition to USP Atwater, all inmates performing baling operations, particularly metal baling, at all UNICOR factories should enrolled in a hearing conservation program.

13. UNICOR should ensure that USP Atwater has implemented heat exposure assessments and controls as required by the UNICOR heat stress program.

14. UNICOR should also ensure that other hazards are evaluated and controlled such as tasks that are potentially biomechanically taxing (e.g., lifting and repetitive stress).

6.3 Safety and Health Programs, Practices, and Plans

15. For all factories performing glass breaking (if resumed), UNICOR should standardize its work instructions and procedures regarding work practices, hazard controls, and other safety and health practices. The standardized documents could then be tailored, if required, for individual factories where modifications are necessary for any site-specific conditions.

16. For all its factories, UNICOR should revise its work instructions, process descriptions, respiratory protection program and other documentation to ensure consistency in work practice and hazard control content among the documents and to ensure all written documents are consistent with actual work practices and processes.

17. As a “good practice” approach, UNICOR should prepare a concise written safety and health document specifically for its recycling operations at USP Atwater as well as for each of its other recycling factories that lack such a document. Such a document should be developed and implemented to define the safety and health requirements and practices for recycling activities. A written safety and health document would ensure that practices are consistent with written requirements and would benefit verification processes. Additionally, the document should prescribe inspection, verification, assessment, and hazard analysis processes. This document should address both routine and non-routine activities.

18. UNICOR should implement a document control system to clearly delineate the status of existing work instructions, procedures, and safety and health programs/plans and other documents. Such a system should clearly define the status of the document (e.g., operational, expired, superseded, revised, etc.). Review and revision cycles and dates should be established. Redundant and inconsistent work instructions, procedures, and other documents should be corrected, consolidated and avoided through document control.

19. UNICOR should develop and implement a hazard analysis program that includes baseline hazard analysis for current operations and also job (activity-specific) hazard analysis (JHA) for both routine and non-routine activities. UNICOR and USP Atwater should conduct JHAs for any new, modified, or non-routine work activity prior to the work being conducted. It should also conduct hazard analyses of existing processes that have not had such an analysis. The JHA process is intended to identify potential hazards and implement controls for the specific work activity prior to starting the work. For instance, the JHA process should be integral to an effective O&M plan, as described in Section 6.1. (Also see NIOSH/HETAB report, Attachment 3, Recommendation 5.)

20. BOP, UNICOR, and USP Atwater should ensure that staff and consultants conducting ES&H assessments, evaluations, inspections, and monitoring activities are qualified for their assigned tasks and led by certified or highly qualified professionals. One benchmark for vetting individuals performing industrial hygiene services is to ensure certification in the practice of industrial hygiene (CIH) by the American Board of Industrial Hygienists (ABIH). (Also see the NIOSH/HETAB report, Attachment 4, Recommendation 3.)

21. BOP and UNICOR should implement a system to list, track, and document closure of any identified deficiencies or recommendations, regardless of the source. Closure of deficiencies and recommendations with documentation of those accepted and implementation details, along with those not accepted or pending (and why) is important to document improvement actions. This recommendation applies to all UNICOR recycling factories.

22. BOP should modify, clarify, and expand its stop-work policy when unsafe work conditions are identified and prepare implementation guidance to detail the stop-

work and restart process. BOP and UNICOR should clearly communicate this policy to its staff and ensure compliance with the policy. This policy and associated implementing guidance should clearly establish the general conditions under which it is the "responsibility" of authorized personnel to stop work, define stop-work authority, identify personnel/positions with stop-work authority, detail the methods to achieve immediate but safe shutdown of work, describe the process for follow-up analyses and corrective action processes after work is stopped, and describe the verification and authorization processes for work start-up. Stop-work actions should always be communicated to all factories as lessons learned information along with any associated UNICOR-wide directives. BOP and UNICOR should expand authority to stop work to more personnel than just the safety staff. In many work settings, all staff, particularly supervisors, have the responsibility to stop work when conditions are identified that could cause excessive exposure to hazards, injuries, death, or significant risk outside the established safe work parameters. Conditions permitting stop-work authorities to be exercised should be expanded to include any work or condition that is outside of established safe work parameters, which would include work being conducted with a failed or improperly operated engineering control. The means for inmates and other workers to promptly communicate unsafe conditions to appropriate staff should be established in policy and procedures and effectively communicated to all. An example Stop Work policy is provided as Attachment 4.

23. UNICOR should develop other essential management systems for information sharing, lessons learned, and factory-wide directives. BOP and UNICOR should ensure that staff responsibilities for verifying and enforcing hazard controls are established and carried out.

24. See Sections 6.2 and 6.4 regarding requirements for a hearing conservation program.

6.4 Health and Safety Regulatory Compliance

25. UNICOR should discontinue dry brushing and dry sweeping of lead and cadmium contaminated dusts. Use HEPA vacuuming and wet methods instead (see NIOSH/DART Recommendation 6 in Attachment 1). For larger debris, use wet misting and squeegees per NIOSH/HETAB recommendations.

26. UNICOR should evaluate whether the fans used at the working level (height) constitute a similar violation as issued by OSHA to UNICOR at USP Lewisburg. UNICOR should implement alternate methods of ventilation and cooling if these fans have potential to disturb, re-suspend, and redistribute surface contamination or contamination that could be released from equipment being recycled. [Note: OSHA issued a violation for pedestal fan use at USP Lewisburg even though exposures were less than the action levels.]

27. UNICOR should implement a hearing conservation program (see Section 6.2, Noise Exposure and Other Hazards), and enforce use of hearing protection for baling operations.

28. UNICOR should ensure the evaluation of heat exposures and implement hazard controls accordingly.

29. UNICOR should evaluate and appropriately control ergonomic hazards.

30. Also see hazard analysis recommendations in Section 6.3.

6.5 Environmental Compliance

31. UNICOR should ensure proper management of its hazardous wastes (tracking volumes, labeling, characterization, etc.) in light of all applicable regulatory requirements (federal, state and local).

32. UNICOR should share salient lessons learned regarding the environmental aspects of its e-waste operations among all its recycling facilities (e.g., waste characterization testing results, compliance strategies, etc.)

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APPENDIX

Guidance for Evaluating Surface Samples

As part of the OIG investigation, NIOSH/DART, FOH and others have conducted bulk dust and surface wipe sampling at UPS Atwater in areas where e-waste recycling is performed. Samples were analyzed for total lead, cadmium, and other toxic metals. Available criteria and guidance to evaluate surface sample results are discussed below.

Federal standards or other definitive criteria or guidelines have not been developed for acceptable levels of lead or cadmium surface contamination or dust concentrations in industrial areas where activities are performed involving lead and/or cadmium bearing materials. However, several recommendations or guidelines, primarily for lead, provide points of reference to subjectively evaluate the significance of surface contamination. Some guidelines are available and are noted below (see the NIOSH/DART Elkton report for a more detailed discussion of guidelines):

- OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace (i.e., 29 CFR 1926.62) can be summarized and/or interpreted as follows: all surfaces shall be maintained as 'free as practicable' of accumulations of lead; the employer shall provide clean change areas for employees whose airborne exposure to lead is above the PEL; and the employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination. The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of the Department of Housing and Urban Development's (HUD) initially proposed decontamination criteria of 200 $\mu g/ft^2$ for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas. In situations where employees are in direct contact with lead-contaminated surfaces, such as working surfaces or floors in change rooms, storage facilities, and lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level.

- For other surfaces (e.g., work surfaces in areas where lead-containing materials are actively processed), OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of lead contamination meets the definition of "practicable." Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of lead dust does not become a source of employee lead exposures.

OSHA [29 CFR, Part 1910.1025] has stated that any method that achieves this end is acceptable.

- Lange [2001] proposed a clearance level of 1,000 $\mu g/ft^2$ for floors of non-lead free commercial buildings and 1,100 $\mu g/ft^2$ for lead-free buildings. These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions.

- HUD [24 CFR 35] has established clearance levels for lead on surfaces after lead abatement. These levels range from 40 to 800 $\mu g/ft^2$, depending on the type of surface. The level of 200 $\mu g/ft^2$ is most commonly used. These levels, however, apply to occupied living areas where children reside, and are not intended for industrial operations.

- Regarding lead in bulk dust or soil samples, the U.S. EPA [EPA n.d.] has proposed standards for residential soil-lead levels. The level of concern requiring some degree of risk reduction is 400 ppm (mg/kg), and the level requiring permanent abatement is 2,000 ppm (mg/kg). Again these levels are residential criteria, rather than for industrial settings.

- There is no quantitative guidance for surface cadmium concentrations. OSHA [40 CFR 745.65]states that surfaces shall be as free as practicable of accumulations of cadmium, all spills and sudden releases of cadmium material shall be cleaned as soon as possible, and that surfaces contaminated with cadmium shall be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne.

ATTACHMENT 1

WALK-THROUGH SURVEY REPORT:
ELECTRONIC RECYCLING OPERATION

At

UNITED STATES PENETENTIARY
ATWATER, CALIFORNIA

PRINCIPAL AUTHOR:
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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Division of Applied Research and Technology
4676 Columbia Parkway
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SITES SURVEYED: UNICOR Recycling Operations
Federal Penitentiary
Atwater, CA

NAICS: 562920

SURVEY DATE: April 24 - 25, 2007

SURVEY CONDUCTED BY: Edward Burroughs, PhD, CIH. CSP (NIOSH)
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"The findings and conclusions in this report have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy."

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Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention.

The findings and conclusions in this report do not necessarily reflect the views of the National Institute for Occupational Safety and Health.

INTRODUCTION

On April 24 - 25, 2007 a researcher from the National Institute for Occupational Safety and Health (NIOSH) and a representative from Federal Occupational Health (FOH), accompanied by representatives from Federal Prison Industries (aka, UNICOR) conducted a walk-through evaluation of exposures to metals and other occupational hazards associated with the recycling of electronic components at the UNICOR facility in the United States Penitentiary (USP) complex, Atwater, CA. The principal objectives of this study were:

a. To observe potential exposures to metals including barium (Ba), beryllium (Be), cadmium (Cd), lead (Pb) and nickel (Ni).

b. To evaluate contamination of surfaces in the work areas that could create dermal exposures or allow re-entrainment of metals into the air.

c. To identify and describe the control technology and work practices used in operations associated with occupational exposures to toxic substances, and to determine additional controls, work practices, substitute materials, or technology that can further reduce these exposures.

d. To evaluate the use of personal protective equipment in operations involved in the recycling of electronic components.

PROCESS DESCRIPTION

The recycling of electronic components at USP Atwater is done in two separate buildings: 1) the main factory located within the penitentiary; and 2) the warehouse located approximately a quarter mile away on the same property. Diagrams of these work areas are shown in Figures I and II, respectively. These figures provide a general visual description of the layout of the work process, although workers often moved throughout their respective areas in the performance of their tasks. The population of the UNICOR facility was approximately 68 workers in the Penitentiary factory with an additional 28 in the camp warehouse.

The recycling of electronic components at this facility can be organized into three production processes: a) receiving and sorting, b) disassembly, and c) packaging and shipping. Incoming materials to be recycled are received at a warehouse where they are examined and sorted. During this evaluation it appeared that the bulk of the materials received were computers, either desktop or notebooks, or related devices such as printers. Some items, notably notebook computers, could be upgraded and resold, and these items were sorted out for that task.

After electronic memory devices (e.g., hard drives, discs, etc.) were removed and degaussed or destroyed, computers' central processing units (CPUs), servers and similar devices were sent for disassembly; monitors and other devices (e.g., televisions) that contain cathode ray tubes (CRTs) were separated and sent for disassembly and removal of the CRT. Printers, copy machines and any device that could potentially contain toner, ink, or other expendables were segregated and those expendables were removed prior to the device being sent to the disassembly area.

In the disassembly process external cabinets, usually plastic, were removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing were removed and sorted by grade for further treatment if necessary. Components such as circuit boards or chips that may have value or may contain precious metals such as gold or silver were removed and sorted. With few exceptions each of the workers in the main factory will perform all tasks associated with the disassembly of a piece of equipment into the mentioned components with the use of powered and un-powered hand tools (primarily screwdrivers and wrenches), with a few workers collecting the various parts and placing them into the proper collection bin. Work tasks included removing screws and other fasteners from cabinets, unplugging or clipping electrical cables, removing circuit boards, and using whatever other methods necessary to break these devices into their component parts. Essentially all components currently are sold for some type of recycling.

The final process, packing and shipping, returned the various materials segregated during the disassembly process to the warehouse to be sent to contracted purchasers of those individual materials. To facilitate shipment some bulky components such as plastic cabinets or metal frames were placed in a hydraulic bailer to be compacted for easier shipping. Other materials were boxed or containerized and removed for subsequent sale to a recycling operation.

A fourth production process, the glass breaking operation (GBO) where CRTs from computer monitors and TVs were sent for processing, was not currently being done at Atwater. Glass breaking had been done there in the past, and areas where this had occurred were observed, but according to sources within the Bureau of Prisons plans do not call for the resumption of glass breaking at this facility. CRTs are shipped, unbroken, from Atwater to other locations for breaking and recycling. This process was observed and evaluated at other UNICOR facilities as part of this research and those reports are available.

POTENTIAL HAZARDS

Computers and their components contain a number of hazardous substances. Among these are "platinum in circuit boards, copper in transformers, nickel and cobalt in disk drives, barium and cadmium coatings on computer glass, and lead solder on circuit boards and video screens" [Chepesiuk 1999]. The Environmental Protection Agency (EPA) notes that "In addition to lead, electronics can contain chromium, cadmium, mercury, beryllium, nickel, zinc, and brominated flame retardants" [EPA 2008]. Schmidt [2002] linked these and other substances to their use and location in the "typical" computer: Pb used to join metals (solder) and for radiation protection, is present in the cathode ray tube (CRT) and printed wiring board (PWB). Aluminum, used in structural components and for its conductivity, is present in the housing, CRT, PWB, and connectors. Gallium is used in semiconductors; it is present in the PWB. Ni is used in structural components and for its magnetivity; it is found in steel housing, CRT and PWB. Vanadium functions as a red-phosphor emitter; it is used in the CRT. Be, used for its thermal conductivity, is found in the PWB and in connectors. Chromium, which has decorative and hardening properties, may be a component of steel used in the housing. Cd, used in Ni-Cad batteries and as a blue-green phosphor emitter, may be found in the housing, PWB and CRT. Cui and Forssberg [2003] note that Cd is present in components like SMD chip resistors, semiconductors, and infrared detectors. Mercury may be present in batteries and switches, thermostats, sensors and relays [Schmidt 2002, Cui and Forssberg 2003], found in the housing and PWB. Arsenic, which is used in doping agents in transistors, may be found in the PWB [Schmidt 2002].

EVALUATION TECHNIQUES

Observations regarding work practices and use of personal protective equipment were recorded. Information was obtained from conversations with the workers and management to confirm this was a typical workday to help place conclusions in proper perspective.

Bulk material samples were collected by gathering a few grams of settled dust or material of interest and transferring this to a glass bottle for storage and shipment. These samples were analyzed for metals using NIOSH Method 7300 [NIOSH 1994] modified for bulk digestion.

Surface wipe samples were collected using Ghost™ Wipes for metals (Environmental Express, Mt. Pleasant, SC) to evaluate surface contamination. These wipe samples were collected in accordance with ASTM Method D 6966-03 [ASTM 2002], with a disposable paper template with a 12 inch by 12 inch square opening. The templates were held in place by hand or taped in place to prevent movement during sampling. Wipes were placed in sealable test tube containers for storage and then sent to the laboratory to be analyzed for metals according to NIOSH Method 7303 [NIOSH 1994].

An assessment of noise levels in various locations was made in the warehouse using a hand held sound level meter (Model 2400, Quest Technologies, Oconomowoc, WI) calibrated on-site prior to use with a 110 dB source. No noise measurements were made in the penitentiary since the evaluation team was not on the floor during operations.

MEASUREMENTS AND OBSERVATIONS

The measurements and observations described here were made in April, 2007 at the UNICOR recycling operation at USP Atwater. During this visit, surface wipe and bulk dust samples were collected in locations where the electronics recycling operations were taking place or had taken place in the past. The primary purpose of this evaluation was to estimate the potential for exposures of inmates and staff to toxic substances encountered during the recycling of electronic components. Results of surface wipe samples are presented in Table 1, and bulk material sample results are shown in Table 2 for the metals of primary interest. Observations are presented below.

Four of the 26 surfaces tested for Pb indicated levels exceeding the OSHA recommended 200 μg/sq ft [Fairfax 2003]. The highest measurement (850 μg/sq ft, sample # APMWW-16) made on a surface inside the exhaust hood that had formerly been used to ventilate the GBO before that procedure was discontinued. The other Pb measurements above 200 μg/sq ft were wood table tops (2) and the top of an electrical power box, samples APMWW-11, 13 and 2, all from the penitentiary. Additionally, the 200 μg/sq ft recommendation applies to clean areas such as lunch areas, changes, and storage areas, rather than work areas where lead containing materials are actively processed.

One of the Cd surface measurements (APMWW-13) was 330 μg/sq ft., 11 measurements were between 10 and 90, with the remaining 14 below 10 μg/sq ft. Although there are no published criteria for use in evaluating wipe samples, the OSHA Cd standard [29 CFR 1910.1027] mandates that "All surfaces shall be maintained as free as practicable of accumulations of cadmium," that, "all spills and sudden releases of material containing cadmium shall be cleaned up as soon as possible," and that, "surfaces contaminated with cadmium shall, wherever possible, be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne."

Ni surface contamination also reached a high of 330 µg/sq ft. in sample AWMTW-2, with seven measurements ranging from 100 to 200, and the remaining 18 were below 100 µg/sq ft. Like Cd, there are no published criteria for use in evaluating wipe samples for Ni. While the toxicity of this metal is somewhat dependent on species, no compound identification was conducted.

Wipe samples did not indicate levels of Ba on work surfaces at levels of concern, with the highest Ba concentration (AWMTW-1) at 450 µg/sq ft. All other Ba measurements were 200 µg/sq ft or below. There are no published criteria for use in evaluating wipe samples for Ba.

No Be was detected in samples from either the Atwater penitentiary or the warehouse above the limit of detection of 0.03 µg/sq ft.

Of the seven bulk samples collected, the three with the most Pb, Cd and Ni were from the penitentiary, suggesting that the dust in the warehouse in general has a lower level of toxic metals. The reason for this may be that the warehouse is a more open building with a greater chance for ambient dust to enter and dilute the metal levels.

Operations at USP Atwater (penitentiary and warehouse) were similar to procedures observed at other UNICOR recycling facilities where exposures have been evaluated and at which there were few significant exposures in the receiving and sorting, disassembly, and packaging and shipping processes.

No local exhaust ventilation systems were in use in either the penitentiary or warehouse location nor were any needed since the GBO was not being done. Work areas were kept reasonably clean, primarily by the use of brooms and brushes, and while these procedures are good for removal of large particles they are also a potential source of airborne dust, so the use of HEPA vacuums and wet mopping are better techniques to clean dust contamination from surfaces. Care must be taken when using wet methods to assure no electrical or other safety hazard is introduced.

Safety glasses were used in most operations. Hearing protection was available where needed (primarily near the bailer) and disposable respirators were available to workers who chose to use them although respirators were not required at this facility.

Spot measurements of noise made in the warehouse with a hand-held sound pressure meter suggested there was no need for a more comprehensive noise study there. Occasional transient measurements up to 90 dBA were made, but most measurements in the warehouse area were well below this level. Based on this data, investigators believe occupational noise exposures in the warehouse were below both the OSHA 90 dBA and the NIOSH 85 dBA criteria [29 CFR 1910.95, NIOSH 1998]. Noise levels were not measured in the USP factory area since work was not being conducted, but based on measurements made in similar facilities it is recommended that this area be evaluated for noise exposures.

Maximum ambient outdoor temperatures for the two days of this study were 72 and 79 ^{o}F, with corresponding relative humidity of 35% and 24%. Indoor temperatures in the work areas were not measured but were not considered greatly different than outdoor temperatures.

CONCLUSIONS AND RECOMMENDATIONS

Based on measurements and observations presented, the following recommendations are made.

1. Training of workers should be scheduled and documented in the use of techniques for dust suppression, personal protection equipment (e.g., coveralls, respirators, gloves) and hazard communication. Additional training, recordkeeping and other restrictions apply if a formal respiratory protection program is implemented.
2. Frequently while conducting the on-site work, NIOSH researchers observed tasks (such as lifting and using screwdrivers) being conducted in an awkward manner which could produce repetitive stress injuries. Tasks should be evaluated to determine if they are biomechanically taxing and if modifications in procedures or equipment would provide benefit to this workplace.
3. Ambient temperature measurements and climate history did not indicate the need for concern regarding heat stress during the moderate seasons. However, during the summer the need for an evaluation of heat stress should be considered.
4. A program should be established within the Bureau of Prisons to assure that all UNICOR operations, including but not limited to recycling, should be evaluated from the perspective of health, safety and the environment in the near future. This program should be overseen by competent, trained and certified individuals.
5. Due to the levels of surface contamination of lead measured in the recycling facility, workers should wash their hands before eating, drinking, or smoking.
6. Daily and weekly cleaning of work areas by HEPA-vacuuming and wet mopping should be conducted, taking care to assure no electrical or other safety hazard is introduced.
7. Noise levels in the USP recycling factory should be measured during normal operations to evaluate the potential for occupational exposures in this area.

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Table 1.

ATWATER WIPE SAMPLES*

Diagram Location**	Sample ID	Building	Description	Ba µg/ft^2	Be µg/ft^2	Cd µg/ft^2	Pb µg/ft^2	Ni µg/ft^2
A	AWMTW1	Warehouse	Work surface on west table in disassembly area.	450	<0.03	8	61	150
B AW	MTW2	Warehouse	Work surface on second table in disassembly area. 33		<0.03	4	62	330
C	AWMTW3	Warehouse	Work surface on third table in disassembly area.	27	<0.03	22	48	43
D AW	MTW4	Warehouse	Work surface on fourth table in disassembly area. 34		<0.03	7	77	63
E	AWMTW5	Warehouse	Work surface on fifth table in disassembly area.	37	<0.03	6	56	56
F	AWMTW6	Warehouse	Table top in testing area	35	<0.03	1	9.4	40
G	AWMTW7	Warehouse	Table Top in E-bay test area	9	<0.03	1	5.3	6
H AW	MTW8	Warehouse	Table top in monitor testing area	17	<0.03	1	12	4
I	AWMTW9	Warehouse	Side of plastic bailer near metal bailer	17	<0.03	3	18	19
J	APMWW1	Penitentiary	Metal work surface	5	<0.03	3	51	18
K APM	WW2	Penitentiary	Wood table top	140	<0.03	13	240	130
L	APMWW3	Penitentiary	Metal work surface	100	<0.03	2	64	9
M APM	WW4	Penitentiary	Wood table top	30	<0.03	9	100	46
N	APMWW5	Penitentiary	Metal work surface	3	<0.03	0.4	5.9	5
O	APMWW6	Penitentiary	Metal work surface	130	<0.03	19	120	160
P	APMWW7	Penitentiary	Metal work surface	110	<0.03	39	180	140
Q	APMWW8	Penitentiary	Metal work surface	16	<0.03	6	59	16

R APM	WW9	Penitentiary	Wood table top	21	<0.03	5	34	33
S	APMWW10	Penitentiary	Metal work surface	96	<0.03	23	150	160
T APM	WW11	Penitentiary	Wood table top	150	<0.03	21	420	130
U	APMWW12	Penitentiary	Top of change room	83	<0.03	74	160	92
V	APMWW13	Penitentiary	Top of power box BIEHP1 in mechanical room	160	<0.03	330	350	160
W APM	WW14	Penitentiary	Top of cabinet in food area	67	<0.03	16	67	46
X APM	WW15	Penitentiary	Inside locker in change room	26	<0.03	16	48	26
Y	APMWW16	Penitentiary	Work surface inside hood in last GBO area	200	<0.03	84	850	52
Z	APMWW17	Penitentiary	Left side of ventilation system, last GBO	110	<0.03	51	180	67

* WIPE SAMPLES: (All wipe samples were 1 sq ft area)
** Location identifiers correlate with Figures I and II.

Table 2.

ATWATER BULK SAMPLES

Diagram Location*	Sample ID	Building	Description	Ba µg/g	Be µg/g	Cd µg/g	Pb µg/g	Ni µg/g
1	AWMTB1	Warehouse	From Near Disassembly Tables	390	<0.2	11	150	68
2	AWMTB2	Warehouse	From Near Disassembly Tables	400	<0.2	16	430	430
3	AWMTB3	Warehouse	From Near Disassembly Tables	160	<0.2	110	190	110
4	APMWB1	Penitentiary	Floor Sweepings, cage 1	2000	<0.2	230	9100	2600
5	APMWB2	Penitentiary	Floor Sweepings, cage 2	490	<0.2	110	1100	7600
6 APM	W B10	Penitentiary	Dust from around Elec Conduit on wall near food area.	250	<0.2	3	9	10
7 APM	W B11	Penitentiary	From top of exhaust system in last GBO 1400		<0.2	810	1500	740

* Location identifiers correlate with Figures I and II.

Figure I USP Atwater UNICOR Factory Floor Plan Showing Sample Locations

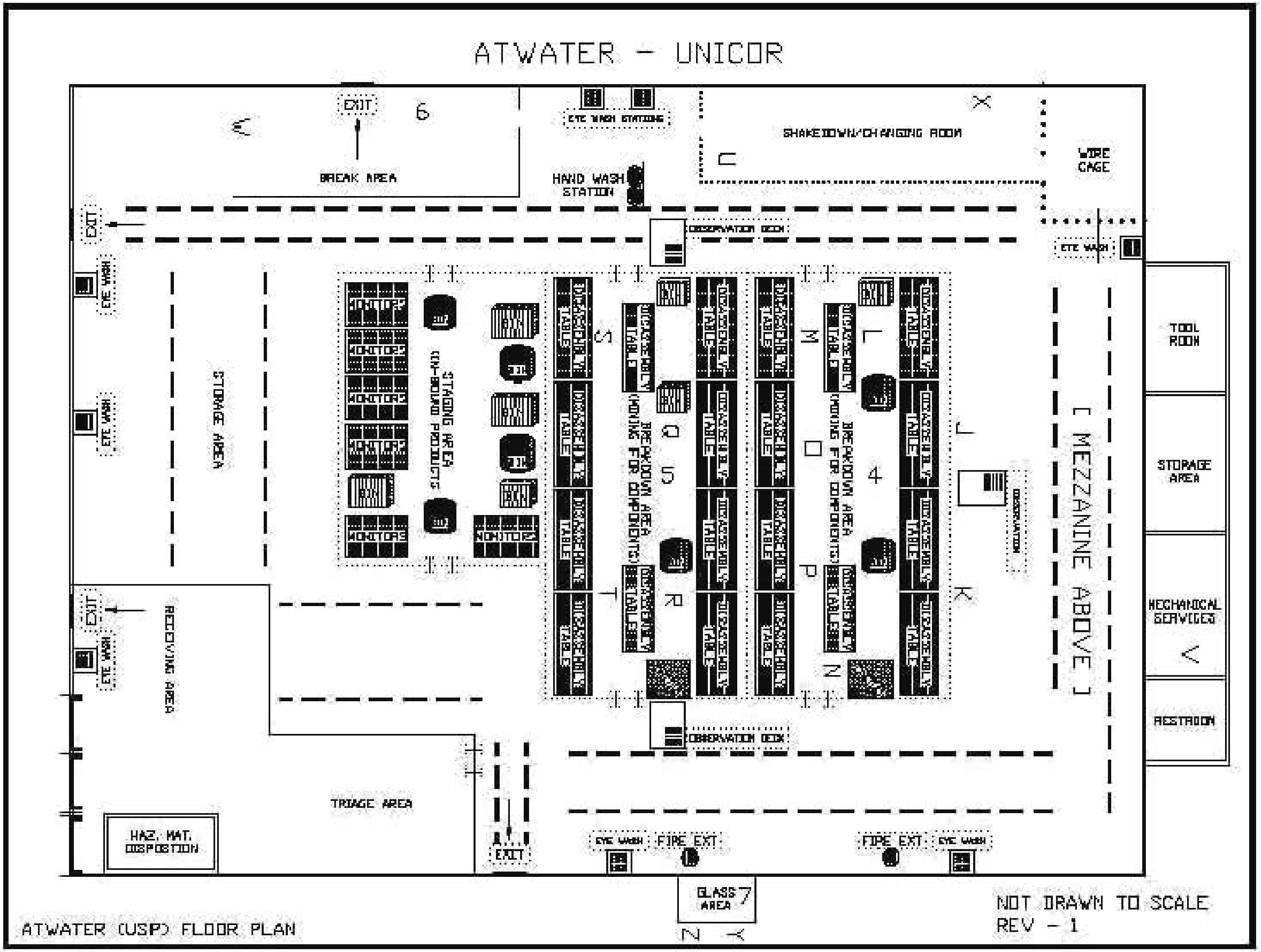
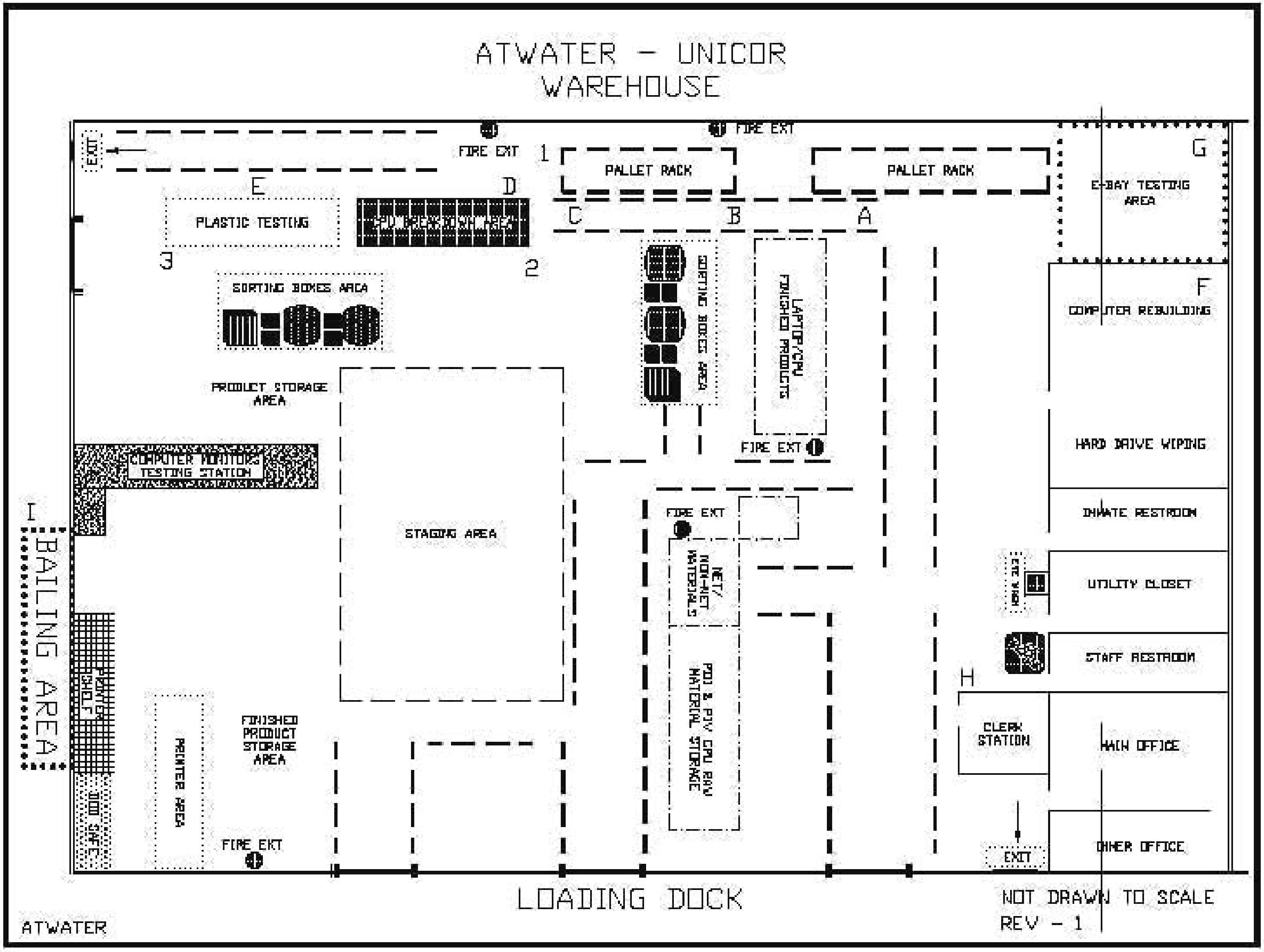


Figure II Atwater UNICOR Warehouse Floor Plan Showing Sample Locations



ATTACHMENTS 2a, 2b, and 2c

Attachment 2a

ATWATER WIPE SAMPLES*

Diagram Location**	Sample ID	Building	Description	Ba µg/ft^2	Be µg/ft^2	Cd µg/ft^2	Pb µg/ft^2	Ni µg/ft^2
A	AWMTW1	Warehouse	Work surface on west table in disassembly area.	450	<0.03	8	61	150
B	AWMTW2	Warehouse	Work surface on second table in disassembly area.	33	<0.03	4	62	330
C	AWMTW3	Warehouse	Work surface on third table in disassembly area.	27	<0.03	22	48	43
D	AWMTW4	Warehouse	Work surface on fourth table in disassembly area.	34	<0.03	7	77	63
E	AWMTW5	Warehouse	Work surface on fifth table in disassembly area.	37	<0.03	6	56	56
F	AWMTW6	Warehouse	Table top in testing area	35	<0.03	1	9.4	40
G	AWMTW7	Warehouse	Table Top in E-bay test area	9	<0.03	1	5.3	6
H	AWMTW8	Warehouse	Table top in monitor testing area	17	<0.03	1	12	4
I	AWMTW9	Warehouse	Side of plastic baler near metal baler	17	<0.03	3	18	19
J	APMWW1	Penitentiary	Metal work surface	5	<0.03	3	51	18
K	APMWW2	Penitentiary	Wood table top	140	<0.03	13	240	130
L	APMWW3	Penitentiary	Metal work surface	100	<0.03	2	64	9
M	APMWW4	Penitentiary	Wood table top	30	<0.03	9	100	46
N	APMWW5	Penitentiary	Metal work surface	3	<0.03	0.4	5.9	5
O	APMWW6	Penitentiary	Metal work surface	130	<0.03	19	120	160
P	APMWW7	Penitentiary	Metal work surface	110	<0.03	39	180	140
Q	APMWW8	Penitentiary	Metal work surface	16	<0.03	6	59	16
R	APMWW9	Penitentiary	Wood table top	21	<0.03	5	34	33
S	APMWW10	Penitentiary	Metal work surface	96	<0.03	23	150	160
T	APMWW11	Penitentiary	Wood table top	150	<0.03	21	420	130
U	APMWW12	Penitentiary	Top of change room	83	<0.03	74	160	92
V	APMWW13	Penitentiary	Top of power box BIEHP1 in mechanical room	160	<0.03	330	350	160
W	APMWW14	Penitentiary	Top of cabinet in food area	67	<0.03	16	67	46
X	APMWW15	Penitentiary	Inside locker in change room	26	<0.03	16	48	26
Y	APMWW16	Penitentiary	Work surface inside hood in last GBO area	200	<0.03	84	850	52
Z	APMWW17	Penitentiary	Left side of ventilation system, last GBO	110	<0.03	51	180	67

* WIPE SAMPLES: (All wipe samples were from 1 sq. ft. area)
** Location identifiers correlate with Figures 1 and 2.

Attachment 2b

ATWATER BULK SAMPLES

Diagram Location*	Sample ID	Building	Description	Ba µg/g	Be µg/g	Cd µg/g	Pb µg/g	Ni µg/g
1	AWMTB1	Warehouse	From near disassembly tables	390	<0.2	11	150	68
2	AWMTB2	Warehouse	From near disassembly tables	400	<0.2	16	430	430
3	AWMTB3	Warehouse	From near disassembly tables	160	<0.2	110	190	110
4	APMWB1	Penitentiary	Floor sweepings, cage 1	2000	<0.2	230	9100	2600
5	APMWB2	Penitentiary	Floor sweepings, cage 2	490	<0.2	110	1100	7600
6	APMWB10	Penitentiary	Dust from around electric conduit on wall near food area.	250	<0.2	3	9	10
7	APMWB11	Penitentiary	From top of exhaust system in last GBO	1400	<0.2	810	1500	740

*Location identifiers correlate with Figures 1 and 2.

Attachment 2c

ATWATER BULK SAMPLES FROM ELEVATED SURFACES

Collected 4/25/2007

Sample ID	Building	Description	Pb (mg/kg)	Cd (mg/kg)
APMWB3	Penitentiary	From top of vent duct and other high horizontal surfaces	500	180
APMWB4	Penitentiary	From top of vent duct and other high horizontal surfaces	52	15
APMWB5	Penitentiary	From top of vent duct and other high horizontal surfaces	580	250
APMWB6	Penitentiary	From top of vent duct and other high horizontal surfaces	110	25
APMWB7	Penitentiary	From top of vent duct and other high horizontal surfaces	170	82
APMWB8	Penitentiary	From top of vent duct and other high horizontal surfaces	44	13
APMWB9	Penitentiary	From top of vent duct and other high horizontal surfaces	44	12

ATTACHMENT 3

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

National Institute for Occupational Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998

June 25, 2009

HETA 2008-0055

[redacted]

Investigative Counsel

Oversight and Review Division

Office of the Inspector General

United States Department of Justice, Suite 13100

Washington D.C. 20530

Dear [redacted]:

On November 27, 2007, the National Institute for Occupational Safety and Health (NIOSH) received your request for technical assistance in your health and safety investigation of the Federal Prison Industries (UNICOR) electronics recycling program at Federal Bureau of Prisons (BOP) institutions in Elkton, Ohio; Texarkana, Texas; and Atwater, California. You asked us to assist the United States Department of Justice, Office of the Inspector General (USDOJ, OIG) in assessing the existing medical surveillance program for inmates and staff exposed to lead and cadmium during electronics recycling, and to make recommendations for future surveillance. In addition, you asked us to assess past exposures to lead and cadmium, and to investigate the potential for "take home" exposure. You later asked us to perform a similar evaluation for the BOP institution in Marianna, Florida. We conducted a site visit at the Atwater BOP institution on October 15, 2008. This interim letter summarizes our findings and provides recommendations to improve the safety and health of the inmates and staff at the United States Penitentiary (USP) in Atwater, California. These findings will be included in a final report that will summarize the evaluations at all four institutions we evaluated.

Inmates were exposed to cadmium and lead above occupational exposure limits during the glass breaking operation (GBO) from 2002-2003. It appears that inmates worked without adequate respiratory protection from April 2002 until July 2002. Exposures seem to have been better controlled with the relocation of the GBO to the spray booth, however, one sample taken after the relocation demonstrated significant cadmium exposure.

Background

The USP in Atwater, California, is a high security facility housing adult male offenders. The institution also includes a minimum security satellite camp. Information provided to us indicates that the UNICOR computer recycling program began at USP Atwater in April 2002. In May 2002, a "3-stage powder booth" was installed for the GBO. Glass breaking continued for 2 months before being suspended pending the results of biological testing for lead, cadmium, and barium. It appears that respirator fit testing was conducted at about the time when glass breaking resumed in mid to late July 2002. An environmental consultant to UNICOR developed a written cadmium and lead compliance plan in August 2002, after air sampling indicated that airborne lead and cadmium concentrations exceeded Occupational Safety and Health Administration

(OSHA) permissible exposure limits (PELs). Glass breaking continued, and in December 2002, UNICOR installed what they termed a "ventilation system that exceeded OSHA standards." In June 2003, the GBO was relocated to take advantage of an existing spray booth on a loading dock. With the exception of several periods when glass breaking was reportedly suspended, glass breaking continued until March 2005 when all glass breaking operations ceased. Throughout this period, UNICOR provided biological monitoring, air sampling, and respirator fit-testing.

Assessment

We reviewed the following documents:

- Results of biological monitoring performed between 2002 and 2008 (provided by your office, the USP clinic, and the factory manager).
- Medical records from seven staff members (provided by your office).
- Work instructions for the GBO and maintenance.
- Rosters for inmates working in the GBO (provided by the factory manager).
- DOJ interviews with staff and inmates.
- Results of industrial hygiene sampling performed by a consultant to UNICOR.

During the site visit on October 15, 2008, we held an opening conference with USP and UNICOR management, American Federation of Government Employees (AFGE) representatives, and the UNICOR factory manager. After the conference we toured the former recycling location in the USP. We met with two inmates individually who had worked in the GBO from its inception to do medical interviews. We spoke to the laundry manager who was concerned about exposures to his staff. We ended the site visit with a closing conference where we presented our initial findings and recommendations.

Results and Discussion[1]

Medical surveillance

Inmates

Biological monitoring is performed by the USP clinic and consists of blood lead levels (BLLs), blood cadmium (CdB), urine cadmium (CdU), urine beta-2-microglobulin (B-2-M), and serum barium. Not all tests were done for each inmate. The test results are reviewed by a physician. Paper copies of test results are maintained in the inmate's personal medical record but not with UNICOR management. No physical examinations are performed and inmates did not receive medical clearance to wear a respirator. Each inmate's medical records are transferred with them; no medical records are retained at Atwater after an inmate is transferred or released. The timeline provided states that blood testing for inmates working in the GBO began in July 2002; however, a handwritten list of test results done in July 2002 had prior test results noted in parentheses. The Health Services Administrator from that time frame reported that tests noted in parentheses were from March 2002 for inmates in the GBO. There was also a typed list of seven inmates' CdB and CdU results dated March 31, 2003. No units of measurement were given on this list, but reference ranges for CdB were given in micrograms per liter (µg/L). The remainder of the biological monitoring results reviewed was provided on the actual laboratory reports. The results of the available inmate biological monitoring are summarized in the following sections.

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[1] See *Occupational exposure limits and health effects* in Appendix.

Preplacement test results from March 2002 were available for 10 inmates who performed glass breaking. All had BLLs, CdB, and serum barium testing. The BLL was below the limit of detection (LOD) of 2 micrograms per deciliter of whole blood (µg/dL) for six inmates, 2 µg/dL for two inmates, and 3 µg/dL for two inmates. CdB was below the LOD of 0.5 µg/L for the one inmate documented to be a nonsmoker. The mean CdB for the remaining inmates was 1.4 µg/L (range: 0.7-2.3 µg/L). Three inmates noted to be smokers had CdBs of 1.7, 2.0, and 2.3 µg/L. Smoking is known to increase CdB levels, sometimes drastically. The mean CdB for the six remaining inmates, for whom smoking status was unknown, was 1.0 µg/L (range: 0.6-2.1 µg/L). No CdU testing was documented. The mean serum barium level was 76.4 µg/L (range: 59-116 µg/L). The reference range provided by the laboratory for serum barium was 0-400 µg/L.

Results were available for 18 inmates who had biological monitoring performed in early July 2002, prior to respirator use but about a week after the temporary shutdown of the GBO. The 10 inmates tested in March 2002 were retested along with eight other inmates who were tested for the first time. The BLLs of the 10 inmates previously tested increased, with all BLLS being above the LOD in July 2002. The mean BLL for these 10 inmates was 4.6 µg/dL (range: 2-9 µg/dL). In contrast, CdBs decreased. The nonsmoking inmate with a nondetectable CdB in March 2002 remained below the LOD. Three others dropped below the LOD of 0.5 µg/L, as well. The remainder had a mean CdB of 1.3 µg/L (range: 0.6-1.8 µg/L). No CdU testing was documented, and mean serum barium was 105.5 µg/L (range: 78-150 µg/L). These test results are the best indication of inmate exposure during the time frame when glass breaking was occurring without controls or respiratory protection. The slightly increased BLLs indicate exposure to lead, however, the decreased CdB results likely represent an inability to leave the work area to smoke.

The eight inmates tested for the first time in July 2002 had a mean BLL of 3.8 µg/dL (range: 2-8 µg/dL). CdB results were below the LOD for four inmates; one nonsmoker, one smoker, and two whose smoking status was unknown. The mean for the other four was 1.4 µg/L (range: 0.7-2.2 µg/L). Two were smokers, one was a nonsmoker, and the status of the other is unknown. No CdU testing was documented, and mean serum barium was 103.1 µg/L (range: 66-240 µg/L). The value of 240 was an outlier, with the next highest value being 96 µg/L.

Ten inmates were tested between one and four times each between March 2003 and November 2004. Thirteen BLLs were available. Four BLLs were below the LOD of 2 µg/dL. The mean of the other nine BLLs was 3.6 µg/dL (range 2-6 µg/dL). Seventeen CdB were available. Three were below the LOD of of 0.5 µg/L. The mean of the remaining 14 CdB was 1.8 µg/L (range 0.6-4.0 µg/L). Seven inmates known to be smokers had a mean CdB of 1.8 µg/L (range: 0.9-4.0 µg/L). Four inmates were documented nonsmokers: two had CdB below the LOD and two had CdB of 0.6 µg/L. Smoking status of the remaining six inmates was not known. Fourteen CdU test results were available. Five were noted to be "negative" and three were below the LOD of 1.0 µg/L. Three CdU concentrations were quantified at 0.6, 1.2, and 1.3 micrograms per gram of creatinine (µg/g/Cr). Another three were noted to be 1.2, 1.8, and 2.8 but no units of measurement were provided. There were 11 serum barium levels, with a mean concentration of 122.2 µg/L (range: 47-385 µg/L). There were three urinary B-2-Ms, all of which were normal, and no zinc protoporphyrins (ZPP).

UNICOR Staff

Records were reviewed from seven staff members who filed workers' compensation claims for exposures from recycling. These seven were seen by an occupational medicine physician and a toxicologist. Two reported no symptoms; five reported cough productive of brown sputum and brown nasal discharge. They had biological monitoring for lead and cadmium; chest x-rays; spirometry; complete blood counts; blood chemistries; blood beryllium, barium, cobalt, arsenic, mercury, and zinc; erythrocyte sedimentation rate; sputum culture and sensitivity; prothrombin time and partial prothrombin time; and electrocardiograms and a variety of other tests performed. Test results were available for eight staff members (the safety manager was also tested during this time frame), each of whom was tested one to four times between February 2003 and December 2004. Ten BLLs were available. Two were above the LOD, both in the same individual, and measured 3.5 and 5 µg/dL. The LOD varied, and was either 2, 3 or 5 µg/dL. Twelve CdB were available, and six were below the LOD of 0.5 µg/L. The remainder ranged from 0.5-0.9 µg/L. The highest was in a smoker. Nine CdU results were available, and six were below the LOD of 0.5 µg/L. Two were 0.1-0.3 µg/g/Cr, and one was 0.7 µg/L. There were five ZPP results and seven B-2-M results; all were within the normal range. There were seven serum beryllium test results and all were below the LOD. Eight serum barium levels were available. The mean concentration was 43.4 µg/L (range: 3.1-86 µg/L). In addition, blood arsenic, mercury, cobalt, and zinc levels were done. These tests are not based upon occupational exposures, but were noted to be normal. The remainder of the tests was unremarkable and did not suggest an occupational hazard. The toxicologist determined that none of the individuals evaluated had any occupational medical problems.

Results of medical surveillance that 10 UNICOR staff received from private physicians between 2007 and 2008 were available. There were eight BLLs, all below the LOD, and nine CdBs, eight of which were below the LOD and one that was 0.8 µg/L. There were nine CdU results; six were below the LOD of 0.5 µg/L and the other three ranged from 0.3-0.4 µg/L. Eight B-2-M results were within the normal range. The mean of nine serum barium levels was 30.9 µg/L (range: 17-47 µg/L).

Finally, five laundry staff had biological monitoring done once each at the USP clinic during 2003. Two BLLS were below the LOD, the others ranged from 2-3 µg/dL. Four CdBs from nonsmokers were below the LOD. One smoker had a CdB of 1.3 µg/L. All five CdUs were reported as 0.0 µg/L. B-2-M measurements were normal, and mean serum barium was 56.2 µg/L (range:42-68 µg/L).

In summary, results of biological monitoring of both staff and inmates were unremarkable with regards to potential occupational exposure to lead, cadmium, and barium.

Interviews with Inmates

Neither inmate reported medical issues related to work in recycling.

Industrial Hygiene

Records Review

The OIG provided 13 reports of occupational exposure assessments of glass breaking operations performed at USP Atwater between June 2002 and March 2005. Eleven reports were prepared by consultants to UNICOR, and two by the BOP industrial hygienist.

<u>2002</u>

A consultant conducted the first exposure assessment on June 20, 2002. During this visit, the consultant collected one 65-minute personal breathing zone (PBZ) sample that indicated an airborne cadmium concentration of 50 micrograms per cubic meter of air (μg/m^3) in glass breaking. (The OSHA PEL for cadmium is 5 μg/m^3 as an 8-hour time-weighted average [TWA]). The airborne lead concentration was reported to be 99 μg/m^3 (the PEL for lead is an 8-hour TWA concentration of 50 μg/m^3). The consultant recommended that respiratory protection be provided and that "personal hygiene procedures" be reviewed. The report contained no other information regarding the work environment, work practices, engineering controls, or personal protective equipment (PPE).

The consultant returned on July 24, 2002, and collected seven full-shift PBZ samples for cadmium and lead. The consultant reported that four samples exceeded the cadmium PEL and two other samples exceeded the cadmium action level (AL) of 2.5 μg/m^3. Cadmium concentrations were reported to be as high as 270 μg/m^3; however, the report did not state the results for the individual samples. The lead PEL was exceeded in one sample; the lead AL (30 μg/m^3) was exceeded in two other samples. The report does not indicate if the results were reported for the sampling period (approximately 6½ hours) or calculated as an 8-hour TWA. Cadmium and lead were detected in each of eight surface wipe samples collected on this date. The highest concentrations were found on surfaces in the glass breaking area; lower concentrations were reported on inmate workers' skin and on surfaces in the food service area. The report repeated the recommendations presented in the previous report.

On September 4-5, 2002, the BOP industrial hygienist conducted a technical assistance visit. He conducted PBZ exposure monitoring in and around the GBO. Five of 11 PBZ samples indicated 8-hour TWA concentrations exceeding the cadmium PEL; one worker was exposed to lead above the PEL. The panel breaker's exposure to cadmium exceeded the PEL on both dates. The panel breaker's exposure to cadmium was an 8-hour TWA concentration of 90 $\mu g/m^3$ (18 times the PEL) while breaking glass outside of the booth under the mezzanine. Of the six samples that did not indicate overexposure to airborne cadmium, five were collected outside the glass breaking area. Shoveling and sweeping of floor debris, and an "aggressive" glass breaking technique were reported as factors contributing to excessive airborne dust concentrations. Recommendations for changing the glass breaking technique, and changing glass breakers' locations relative to the ventilation system were made.

The consultant returned on November 4, 2002, and collected six surface wipe samples, and six full-shift PBZ samples in the GBO. The sampling period was approximately 6 hours. Five of the six samples exceeded the cadmium PEL; one exceeded the lead PEL. PPE worn by workers included half-face piece air purifying respirators fitted with high efficiency particulate air (HEPA) filter cartridges. Both glass breakers were exposed to airborne cadmium concentrations that greatly exceeded the assigned protection factor of 10 for the half-face piece respirators. One glass breaker's lead exposure exceeded the PEL. Lead and cadmium were present in all wipe samples. No recommendations were provided in the report.

<u>2003</u>

On January 21 and February 27, 2003, the consultant assessed worker exposures to barium, beryllium, cadmium, and lead. The report for January 21, 2003, indicates that four of eight PBZ samples exceeded the PEL for cadmium; none were reported to exceed the PEL for lead. Barium concentrations were reported to be very low (beryllium was not detected). The report states that the airborne cadmium concentration near the "exhaust outlet of the booth" exceeded the PEL; however, the report does not describe the location of the outlet, i.e., indoors, outdoors, or proximity to workers. (It is our understanding that the ventilation system used at this time exhausted indoors.) Values reported for barium and beryllium in skin wipe samples were incorrectly interchanged in the report, i.e, the consultant reported beryllium in all wipes samples, while the laboratory analysis report for this visit clearly indicates that beryllium was below the LOD in all wipe samples.

Three PBZ and one area air sample were collected on February 27, 2003. Barium and lead exposures were below PELs; cadmium exposures exceeded the PEL and AL. One PBZ exposure reportedly exceeded the PEL and ACGIH Threshold Limit Value® (TLV) for beryllium; however no supporting documentation (e.g., laboratory analysis reports) was provided to substantiate this finding. In 2003, the PEL and TLV for an eight-hour TWA exposure to beryllium were 0.002 mg/m^3. Given the low beryllium concentrations found in relatively few air samples collected by NIOSH Division of Applied Research Technology (DART) investigators at other UNICOR recycling facilities, the incompleteness of data provided for this visit, and the error in the January report, it is uncertain whether an overexposure to beryllium occurred on this date.

Neither of the reports for 2003 contained recommendations, or provided additional information regarding the work environment, work practices, engineering controls, or PPE.

<u>2004</u>

UNICOR used a different consultant starting in 2004. Another change appears to be the location of the GBO; it is our understanding that in June 2003 the GBO moved from beneath a mezzanine to an existing spray booth on a loading dock, which we toured during our October 2008 site visit.

The consultant conducted four exposure assessments from January through March 2004. During these visits, the consultant collected 18 PBZ and six area air samples that were analyzed for barium, beryllium, cadmium, and lead. With one exception, air sampling indicated airborne concentrations below the LOD and/or occupational exposure limits. The exception was a PBZ sample collected at panel glass breaking on February 9, 2004, which indicated an airborne cadmium concentration of 28 $\mu g/m^3$ during a 287 minute sampling period (17 $\mu g/m^3$ as an 8-hour TWA, assuming no additional cadmium exposure during the unsampled time). No explanation for this singular overexposure was given in the report or in either of the two subsequent reports for 2004. We noted that two reports were written for the February 9, 2004, visit, the first of which suggested that the panel breaker had not been overexposed to cadmium because the worker had been wearing a full-face piece respirator. The transmittal memo for the first report erroneously stated that because a full-face piece respirator was worn, ". . . the PEL for cadmium has been increased to 250." It appears that the second report for this visit was provided a month later in order to correct the errors contained in the initial report; however, the second report merely omitted the errors, and did not provide a correction, per se. We mention the erroneous statements in the report as another example of incorrect or incomplete information that has been provided to UNICOR by environmental consultants.

Reports for the latter three consultant visits in 2004 state that workers wore disposable suits and full-face piece respirators (presumably air-purifying, not powered air-purifying) while breaking cathode ray tubes (CRTs).

On September 28-30, 2004, the BOP industrial hygienist assessed exposure to metals while workers handled computer monitors in the UNICOR factory and warehouse; the purpose of this visit was not to assess exposure during glass breaking. All air sampling results (barium, beryllium, cadmium, lead) were below the LODs and PELs. Air sampling where six monitors were broken in a Gaylord box produced results below the OSHA PELs for the four elements. Wipe samples were collected from workers' hands, table tops in the production area, and in the food service/dining area located in the corner of the UNICOR factory. Metals were reported in wipe samples obtained from table tops in production areas. Wipe samples from workers' hands were generally below the LOD; however, barium and lead were detected in some samples. Cadmium was detected in one hand wipe sample. Barium and cadmium were detected in a sample from a dining room table top that was reportedly used and cleaned each day. Barium, cadmium, and lead were detected in a wipe sample from the top of cabinet in the dining area. The report recommended using butcher paper or other disposable covering on dining tables, wet wiping or HEPA vacuuming surfaces, and wearing disposable gloves to prevent contamination of workers' skin.

2005

Reports were provided to us for two consultant visits conducted in March 2005. Six PBZ and one area air sample were collected. Air samples during these visits indicated concentrations that were low or below the LOD. The most notable result was a PBZ sample on a glass breaker assistant that indicated a cadmium exposure of 3 $\mu g/m^3$ during a 206 minute sampling period (an 8-hour TWA of 1.3 $\mu g/m^3$ assuming no cadmium exposure during the unsampled period). Low concentrations of cadmium and lead were detected in wipe samples. The report for the first March visit correctly noted that PELs are applied without regard for PPE. Worker exposures were described as insignificant.

No other reports of exposure assessments were provided to us.

Conclusions

Inmates were exposed to cadmium and lead above occupational exposure limits during glass breaking from 2002-2003. It appears that inmates worked without adequate respiratory protection from April 2002 until July 2002. Exposures seem to have been better controlled with the relocation of the GBO to the spray booth, however, one sample taken after the relocation demonstrated significant airborne cadmium exposure. No inmates or employees had blood or urine levels of lead or cadmium which exceeded occupational standards. Medical surveillance was not in compliance with the OSHA lead and cadmium standards, and medical clearance was not performed for respirator use, a violation of the OSHA respiratory protection standard. If the

GBO reopens, UNICOR should thoroughly characterize exposures to lead and cadmium, and perform medical surveillance in compliance with the applicable OSHA standards until it is documented that exposures are controlled below the OELs. There is no need to perform any surveillance if the GBO remains closed. It is unclear if there was exposure to beryllium. The industrial hygiene reports often lacked information needed to interpret findings.

Recommendations

The following recommendations are provided to improve the safety and health of the staff and inmates involved with electronics recycling at the USP Atwater.

1. Although engineering controls and work practices in the GBO generally appear to provide effective control of worker exposure to cadmium and lead based upon review of industrial hygiene sampling, exposures should be better characterized if the GBO reopens. UNICOR needs to maintain an ongoing program of environmental monitoring to confirm that engineering and work practice controls are sufficiently protective. Environmental monitoring also provides data needed to determine which provisions of the OSHA cadmium and lead standards should be applied to the GBO.

3. Ensure full compliance with all applicable OSHA standards, including the General Industry Lead Standard [29 CFR 1910.1025], the Cadmium Standard [29 CFR 1910.1027], the Hazard Communication Standard [29 CFR 1910.1200], and the Respiratory Protection Standard [29 CFR 1910.134]. This includes record keeping requirements, hazard communication requirements, compliance plans, and medical surveillance. In addition to the OSHA

requirements, we recommend that the preplacement examination for cadmium exposure be identical to the periodic examinations so that baseline health status may be obtained prior to exposure. We also strongly recommend UNICOR to voluntarily follow the more protective guidelines for lead exposure and BLLs set forth by the expert panel, [Kosnett et al. 2007], that is outlined in the appendix to this letter.

4. Carefully evaluate the qualifications and expertise of consultants who are hired to assess occupational or environmental health and safety issues. One useful benchmark for vetting individuals who provide industrial hygiene services is the designation of Certified Industrial Hygienist (CIH). Certification by the American Board of Industrial Hygiene (ABIH) ensures that prospective consultants have met ABIH standards for education, ongoing training, and experience, and have passed a rigorous ABIH certification examination. The UNICOR and/or BOP industrial hygienists can assist in the selection of your consultants.

5. Perform a detailed job hazard analysis prior to beginning any new operation or before making changes to existing operations. This will allow UNICOR and BOP to identify potential hazards prior to exposing staff or inmates, and to identify appropriate controls and PPE. Involve the UNICOR and/or BOP industrial hygienists in these job hazard analyses. If medical surveillance is needed then UNICOR and BOP should perform pre-placement evaluations of exposed staff and inmates. This medical surveillance should be overseen by an occupational medicine physician.

6. Appoint a union safety and health representative. This individual should be a regular participant on the joint labor-management safety committee that meets quarterly. Since inmates

do not have a mechanism for representation on this committee, ensure that they are informed of its proceedings and that they have a way to voice their concerns about and ideas for improving workplace safety and health.

This interim letter will be part of the final report that will include evaluations at three other BOP facilities. Please post a copy of this letter for 30 days at or near work areas of affected staff and inmates. Thank you for your cooperation with this evaluation. If you have any questions, please do not hesitate to contact us at (513) 841-4382.

Sincerely yours,

Elena H. Page, M.D., M.P.H.

Medical Officer

David Sylvain, M.S., C.I.H.

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Hazard Evaluations and Technical
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cc:

Paul Laird, Assistant Director, UNICOR

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Appendix

Occupational Exposure Limits and Health Effects

In evaluating the hazards posed by workplace exposures, NIOSH investigators use both mandatory (legally enforceable) and recommended occupational exposure limits (OELs) for chemical, physical, and biological agents as a guide for making recommendations. OELs have been developed by Federal agencies and safety and health organizations to prevent the occurrence of adverse health effects from workplace exposures. Generally, OELs suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. However, not all workers will be protected from adverse health effects even if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the exposure limit. Also, some substances can be absorbed by direct contact with the skin and mucous membranes in addition to being inhaled, which contributes to the individual's overall exposure.

Most OELs are expressed as a time-weighted average (TWA) exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday. Some chemical substances and physical agents have recommended short-term exposure limit (STEL) or ceiling values where health effects are caused by exposures over a short-period. Unless otherwise noted, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during a workday, and the ceiling limit is an exposure that should not be exceeded at any time.

In the U.S., OELs have been established by Federal agencies, professional organizations, state and local governments, and other entities. Some OELs are legally enforceable limits, while others are recommendations. The U.S. Department of Labor Occupational Safety and Health Administration's (OSHA) permissible exposure limits (PELs) (29 CFR 1910 [general industry]; 29 CFR 1926 [construction industry]; and 29 CFR 1917 [maritime industry]) are legal limits enforceable in workplaces covered under the Occupational Safety and Health Act. NIOSH recommended exposure levels (RELs) are recommendations based on a critical review of the scientific and technical information available on a given hazard and the adequacy of methods to identify and control the hazard. NIOSH RELs can be found in the *NIOSH Pocket Guide to Chemical Hazards* [NIOSH 2005]. NIOSH also recommends different types of risk management practices (e.g., engineering controls, safe work practices, worker education/training, personal protective equipment, and exposure and medical monitoring) to minimize the risk of exposure and adverse health effects from these hazards. Other OELs that are commonly used and cited in the U.S. include the threshold limit values (TLVs) recommended by the American Conference of Governmental Industrial Hygienists® (ACGIH), a professional organization, and the Workplace environmental exposure limits (WEELs) recommended by the American Industrial Hygiene Association, another professional organization. ACGIH TLVs are considered voluntary exposure guidelines for use by industrial hygienists and others trained in this discipline "to assist in the control of health hazards" [ACGIH 2009]. WEELs have been established for some chemicals "when no other legal or authoritative limits exist" [AIHA 2009].

Outside the U.S., OELs have been established by various agencies and organizations and include both legal and recommended limits. Since 2006, the Berufsgenossenschaftlichen Institut für Arbeitsschutz (German Institute for Occupational Safety and Health) has maintained a database of international OELs from European Union member states, Canada (Québec), Japan, Switzerland, and the U.S. [www.hvbg.de/e/bia/gestis/limit_values/index.html]. The database contains international limits for over 1250 hazardous substances and is updated annually.

Employers should understand that not all hazardous chemicals have specific OSHA PELs, and for some agents the legally enforceable and recommended limits may not reflect current health-based information. However, an employer is still required by OSHA to protect its employees from hazards even in the absence of a specific OSHA PEL. OSHA requires an employer to furnish employees a place of employment free from recognized hazards that cause or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970 (Public Law 91–596, sec. 5(a)(1))]. Thus, NIOSH investigators encourage employers to make use of other OELs when making risk assessment and risk management decisions to best protect the health of their employees. NIOSH investigators also encourage the use of the traditional hierarchy of controls approach to eliminate or minimize identified workplace hazards. This includes, in order of preference, the use of: (1) substitution or elimination of the hazardous agent, (2) engineering controls (e.g., local exhaust ventilation, process enclosure, dilution ventilation), (3) administrative controls (e.g., limiting time of exposure, employee training, work practice changes, medical surveillance), and (4) personal protective equipment (e.g., respiratory protection, gloves, eye protection, hearing protection). Control banding, a qualitative risk assessment and risk management tool, is a complementary approach to protecting worker health that focuses resources on exposure controls by describing how a risk needs to be managed [http://www.cdc.gov/niosh/topics/ctrlbanding/]. This approach can be applied in situations where OELs have not been established or can be used to supplement the OELs, when available.

Lead

Occupational exposure to inorganic lead occurs via inhalation of lead-containing dust and fume and ingestion of lead particles from contact with lead-contaminated surfaces. In cases where careful attention to hygiene (for example, handwashing) is not practiced, smoking cigarettes or eating may represent another route of exposure among workers who handle lead and then transfer it to their mouth through hand contamination. Industrial settings associated with exposure to lead and lead compounds include smelting and refining, scrap metal recovery, automobile radiator repair, construction and demolition (including abrasive blasting), and firing range operations [ACGIH 2007]. Occupational exposures also occur among workers who apply and/or remove lead-based paint or among welders who burn or torch-cut metal structures.

Acute lead poisoning, caused by intense occupational exposure to lead over a brief period of time can cause a syndrome of abdominal pain, fatigue, constipation, and in some cases alteration of central nervous system function [Moline and Landrigan 2005]. Symptoms of chronic lead poisoning include headache, joint and muscle aches, weakness, fatigue, irritability, depression, constipation, anorexia, and abdominal discomfort [Moline and Landrigan 2005]. These symptoms usually do not develop until the blood lead level (BLL) reaches at least 30-40 micrograms per deciliter of whole blood (µg/dL) [Moline and Landrigan 2005]. Psychiatric symptoms such as depression, anxiety and irritability appear to be related to high levels of current lead exposure, while decrements in cognitive function are related to both recent and cumulative dose [Schwartz and Stewart 2007]. One study documented a significant positive relationship between white matter lesion of the brain noted on magnetic resonance imaging (MRI) and tibia lead levels in former organolead workers [Stewart et al. 2006]. However, the strongest predictors of white matter lesions are sex, age, blood pressure, education, smoking history, alcohol consumption, and ApoE genotype [Stewart et al. 2006]. Overexposure to lead may result in damage to the kidneys, anemia, high blood pressure, impotence, and infertility and reduced sex drive in both sexes. Studies have shown subclinical effects on heme synthesis, renal function, and cognition at BLLs <10 µg/dL [ATSDR 2007a]. Inorganic lead is reasonably anticipated to cause cancer in humans [ATSDR 2007a].

In most cases, an individual's BLL is a good indication of recent exposure to lead, with a half-life (the time interval it takes for the quantity in the body to be reduced by half its initial value) of 1-2 months [Lauwerys and Hoet 2001; Moline and Landrigan 2005; NCEH 2005]. The majority of lead in the body is stored in the bones, with a half-life of years to decades. Bone lead can be measured using K-shell x-ray fluorescence instruments, but these are primarily research based and are not widely available. Elevated zinc protoporphyrin (ZPP) levels have also been used as an indicator of chronic lead intoxication, however, other factors, such as iron deficiency, can cause an elevated ZPP level, so the BLL is a more specific test for evaluating occupational lead exposure.

The NIOSH REL for inorganic lead is 50 micrograms per cubic meter of air ($\mu g/m^3$) as an 8-hour TWA. This REL is consistent with the OSHA PEL, which is intended to maintain worker BLLs below 40 µg/dL; medical removal is required when an employee has a BLL of 60 µg/dL, or the average of the last 3 tests at 50 µg/dL or higher [29 CFR 1910.1025; 29 CFR 1962.62]. This is intended to prevent overt symptoms of lead poisoning, but is not sufficient to protect workers from more subtle adverse health effects like hypertension, renal dysfunction, and reproductive and cognitive effects [Schwartz and Stewart 2007; Schwartz and Hu 2007; Brown-Williams et al. 2009]. Adverse effects on the adult reproductive, cardiovascular, and hematologic systems, and on the development of children of exposed workers, can occur at BLLs as low as 10 µg/dL [Sussell 1998]. At BLLs below 40 µg/dL, many of the health effects would not necessarily be evident by routine physical examinations but represent early stages in the development of lead toxicity. In recognition of this, voluntary standards and public health goals have established lower exposure limits to protect workers and their children. The ACGIH TLV for lead in air is 50 $\mu g/m^3$ as an 8-hour TWA, with worker BLLs to be controlled to ≤ 30 µg/dL [ACGIH 2009]. A national health goal is to eliminate all occupational exposures that result in BLLs >25 µg/dL [DHHS 2000]. A panel of experts recently published guidelines for the management of adult lead exposure intended to prevent both acute and chronic effects of lead poisoning [Kosnett et al. 2007]. They recommended that an employee be removed from exposure if a single BLL exceeds 30 µg/dL, or if two measurements taken over 4 weeks exceed 20 µg/dL. Removal should be considered if control measures over an extended period do not decrease BLLs to < 10 µg/dL. The panel also recommended quarterly BLL testing if the BLL is between 10-19 µg/dL, and semiannual testing if the BLL is < 10 µg/dL. Pregnant women should avoid BLLs > 5 µg/dl. The Third National Report on Human Exposure to Environmental Chemicals (TNRHEEC) found the geometric mean blood lead among non-institutionalized, civilian males in 2001-2002 was 1.78

μg/dL [NCEH 2005]. However, widespread contamination of the environment from leaded gasoline in the past led to significant lead exposure among the general population. This contamination peaked between 1950 and the early 1970s. The average blood lead in Americans in 1965 was over 20 μg/dL [Patterson 1965]. Therefore, persons born prior to the 1970s may have substantial body burdens of lead.

OSHA requires medical surveillance on any employee who is or may be exposed to an airborne concentration of lead at or above the action level, which is 30 $\mu g/m^3$ as an 8-hour TWA ,for more than 30 days per year [29 CFR 1910.1025]. Blood lead and ZPP levels must be done at least every 6 months, and more frequently for employees whose blood leads exceed certain levels. In addition, a medical examination must be done prior to assignment to the area, and should include detailed history, blood pressure measurement, blood lead, ZPP, hemoglobin and hematocrit, red cell indices, and peripheral smear, blood urea nitrogen (BUN), creatinine, and a urinalysis. Additional medical exams and biological monitoring depend upon the circumstances, for example, if the blood lead exceeds a certain level.

Cadmium

Cadmium is a metal that has many industrial uses, such as in batteries, pigments, plastic stabilizers, metal coatings, and television phosphors [ACGIH 2007]. Workers may inhale cadmium dust when sanding, grinding, or scraping cadmium-metal alloys or cadmium-containing paints [ACGIH 2007]. Exposure to cadmium fume may occur when materials containing cadmium are heated to high temperatures, such as during welding and torching operations; cadmium-containing solder and welding rods are also sources of cadmium fume. In addition to inhalation, cadmium may be absorbed via ingestion; non-occupational sources of cadmium exposure include cigarette smoke and dietary intake [ACGIH 2007]. Early symptoms of cadmium exposure may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or cough. Short-term exposure effects of cadmium inhalation include cough, chest pain, sweating, chills, shortness of breath, and weakness [Thun et al. 1991]. Short-term exposure effects of ingestion may include nausea, vomiting, diarrhea, and abdominal cramps [Thun et al. 1991]. Long-term exposure effects of cadmium may include loss of the sense of smell, ulceration of the nose, emphysema, kidney damage, mild anemia, and an increased risk of cancer of the lung, and possibly of the prostate [ATSDR 1999].

The OSHA PEL for cadmium is 5 $\mu g/m^3$ as an 8-hour TWA [29 CFR 1910.1027]. The ACGIH has a TLV for total cadmium of 10 $\mu g/m^3$ (8-hour TWA), with worker cadmium blood level to be controlled at or below 5 micrograms per liter (µg/L) and urine level to be below 5 micrograms per gram creatinine (µg/g/Cr), and designation of cadmium as a suspected human carcinogen [ACGIH 2009]. NIOSH recommends that cadmium be treated as a potential occupational carcinogen and that exposures be reduced to the lowest feasible concentration [NIOSH 1984].

Blood cadmium levels measured while exposure is ongoing reflect fairly recent exposure (in the past few months). The half-life is biphasic, with rapid elimination (half-life approximately 100 days) in the first phase, but much slower elimination in the second phase (half-life of several years) [Lauwerys and Hoet 2001; Franzblau 2005]. Urinary cadmium levels are reflective of body burden and have a very long half-life of 10-20 years [Lauwerys and Hoet 2001].

OSHA requires medical surveillance on any employee who is or may be exposed to an airborne concentration of cadmium at or above the action level, which is 2.5 µg/m^3 as an 8-hour TWA, for more than 30 days per year [29 CFR 1910.1027]. A preplacement examination must be provided, and shall include a detailed history, and biological monitoring for urine cadmium (CdU) and beta-2-microglobulin (B-2-M), both standardized to grams of creatinine (g/Cr), and blood cadmium (CdB), standardized to liters of whole blood. OSHA defines acceptable CdB levels as < 5 µg/L, CdU as < 3 µg/g/Cr, and B-2-M as < 300 µg/g/Cr. TNRHEEC found geometric mean CdB of 0.4 µg/L among men in 1999-2000. Smokers can have CdB levels much higher than nonsmokers, with levels up to 6.1 µg/L [Martin et al. 2009]. The geometric mean CdU for men in 2001-2002 was 0.2 µg/g/Cr in TNRHEEC. Periodic surveillance is also required one year after the initial exam and at least biennially after that. Periodic surveillance shall include the biological monitoring, history and physical examination, a chest x-ray (frequency to be determined by the physician after the initial x-ray), pulmonary function tests, blood tests for BUN, complete blood count, and Cr, and a urinalysis. Men over 40 years of age require a prostate examination as well. The frequency of periodic surveillance is determined by the results of biological monitoring and medical examinations. Biological monitoring is required annually, either as part of the periodic surveillance or on its own. We recommend that the preplacement examination be identical to the periodic examinations so that baseline health status may be obtained prior to exposure. Termination of employment examinations, identical to the periodic examinations, are also required. The employer is required to provide the employee with a copy of the physician's written opinion from these exams and a copy of biological monitoring results within 2 weeks of receipt.

Biological monitoring is also required for all employees who may have been exposed at or above the action level unless the employer can demonstrate that the exposure totaled less than 60 months. In this case it must also be conducted one year after the initial testing. The need for further monitoring for previously exposed employees is then determined by the results of the biological monitoring.

Barium

Barium is a silver-white metal found in the earth's crust [ATSDR 2007b; NCEH 2005]. It binds with a variety of chemicals to form barium salts. About half of these salts (including barium oxide) are soluble in water, and the other half are not (i.e. barium sulfate used in medical procedures). Barium can be found in food and water, and can be released into the air during mining and certain industrial processes. It is used to make drilling muds, paints, bricks, tiles, ceramics, insect and rat poisons, and a variety of other products. Barium oxide is incorporated into the glass of CRT monitors. Ingestion of large amounts of soluble barium compounds leads to numbness around the mouth, diarrhea, vomiting, weakness or paralysis, and cardiac rhythm disruption [ATSDR 2007b; NCEH 2005]. These symptoms are due to hypokalemia, or low blood potassium levels. Studies of humans or animals exposed to barium compounds in the air are conflicting. Some workers have developed baritosis, a benign lung condition that shows x-ray changes but does not cause abnormal lung function. No routine medical tests are available to determine exposure to barium, and barium levels in blood or urine cannot determine the level of exposure or whether health effects will occur [ATSDR 2007b]. TNRHEEC found geometric mean urine barium levels of 1.32 μg/g/Cr among men in 2001-2002.

The OSHA PEL and the NIOSH REL for soluble barium compounds (except barium sulfate) is 0.5 mg/m^3 as an 8-hour TWA.

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ATTACHMENT 4

Stop Work

DOE-0343

Revision 1

Effective Date: December 18, 2009

1.0 PURPOSE

The purpose of this procedure is to ensure that all employees are given the responsibility and authority to stop work when employees believe that a situation exists that places them, their coworker(s), contracted personnel, or the public at risk or in danger; could adversely affect the safe operation or cause damage to the facility; or result in a release of radiological or chemical effluents to the environment above regulatory requirements or approvals; and provides a method to resolve the issue. Maintaining a diligent questioning attitude is vital to safe execution of work-scope and is a cornerstone to effective Conduct of Operations and Integrated Safety Management.

Portions of this procedure implement requirements of the Worker Safety and Health Program Plan for compliance to 10 *Code of Federal Regulations* (CFR) 851, "Worker Safety and Health Program" and are bracketed in the text. This procedure also implements the "Stop Work and Shutdown Authorization" clause included in section H of each of DOE's Prime Contracts (see Appendix B).

This procedure extends the authority to stop work to situations where an employee believes there is a need to clarify work instructions; or to propose additional controls.

2.0 SCOPE

This procedure is applicable to all contractors and subcontract personnel working at the Hanford site.

3.0 RESPONSIBILITIES

3.1 Employees

In supporting safe execution of work, all personnel, have the following responsibilities [10 CFR 851.A1]:

- The responsibility and authority to stop work or decline to perform an assigned task without fear of reprisal, to discuss and resolve work and safety concerns. The Stop Work may include discussions with co-workers, supervision, or safety representative to resolve work related issues, address potential unsafe conditions, clarify work instructions, propose additional controls, etc.
- The responsibility and authority to initiate a Stop Work IMMEDIATELY, without fear of reprisal, when the employee believes a situation exists which places himself/herself, a coworker(s), or the environment in danger or at risk.
- The responsibility to report any activity or condition the employee believes is unsafe or for which they have initiated a Stop Work. Notification should be made to the affected worker(s) and to the supervisor or their supervisor's designee at the location where the activity or condition exists.
- The responsibility to notify their supervisor if a raised Stop Work issue has not been resolved to their satisfaction through established channels prior to the resumption of

work. Alternatively, contact the employer's Employee Concerns Program or the DOE Employee Concerns Program.

- Employee can contact their safety representative or union safety representative with a concern or to initiate a stop work, if the employee prefers to remain anonymous.

3.2 Management/Supervisor/Person in Charge (PIC)/ Field Work Supervisor (FWS)

Management and supervision are committed to promptly resolve issues resulting from an employee-raised Stop Work [10 CFR 851.20]. Management (e.g., Directors, Managers, Supervisors) responsibilities are to:

- Resolve any issues that have resulted in an individual stopping a specific task(s) or activity.
- Provide feedback to individual/s and the affected work group who have exercised their Stop Work responsibility on the resolution of their concern prior to resuming work. If the employee that issued a stop work is not available due to reasons such as vacation, PTB, PTO, shift change, or training then the supervisor provides the feedback to the safety representative and union safety representative, prior to resuming work.
- Notify the employer's Safety Representative or the Union Safety Representative, when bargaining unit personnel are affected, if a raised stop work issue has not been resolved.
- Notify the DOE Facility Representative if the Contractor's Stop Work action meets the Stop Work Criteria defined in Appendix B.
- Ensure no actions are taken as reprisal or retribution against individuals who raise safety concerns or stop an activity they believe is unsafe.
- If a stop work is not brought up by a bargaining unit employee, but does impact bargaining unit personnel, then also notify the union safety representative.

3.3 Safety Representatives(s) and Union Safety Representative(s) are Responsible to:

- Assist employees, supervision and management in the resolution of safety issues and concerns.
- Immediately contact management and work to resolve issues when an employee has called a situation to their attention that has not been resolved.
- Discuss resolution with employees involved in a work stoppage where resolution was completed after their shift or when they were unavailable, or where he/she acted as their representative in reaching resolution.
- Work as the agent of an employee that prefers to remain anonymous to work directly in the resolution of the stop work.

4.0 IMPLEMENTATION

Effective immediately.

5.0 PROCESS

Actionee	*Step*	*Action*
Employee	1.	Stop work if an activity or condition is believed to be unsafe, such as: a. A situation exists that places them, their coworker(s), contracted personnel, or the public at risk or in danger; b. A situation could adversely affect the safe operation or cause damage to the facility; or c. A situation could result in a release of radiological or chemical effluents to the environment above regulatory requirements or approvals. d. To clarify work instructions or to propose additional controls
	2.	Ensure the work/activity is in, or placed in a safe condition and <u>immediately</u> notify supervision/management and affected workers when you stop work or decline to perform an activity.
Manager/ Supervisor/PIC/ FWS	3.	Resolve any issues that have resulted in an employee stopping work or an activity. Involve individuals who initiated the Stop Work or their appropriate safety representatives if the individual is not available, in reaching mutual agreement on the resolution or proposed actions necessary to return to work. Be sure any necessary corrective or compensatory actions are taken before resuming an activity and are documented* in accordance with Contractor procedures (logbook or other established method of reporting/tracking/communicating safety issues and corrective action management). Notify senior management, and the DOE Facility Representative if the Stop Work meets the Stop Work Criteria defined in Contract Section H "Stop-Work and Shutdown Authorization" (Appendix B), Report in accordance with established notification processes (e.g., occurrence reporting).

Actionee	*Step*	*Action*
	4.	If a Stop Work has not been resolved to the mutual agreement of manager and employee, then the stop work remains in place and the Supervisor/PIC/FWS will notify the appropriate company management, safety representative and union safety representative. Resolution of the stop work resides with the union safety representative and company management to resolve and/or propose actions necessary to return to work. Work may be resumed when union safety representation and management agree that the issue has been resolved. The objective is to reach resolution at the lowest levels of engagement. Notify the DOE Facility Representative that a Stop Work has resulted in an unresolved issue. ***NOTE**: For resumption of radiological work, consult the Radiological Control Manual for additional approval requirement.

5.0 REFERENCES

Hanford Site Stop Work Policy
10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*
10 CFR 851, "Worker Safety and Health Program," *Code of Federal Regulations*
10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations**
DOE-STD-1098-2008, Department of Energy (DOE) Radiological Control Standard

Appendix A
Stop Work Policy

Stop Work Responsibility: Every Hanford site employee, regardless of employer, has the responsibility and authority to stop work IMMEDIATELY, without fear of reprisal, when the employee is convinced:

1. Conditions exist that pose a danger to the health and safety of workers or the public; or

2. Conditions exist, that if allowed to continue, could adversely affect the safe operation of, or could cause serious damage to, a facility; or

3. Conditions exist, that if allowed to continue, could result in the release from the facility to the environment of radiological or chemical effluents that exceed applicable regulatory requirements or approvals.

Reporting Unsafe Conditions: Employees are expected to report any activity or condition which he/she believes is unsafe. Notification should be made to the affected worker(s) and then to the supervisor or designee at the location where the activity or condition exists. Following notification, resolution of the issue resides with the responsible supervisor.

Right to a Safe Workplace: Any employee who reasonably believes that an activity or condition is unsafe is expected to stop or refuse work without fear of reprisal by management or coworkers and is entitled to have the safety concern addressed prior to participating in the work.

Stop Work Resolution: If you have a "stop work" issue that has not been resolved through established channels, immediately contact your employer's Safety Representative or your Union Safety Representative. Alternatively, you may contact the employer's Employee Concerns Program or the DOE Employee Concerns Program.

Appendix B
DOE Facility Representative (FR) Notification Requirements

If any of the following criteria is met or notification of facility management is required for the issue, the Supervisor/Manager will notify the FR on a 24 hour real time basis.

Stop Work Criteria:

1. Conditions exist that pose an imminent danger to the health and safety of workers or the public; or

2. Conditions exist, that if allowed to continue, could adversely affect the safe operation of, or could cause serious damage to, the facility; or

3. Conditions exist, that if allowed to continue, could result in the release from the facility to the environment of radiological or chemical effluents that exceed applicable regulatory requirements or approvals.

The following definitions shall be used in conjunction with the above stated criteria:

Imminent Danger: Any condition or practice such that a hazard exists that could reasonably be expected to cause death, serious physical harm, or other serious hazard to employees, unless immediate actions are taken to mitigate the effects of the hazard and/or remove employees from the hazard.

Adversely Affects Safe Operation of Facility or Serious Facility Damage: A condition, situation, or activity that if not terminated or mitigated could reasonably be expected to result in: nuclear criticality; facility fire/explosion; major facility or equipment damage or loss; or, a facility evacuation response.

FCI ELKTON

EVALUATION OF ENVIRONMENTAL, SAFETY, AND HEALTH INFORMATION RELATED TO CURRENT UNICOR E-WASTE RECYCLING OPERATIONS AT FCI ELKTON

PREPARED FOR THE UNITED STATES DEPARTMENT OF JUSTICE
OFFICE OF THE INSPECTOR GENERAL

Submitted to: [redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
U.S. Department of Justice

Submitted by: Mr. George Bearer, CIH
FOH Safety and Health Investigation Team
Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

April 23, 2010

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Attachments

Attachment 1	NIOSH, Control Technology and Exposure Assessment for Electronic Recycling Operations, Elkton Federal Correctional Institution, July 2008
Attachment 2	FOH, Summary of Findings and Recommendations Pertaining to Air/Wipe/Bulk/TCLP Sampling Data from Electronics Recycling Facilities, FCI Elkton, November 15, 2007
Attachment 3	NIOSH, Interim letter report assessing the existing medical surveillance program for inmates and staff exposed to lead and cadmium during electronics recycling at FCI Elkton, July 16, 2008
Attachment 4	Letter Report of OSHA Compliance Inspection and Citations, February 27, 2006
Attachment 5	U.S. EPA, Multimedia Inspection Report, April 23, 2008
Attachment 6	Assessment of UNICOR Electronics Recycling Operations, Senior Environmental Scientist, Office of Solid Waste, U.S. Environmental Protection Agency (Email correspondence to [redacted] DOJ OIG, February 8, 2007

1.0. INTRODUCTION

At the request of the U.S. Department of Justice (DOJ) Office of the Inspector General (OIG), the Federal Occupational Health Service (FOH) coordinated environmental, safety and health (ES&H) assessments of electronics equipment recycling operations conducted by the Federal Bureau of Prisons (BOP) at the Elkton Federal Correctional Institution (FCI) located at 8730 Scroggs Road, Elkton, Ohio. The assessments were conducted as a result of whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium, at electronics recycling operations overseen by Federal Prison Industries (UNICOR) at a number of BOP facilities around the country.[1] The allegations stated that these exposures were occurring from the breaking of cathode ray tubes (CRTs) and other activities associated with the handling, disassembly, recovery, and recycling of electronic components found in equipment such as computers and televisions (i.e. e-waste).[2] It was further alleged that appropriate corrective actions had not yet been taken by BOP and UNICOR officials and that significant risks to human health and the environment remained.

This FOH report[3] consolidates and presents the findings of multiple technical assessments recently performed on UNICOR's e-waste recycling operations at FCI Elkton by industrial hygienists, occupational physicians, and environmental specialists representing several federal agencies including, FOH, the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH), the Occupational Safety and Health Administration (OSHA), and the United States Environmental Protection Agency (U.S. EPA). Reports from each of these agencies are presented in Attachments 1 – 5 (see references for these reports in Section 9.0). The primary objectives of these assessments were to characterize current UNICOR operations and working conditions at FCI Elkton (i.e. 2003 to present) in light of the whistleblower allegations and to identify where exposures, environmental contamination/degradation, and violations of governmental regulations and BOP policies may still exist so that prompt corrective actions may be taken where appropriate.

FCI Elkton is one of eight BOP institutions that have ongoing e-waste recycling operations. FOH will issue separate reports detailing current exposure conditions for each of the seven other institutions upon completion of the relevant ES&H assessments. FOH's assessment of historical conditions at FCI Elkton and the other UNICOR e-waste recycling locations will be presented in a subsequent OIG report.

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[1] FPI, (commonly referred to by its trade name UNICOR) is a wholly-owned, Government corporation that operates factories and employs inmates at federal correctional institutions.

[2] E-Waste is defined as a waste type consisting of any broken or unwanted electrical or electronic device or component.

[3] FOH prepared this report in October 2008 and its findings and conclusions address e-waste recycling conditions known to FOH at that time. FOH provided the report to the OIG, which shared it with the BOP and sought feedback on it. The BOP and UNICOR later provided their comments to FOH about the report's contents, which resulted in FOH making limited changes to some text and figures, as reflected herein.

This report is comprised of the following sections:

- BACKGROUND (Section 2.0) provides additional information about the nature of the whistleblower allegations, summaries of reports provided by the federal agencies that the OIG requested to evaluate the allegations, the scope of the various site visits performed by the federal agencies involved, the resulting federal agency reports upon which this report is based, and the hazards associated with e-waste recycling.

- ENVIRONMENTAL, SAFETY, AND HEALTH LAWS AND REGULATIONS APPLICABLE TO E-WASTE RECYCLING (Section 3.0) summarizes the various applicable requirements and standards of care which were used by the investigators to characterize the operations and conditions.

- UNICOR E-WASTE RECYCLING FACILITIES AND OPERATIONS AT FCI ELKTON (Section 4.0) provides an overview of the electronics recycling facilities at FCI Elkton and the operations which were characterized from an ES&H perspective.

- FIELD INVESTIGATIONS AND MONITORING RESULTS (Section 5.0) details the findings of the field investigations as derived from the inspections performed and the testing data obtained.

- REGULATORY COMPLIANCE EVALUATION (Section 6.0) provides an assessment of the current facilities and operations based on pertinent regulations, requirements and policies, and establishes the technical basis for the conclusions and recommendations offered.

- CONCLUSIONS (Section 7.0) summarizes the overall findings of the FCI Elkton assessments and provides technical conclusions.

- RECOMMENDATIONS (Section 8.0) provides recommendations for corrective actions which are deemed necessary to protect human health and the environment and ensure BOP's compliance with ES&H regulations applicable to electronics recycling operations.

Overall, we have determined that current e-waste recycling operations at FCI Elkton have the potential to create personal exposures[4] to lead and cadmium from routine glass breaking operations as well as cleaning and filter maintenance activities related to glass breaking; however, we found that UNICOR has implemented measures to control these exposures. Since 2003, UNICOR has made major improvements in engineering controls and its policies regarding the usage of personal protective equipment (PPE). Additional improvements are recommended

[4] Regarding inhalation exposure, it is important to emphasize that as used in this report the term "exposure" refers to the airborne concentration of a contaminant (e.g., lead or cadmium) that is measured in the breathing zone of a worker but outside of any respiratory protection devices used. Unless otherwise noted, "exposure" should not be confused with the ingestion, inhalation, absorption, or other bodily uptake of a contaminant. Concentrations reported and discussed in this report are not adjusted based on respirator protection factors. However, when reported, it is noted whether the exposure was within the protective capacity of the respirator.

in this report to further reduce and consistently maintain exposures below exposure limits and to achieve full compliance with applicable regulations and standards.

More specifically, we have concluded in part as follows:

Heavy Metals Exposures

- Exposures were evaluated for 31 toxic metals. Only lead and cadmium exposures have the potential, at times, to be above the action levels or PELs for routine glass breaking operations and weekly glass breaking room cleaning, when conducted in the manner evaluated at the time of this investigation. Exposures to the other metals were well below the PELs.

- Current lead and cadmium exposures were minimal (far below action levels) for work activities conducted on the general factory floor outside of the glass breaking room, and in other FCI Elkton recycling areas. Minimal and limited exposure potential exists outside the glass breaking room.

- A non-routine activity involving the HEPA filter change-out demonstrated potential for very high lead and cadmium exposures without effective and consistent implementation of the improved work practice modifications evaluated in December 2007. Prior to the implementation of improved work practices, yttrium exposure was also above the PEL, but within the protective capacity of respirators in use. The improved work practices dramatically reduced these exposures, although further improvements in controls for this activity are desirable.

- Two periodic or non-routine activities, weekly cleaning activities in the glass breaking room and the HEPA filter change-out, also demonstrated potential exposure for lead and cadmium at levels above the action limits or PELs. The latter has the potential for very high exposures without effective and consistent implementation of the recently improved work practice modifications. Further improvements in controls for this activity are desirable.

- Surface lead and cadmium contamination in various areas throughout the recycling facilities is elevated. In addition, past UNICOR testing of air filters used in the buildings' HVAC (general ventilation) systems serving the electronics factory workspaces have shown significant levels of lead and cadmium. TCLP analyses have shown that these filters exceeded EPA criteria for lead and cadmium and, therefore, must be treated as hazardous waste. These findings support the conclusion that uncontrolled releases of lead and cadmium occurred from past glass breaking and de-soldering operations. For current operations, this legacy contamination is not contributing significantly to staff and inmate exposures. Contractor activities are pending to remediate this legacy contamination.

- Skin/hand wipe samples showed some potential for exposure to lead and cadmium via the ingestion route (e.g., from hand to mouth contact). Better and more consistent and thorough hand washing by inmate workers is needed. Some contamination of inmate housing and staff vehicles is also occurring, but is minimal.

- Particle size determinations found that dusts released from the glass breaking activities were sufficiently small to have significant potential for release to the ambient air and breathing zone of workers.

- The current local exhaust ventilation (LEV) system in the glass breaking room appears to be generally effective in capturing emissions from the glass breaking activity, however, in certain areas, some emissions escape capture. Improvement of this system could further reduce lead and cadmium exposures and is needed to comply with OSHA requirements for mechanical ventilation under the lead standard.

- Since 2003, UNICOR has made progress in controlling exposure to lead and cadmium. Positive actions include installation of the enclosed glass breaking room, installation of LEV in the glass breaking room, implementation of work practice controls, use of personal protective equipment and hooded powered air purifying respiratory protection for glass breaking workers, implementation of housekeeping measures, and provision of a change room. Nevertheless, at times, exposures in the glass breaking room have exceeded action levels and PELs, particularly for cadmium, between 2003 and 2007. Although respiratory protection is used to control these exposures, OSHA requires the use of engineering and work practice controls. Further improvements in controls are, therefore, necessary.

Medical Surveillance for Lead and Cadmium

- The highest annual mean BLL for inmates doing glass breaking was measured at 5.6 µg/dL in 2003. These biological monitoring results indicate some bodily uptake of lead. These BLLs are well below levels that would warrant medical removal protection under the OSHA standard, however, subclinical adverse health effects at BLLs of <10 µg/dL have been reported in the literature (see Attachment 3). The BLLs have generally declined over time from 2003 – 2007, indicating that exposures have likely similarly decreased. The blood and urine cadmium results from 2003 – 2007 were well below levels that would warrant medical removal protection under the OSHA standard. No biological monitoring results were available for inmates doing glass breaking from 1997 – 2003, when exposures were likely higher.

- Medical surveillance provided to inmates and staff involved with glass breaking operations is not in compliance with OSHA standards. For instance, no medical exams (including physical examination) are performed on inmates; staff receive inconsistent examinations and biological monitoring by their personal physicians; biological monitoring for lead is not conducted at the prescribed six month intervals; and results have not been consistently communicated to workers. In addition, inappropriate biological monitoring tests have been performed. Records of medical surveillance are not maintained by UNICOR or FCI Elkton for the appropriate length of time.

- The only persons with current potential for exposure to either lead or cadmium over the action levels are inmates who perform glass breaking, cleaning in the glass breaking room, or monthly filter change-outs. These inmates require continued medical surveillance. Medical surveillance can be discontinued for all other inmates and staff, although some former inmates and/or staff may require continued surveillance under the OSHA cadmium standard because of potential past exposures.

- Exposure to lead from the past chip recovery process cannot be conclusively determined because of the lack of biological monitoring and exposure data.

Health and Safety Regulatory Compliance

- Beginning for the most part in 2003 and continuing through the time of this investigation, UNICOR at FCI Elkton has implemented engineering controls, work practices, personal protective equipment, respiratory protection, housekeeping, and other measures to mitigate inmate and staff exposures to lead and cadmium during glass breaking. These actions are partially consistent with the OSHA lead and cadmium standards which require that engineering and work practice controls be implemented to maintain exposures at or below the PELs. However, engineering controls (i.e., the LEV mechanical ventilation system) are not designed or tested in compliance with OSHA standards. At times since 2003, exposure excursions above the PEL for cadmium have occurred, which indicates that further improvements in engineering and work practice controls are required.

- The use of respiratory protection between 2004 and present has been adequate to protect workers against the exposure excursions above the action levels and PELs during routine glass breaking. OSHA standards, however, require that routine exposures above the PEL (i.e., over 30 days per year) be controlled by the use of engineering and work practice controls, regardless of whether respiratory protection is used.

- UNICOR's response to elevated exposures is unclear. UNICOR has made continued improvements in exposure controls since 2003. However, when exposures exceed the PEL, OSHA requires that actions be detailed to reduce exposures to below the PEL. Past monitoring results showing elevated exposures cannot be clearly linked to subsequent improved control actions. UNICOR lacks a compliant exposure monitoring program that is followed by improved exposure controls should results so warrant. Control actions are not documented in a written compliance program for lead and cadmium.

- UNICOR has not conducted exposure monitoring consistent with OSHA lead and cadmium standards that require initial monitoring and follow-up monitoring at a frequency that is based on results and exposure potential or changes in process and controls.

- Past UNICOR recycling practices at FCI Elkton were likely to have produced uncontrolled or poorly controlled releases of lead and cadmium dusts.

Hazard Analysis and Hazard Controls

- Prior to the DOJ OIG's investigation, neither UNICOR nor FCI Elkton had implemented effective hazard analysis processes to proactively identify hazards and degrees of exposure and ensure adequate control measures. This is evidenced by the various findings of this report, including failure to recognize, evaluate, or control the extent of the filter maintenance exposure, deficient exposure monitoring, deficient medical surveillance, OSHA non-compliances, and others.

Environmental Compliance

- UNICOR and FCI Elkton have not adequately evaluated their wastewater, air emissions, and hazard waste streams for compliance with applicable environmental standards. BOP and UNICOR need to better coordinate their environmental control efforts.

Exposures to Other Hazards

- Noise exposure during glass breaking was above the level that requires the implementation of a Hearing Conservation Program. Potential hazards from excessive heat and from lifting/twisting also exist.

We also found that UNICOR has been responsive to recommendations made by the various federal agencies during the course of our assessments at FCI Elkton. In particular, it has effectively implemented several protective controls to mitigate elevated exposures identified during a non-routine operation (i.e., filter change-out maintenance in the CRT glass breaking area), and will be remediating legacy contamination from early recycling operations and the chip removal project as identified in our earlier interim report concerning FCI Elkton (see FOH report in Attachment 2). BOP also has retained a board-certified occupational physician who will be stationed at BOP headquarters and provide medical consultation to improve the medical surveillance program at FCI Elkton and other institutions where electronic recycling is performed.

We further believe that it is worth noting that our investigation has revealed that UNICOR's e-waste recycling operations provide meaningful employment for BOP inmates and staff and make important environmental contributions that should be recognized. For example, during fiscal years 2003 to 2005, UNICOR processed more than 120 million pounds of e-waste. UNICOR's recycling factories, including FCI Elkton, also have obtained IS0 9000 certification from the National Standards Authority of Ireland, demonstrating UNICOR's commitment to institute quality controls to meet customer and regulatory requirements. We also acknowledge the views of U.S. EPA Senior Scientist, Robert Tonetti, an internationally recognized expert on e-waste recycling. In February 2007, Mr. Tonetti advised FOH and the OIG of his positive opinion of UNICOR's e-waste recycling operations. Mr. Tonetti's opinion is provided as Attachment 6 to this report. However, despite UNICOR's recycling achievements, its past e-waste recycling operations are a major concern and are part of an ongoing assessment that is not yet concluded. As explained by NIOSH, electronics recycling at FCI Elkton appears to have been performed from 1997 until May 2003 without adequate engineering controls, respiratory protection, medical surveillance, or industrial hygiene monitoring (see Section 5.4). Also, while the current operations reflect a significant improvement, further ES&H enhancements are recommended in order to limit personal exposures, prevent uncontrolled migration of lead and cadmium-laden dust, implement a more effective medical surveillance program, and, overall, fully comply with current regulatory requirements and 'good practice' standards.

Lastly, aside from UNICOR's recycling operations, we are concerned about the limited amount of research that has been conducted on the health effects of e-waste recycling. We found few peer-reviewed studies dealing with the recognition, evaluation, and control of occupational hazards associated with the de-manufacturing of waste electronic equipment and the recovery and recycling of its toxic components. This information deficit is one that the industrial hygiene community should address given the increasing importance of e-waste recycling and predictions regarding the large volumes of e-waste that will be generated in the future.[5]

2.0 BACKGROUND

2.1 Whistleblower Allegations and Referral to DOJ OIG

In March 2004, Mr. LeRoy Smith, BOP Safety Manager at the United States Penitentiary (USP) in Atwater, California alleged to the U.S. Office of Special Counsel (OSC) that UNICOR inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium at USP Atwater and other BOP institutions as a result of the breaking of CRTs during computer recycling operations. Mr. Smith stated that air quality testing conducted on multiple occasions from 2002-2004 at USP Atwater repeatedly revealed elevated levels of airborne lead and cadmium in the UNICOR recycling facility. According to Mr. Smith, after each such test he would direct the suspension of operations and recommend additional safety precautions, but management personnel at the BOP and UNICOR repeatedly abused their authority by ordering the reactivation of operations without implementing his recommended safety measures and without the written approval of the Atwater Safety Department. In addition, Mr. Smith disclosed that BOP and UNICOR located a food service area in the recycling facility at USP Atwater despite the fact that, according to Mr. Smith, it was exposed to toxic releases. Finally, Mr. Smith disclosed that in the course of his attempts to address his safety concerns, he learned that similar alleged dangers existed in the recycling facilities located at several other BOP institutions throughout the country.

On November 15, 2004, OSC referred Mr. Smith's allegations to the Attorney General for investigation by the U.S. DOJ. Attorney General Ashcroft delegated responsibility for the

[5] For example, even prior to the initiation of the demanufacturing process, contamination from incoming waste electronics is also possible as a result of CRT breakage during shipment in trailers, and other factors. While it was beyond the scope of this investigation to evaluate the exposure potential associated with the initial receipt and handling of these materials, this should be further investigated by UNICOR.

investigation to the Director of the BOP. The BOP subsequently produced a report and an addendum in June and August 2005 respectively that substantiated some of Mr. Smith's allegations but ultimately concluded that "BOP, [UNICOR] and Safety Staff appeared to have adequately addressed" the safety concerns raised in Mr. Smith's disclosures. According to the BOP, BOP and UNICOR took "appropriate steps to ensure factories were operating properly." Mr. Smith vigorously disputed these findings and according to OSC provided it with documentary evidence to support his claims. Mr. Smith stated that BOP investigators failed to interview witnesses with relevant information and maintained that "[UNICOR] officials knowingly and willfully violated OSHA guidelines" and that BOP's investigation "was not impartial or comprehensive."

In a letter to DOJ dated April 3, 2006, OSC indicated that it had reviewed the BOP's reports and Mr. Smith's comments. OSC determined that while the BOP's reports contained all of the information required by statute, its findings were "unreasonable" and "inconsistent" with the documentary evidence provided by Mr. Smith. In particular, OSC indicated that the BOP's reports made little effort to explain why the documentary evidence furnished by Mr. Smith was unreliable or how it could be reconciled with the conclusions of the BOP investigation. OSC listed four specific defects in the BOP's reports, as presented in Figure 1 which follows.

Figure 1
OSC Identified Defects in the BOP's Investigation

1. The BOP failed to address the extensive body of countervailing evidence furnished by Mr. Smith.
2. The BOP's investigation into allegations that hazardous conditions existed in recycling facilities located at BOP institutions other that USP Atwater is cursory and does not appear to have sought evidence from staff members who have relevant knowledge about these facilities. In particular, the BOP failed to address conditions in the recycling facility at FCI Mariana despite the concerns raised by Mr. Smith regarding this facility.
3. BOP's contention that OSHA regulations only prohibit the consumption of food in areas exposed to excessive levels of airborne heavy metals is disingenuous in light of the regulatory definitions concerning 'recognized hazards.'
4. BOP wrongly excuses the conduct of UNICOR and BOP staff on the grounds that exposures were not "imminently dangerous, as no immediate threat of death or serious physical harm occurred" whereas the BOP program statement actually requires only that conditions "could reasonably be expected to cause death or serious physical harm" in order to trigger the safety manager's authority to shut down operations.

As a result of these perceived defects, OSC concurred with Mr. Smith's recommendation that an investigation be conducted by independent parties not subject to the supervision of BOP management. According to OSC, the investigation should "reliably ascertain the scope of the past and present dangers in [UNICOR's] computer recycling facilities and determine appropriate remedial measures for staff and inmate workers who may have been exposed to toxic materials in those facilities."

OSC conveyed its findings to the DOJ in April 2006. DOJ subsequently requested that the OIG oversee an independent investigation following a request for the same from the Director of the BOP.

2.2 Coordination of Federal Agency Responses

In May 2006, the OIG requested that FOH, NIOSH, and OSHA provide assistance with its investigation of Mr. Smith's allegations and participate in the collection of data, provide technical advice, and analyze various safety and health issues concerning BOP e-waste recycling facilities across the U.S. Later in 2007, following several site visits to FCI Elkton, the OIG requested the assistance of subject matter experts from the U.S. EPA to evaluate possible environmental concerns associated with the recycling operations there. Figure 2, *Objectives of ESH Investigation,* provides a listing of the team's overall objectives as specified by the OIG.

Figure 2
Objectives of ESH Investigation

1. Render independent judgments and opinions to the OIG concerning the BOP's current and past compliance with ESH regulations applicable to electronics (computer) recycling operations, especially as concerns improper exposure to toxic materials.
2. Address Mr. Smith's allegations that the BOP has not taken adequate precautions to ensure employee and inmate safety and health at its electronics recycling facilities.
3. In support of objectives 1 and 2, conduct interviews, document reviews, and site visits, and collect industrial hygiene samples, as necessary.
4. Address the perceived 'defects' identified by the OSC in the report concerning the BOP's evaluation of its recycling activities at United States Penitentiary Atwater (USP Atwater) (see Figure 1).
5. Provide recommendations for corrective actions to ensure the BOP's compliance with ESH regulations applicable to electronics recycling operations.
6. Identify for the BOP's consideration industry-accepted ESH best management practices for electronics recycling that would benefit the BOP's recycling operations.

Each federal agency had its own distinct responsibilities. FOH provided senior technical and managerial staff to coordinate the federal response, provided administrative support, and integrated findings into cohesive reports. NIOSH's Division of Applied Research and Technology (DART), Engineering and Physical Hazards Branch focused on characterizing current exposures from an industrial hygiene standpoint and provided information on the latest research dealing with substance toxicities and exposure limits and other worker protection issues. NIOSH's Division of Surveillance Hazard Evaluation and Field Studies/Hazard Evaluations and Technical Assistance Branch (DSHEFS/HETAB) evaluated current and past exposures from a medical perspective. OSHA helped determine the status of current operations with respect to compliance with pertinent OSHA regulations. U.S. EPA Region 5 performed an environmental audit to determine current regulatory compliance with existing federal environmental regulations and rules. Lastly, scientists from U.S. EPA's Headquarters Office of Solid Waste (OSW) provided guidance on various environmental-related technical issues pertaining to electronics recycling operations in the United States and around the world.

In general, the focus of the investigation at FCI Elkton, as described in this report, involved the inspection of UNICOR's current e-waste recycling facilities and operations; interviews of staff and inmate personnel; and reviews of salient documents such as recent internal workplace inspection records, recycling production reports, and medical records. These activities were sequenced in a logical fashion. First, an evaluation of personal exposures to toxic materials was performed along with limited testing of building surfaces in order to ascertain the degree and locations of exiting surface contamination from past operations (i.e., legacy contamination). Then, based on concerns identified from these initial assessments, the scope of the investigation was expanded to include an assessment of the medical surveillance program, an environmental audit to better identify and understand the nature of various waste streams associated with the recycling operations, and additional personal exposure monitoring and surface wipe sampling. Various samples and measurements were collected, including:

- Personal breathing zone and workplace area air quality samples;
- Wipe samples (walls, floors and other building components);
- Hand/skin wipe samples;
- Dust samples;
- Waste glass samples;
- Mop rinseate samples;
- Noise measurements (area and personal dosimeter); and
- Local exhaust ventilation (LEV) qualitative testing.

In all cases, samples were collected using calibrated equipment in strict accordance with standardized and accepted methodologies. Similarly, sample analyses were performed by accredited laboratories using approved methodologies.

2.3 Findings Incorporated into this Report

The evaluation of current ES&H controls as they relate to worker and environmental protection together with the professional opinions offered in this report stem from the various site visits performed at FCI Elkton primarily during 2007 and 2008. A summary of the key work products that have been incorporated into this report is provided below in Figure 3, *Summary of Key Federal Agency Reports and Activities*. In addition, a variety of other sources of information was used as identified in the attached reference lists.

In summary, it is the overall objective of this report to accurately reflect the key findings, conclusions and recommendations provided by the various federal agencies. This report also provides additional conclusions and recommendations based upon the integrated findings of the various reports. Where judged appropriate, the sources of information relied upon for specific statements made in this report have been carefully cited.

Figure 3
Summary of Key Federal Agency Reports and Activities

Report	Organization	Visit Dates	Summary
"Control Technology and Exposure Assessment for Electronic Recycling Operations, Elkton Federal Correctional Institution" July 2008 (Attachment 1)	NIOSH DART/EPHB	February 26 – March 2, 2007 December 11 – 13, 2007	Provides an in-depth evaluation of exposures to metals and other occupational hazards as well as changes made in selected activities as a result of initial recommendations. Additional testing for noise showed that some exposures were in excess of action levels. Numerous recommendations are provided.
"Summary of Findings and Recommendations Pertaining to Air/Wipe/Bulk/TCLP Sampling Data from Electronics Recycling Facilities, FCI Elkton" November 15, 2007 (Attachment 2)	FOH EHS	February 26 - March 2, 2007	Provides interim findings from initial on-site assessments and includes data from a variety of testing methods utilized in each of the three buildings where e-waste recycling operations were conducted. Elevated levels of lead and cadmium contamination were identified on various surfaces of each building consistent with the premise that dust particles from past glass breaking operations and fumes from past chip recovery operations were released into the general factory environment and not effectively addressed via engineering controls. Surface contamination detected in change rooms and other surfaces showed that some migration from current operations is occurring. Air sampling showed that current exposures from routine operations (glass breaking and others) are within acceptable limits while excessive exposures were identified during filter change-out operations in the glass breaking area. Testing of rinse water from floor mopping activities showed that the rinseate is not a hazardous waste. Recommendations provided for additional exposure characterizations and the immediate implementation of an operations and maintenance plan to protect building occupants from surface contamination.

Interim letter report assessing the existing medical surveillance program for inmates and staff exposed to lead and cadmium during electronics recycling at FCI Elkton July 16, 2008 (Attachment 3)	NIOSH/DSHEFS/HETAB	February 21-22, 2008 and March 25, 2008	Provides a summary of findings and recommendations relative to the existing medical surveillance program for workers involved in e-waste recycling operations as based on a review of medical surveillance and blood/urine monitoring results, industrial hygiene assessments, interviews, and other information. Also provides an industrial hygiene evaluation. Findings indicated that from 1997 to 2003 inadequate engineering controls were utilized and that respiratory protection, medical surveillance, and industrial hygiene monitoring were also not sufficient. Testing showed that contamination of inmate housing and staff vehicles is occurring but is minimal, and while some take-home contamination occurs it does not pose a health threat at this time. NIOSH further concluded that the only persons with the current potential for exposure to either lead or cadmium over the action levels are the inmates who perform glass breaking or the monthly filter change-out and that medical surveillance can be discontinued for all other inmates and staff. Numerous recommendations are provided.
Letter Report of OSHA Compliance Inspection and Citations February 27, 2006 (Attachment 4)	OSHA (Cleveland Area Office)	August 24 - November 29, 2005	Provides findings from multiple OSHA site visits conducted during the latter part of 2005. Sampling to determine lead and cadmium exposures among UNICOR inmates working in the CRT glass breaking area showed that the OSHA Permissible Exposure Limit for cadmium was exceeded. Also, OSHA Action Levels were exceeded for both lead and cadmium. As a result, OSHA issued a Notice of Unsafe or Unhealthful Working Conditions which included two "serious" citation items.
"Multimedia Inspection Report" April 23, 2008 (Attachment 5)	U.S. EPA Region V	December 10-13, 2007	Provides the findings from a multi-media compliance investigation encompassing wastewater, storm water, air, and hazardous waste regulations. According to U.S. EPA, storage of some e-waste materials where stormwater is generated outside the warehouse building may necessitate UNICOR or FCI Elkton to apply to Ohio EPA for a NPDES

			permit or a "no exposure permit exemption." One currently active air emission source was identified (glass breaking operation) which may require a state permit to install and/or operate unless it can be demonstrated that an exemption to these permitting requirements is applicable. In addition, a number of potential hazardous waste-related regulatory violations were identified dealing with, for example, leaking boxes of contaminated waste air filters, incorrect RCRA identification numbers, inaccurate waste shipment logs, etc.

2.4. Hazards in E-Waste

Electronic equipment such as televisions, monitors, CRTs, personal computers, and peripherals are known to contain various toxic materials that pose a potential worker and environmental hazard. More specifically, different toxic materials are associated with the various individual components of the equipment. When these components are processed for recycling or disposed in a landfill, toxic materials may be released which can adversely impact human health and the environment.

The personal computer is comprised of the main machine (central processing unit (CPU)), a monitor, and a keyboard. Various peripheral devices also can be added, including printers and external hard drives. As indicated in Figure 4 a number of toxic materials are present within the various components used to manufacture these devices.

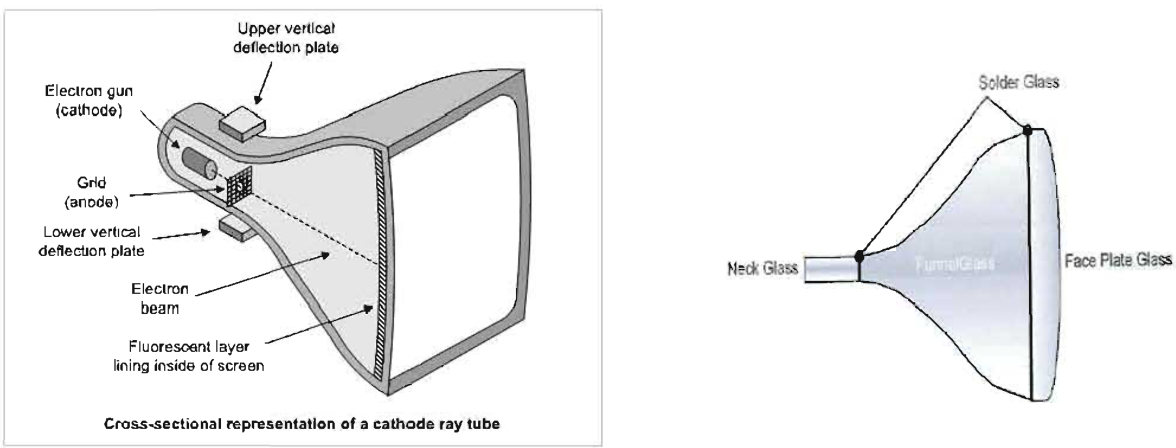
Figure 4
Toxic Materials in Computer Components

Toxic Materials	Reference
• Nickel and cobalt in disk drives • Barium and cadmium coatings on computer glass • Lead solder on circuit boards and video screens	Chepesiuk [1999]
• Lead used to join metals (solder) and for radiation protection is present in the CRT and printed wiring board (PWB). • Gallium is used in semiconductors; it is present in the PWB. • Nickel is used in structural components and for its magnetivity; it is found in steel housing, CRT and PWB. • Vanadium and yttrium function as red-phosphor emitters and are used in the CRT.	Schmidt [2002]

Toxic Materials	Reference
• Beryllium, used for its thermal conductivity, is found in the PWB and in connectors. • Chromium, which has decorative and hardening properties, may be a component of steel used in the housing. • Cadmium, used in Ni-Cad batteries and as a blue-green phosphor emitter, may be found in the housing, PWB and CRT.	
• Cadmium is present in components like surface mount device (SMD) chip resistors, semiconductors, and infrared detectors.	Cui and Forssberg [2003]
• Arsenic, which is used in doping agents in transistors, may be found in the PWB	Schmidt [2002]

Furthermore, as illustrated in Figure 5, the CRT of a color monitor is comprised of the "panel glass (faceplate), shadow mask (aperture), electronic gun (mount), funnel glass and deflection yoke.

Figure 5
CRT Components



Source: Maxfield, CM, & Brown, A. DIY Calculator. The origin of the computer console/ display/screen/monitor. Retrieved July 30, 2008 from: http://www.diycalculator.com/sp-console.shtml; and ICER. [2003]. New Approach to Cathode Ray Tube (CRT) Recycling. Report prepared for DTI. GW-12.10-130.

The degree of hazard posed by the toxic materials present in CRTs and other electronics components is a function of a number of factors. First, the amount (i.e., weight, concentration) of a given toxic material can directly impact how hazardous that component can be to workers who handle it or to the propensity for it to cause environmental degradation in a landfill. For example, references note that face plate (panel) glass has a high barium concentration (up to 13%) for radiation protection and a low concentration of lead oxide while the funnel glass has a higher amount of lead oxide (up to 20%) and a lower barium concentration. Analysis of a typical 14-in Philips color monitor showed that the panel contained silicon, oxygen, potassium, barium and aluminum in concentrations greater than 5% by weight, and titanium, sodium, cerium, lead, zinc, yttrium, and sulfur in amounts less than 5% by weight. Analysis of the funnel glass revealed greater than 5% silicon, oxygen, iron and lead by weight, and less than 5% by weight potassium, sodium, barium, cerium, and carbon. [Lee, et al., 2004]

Second, different materials have different occupational exposure limits (OELs). For example, the OSHA airborne permissible exposure limits (PELs) for cadmium is 0.005 mg/m^3, while lead has a PEL of 0.05mg/m^3 and barium has a PEL 0.5 mg/m^3 (for barium sulfate, as barium).

Finally, from a worker exposure perspective, hazards are also a function of the types of activities performed with the component and the protective controls employed. For example, the CRT recycling process at FCI Elkton involves breaking the CRT glass with a hammer. This releases fine dust particles which can contribute to the spread of contamination and inhalation hazards due to lead, cadmium, and other toxic materials. However, this can be dramatically mitigated, if not eliminated, by process modifications and the use of effective engineering controls (e.g., local exhaust ventilation) and personal protection equipment such as respirators.

Overall, not all of the toxic materials found in the electronics equipment being recycled at FCI Elkton were judged to warrant investigation from a hazardous exposure viewpoint. The elements deemed to be the most important include lead, cadmium, beryllium, barium, nickel, chromium, zinc, and arsenic. Other materials were considered less hazardous due to their relative amounts, toxicities, and based on the premise that the protective controls utilized for the more hazardous materials would be adequately protective for them as well. These and other considerations dealing with the hazards in electronics equipment are discussed in greater detail and referenced in the NIOSH/DART report, Attachment 1.

Finally, based on the literature reviews conducted as a part of this investigation, it is apparent that there is currently a dearth of information regarding the industrial hygiene aspects of electronics recycling operations. While there is much published dealing with the environmental consequences of disposing of 50 million tons annually of electronics waste worldwide [DataChem, 2008], few peer-reviewed studies were found dealing with the recognition, evaluation, and control of occupational hazards associated with the de-manufacturing of waste electronic equipment and the recovery and recycling of its toxic components. This information deficit is one that the industrial hygiene community should address given the increasing importance of e-waste recycling and predictions regarding the large volumes of e-waste that will be generated in the future.

3.0 ENVIRONMENTAL, SAFETY, AND HEALTH LAWS AND REGULATIONS APPLICABLE TO E-WASTE RECYCLING

OSHA regulates occupational exposure to air contaminants such as lead, cadmium, and other toxic metals, as well as other workplace hazards such as noise. The U.S. EPA regulates environmental hazards such as air emissions, wastewater discharges, and hazardous waste storage and disposal. Laws, regulations, and other standards that apply to FCI Elkton electronics recycling operations are discussed in this section.

3.1 OSHA Standards and Other Guidelines

In order to regulate occupational exposures to air contaminants, such as toxic metals and physical hazards such as noise, OSHA establishes permissible exposure limits (PELs), that are generally specified as time weighted average (TWA) concentrations that cannot be exceeded over an 8 hour work day. For some hazards, OSHA also establishes an acceptable ceiling (C) concentration or short term exposure limit (STEL) that cannot be exceeded at any time (or over a specified short period of time) during the work shift. When these exposure limits are exceeded, the employer must take action to reduce and maintain the exposures to at or below the exposure limits. [Note: STEL and C limits are not applicable to lead or cadmium.]

In general and whenever feasible, OSHA requires the use of engineering and work practice controls to correct any overexposure, rather than use of personal protective equipment or respiratory protection as the primary means of exposure control. In addition, certain substance specific OSHA standards contain specific requirements for engineering and work practice controls, such as the lead and cadmium standards.

In addition to the PELs, OSHA also establishes action levels (ALs) that are generally half or approximately half of the PEL. When action levels are exceeded, OSHA standards often mandate actions that the employer must take to control exposures, such as exposure monitoring, training, engineering and work practice controls, and medical surveillance.

Aside from regulatory requirements, the American Conference of Governmental Industrial Hygienists (ACGIH) establishes and publishes non-binding Threshold Limit Values (TLVs) for many air contaminants and other hazards. These TLVs are not mandated by regulation, but provide a good practice standard based on current and peer reviewed information. They are more regularly updated than OSHA PELs. Similar to the PELs, the TLVs are specified as TWAs over an 8 hour work shift and 40 hour work week, and/or as a STEL that usually refers to a 15 minute duration. Many government and industry organizations, by internal policy, use the lower of the OSHA PEL or ACGIH TLV to evaluate and control exposures, but this approach is not a requirement.

NIOSH also establishes non-binding “recommended exposure limits” (RELs). The RELs are also not mandated, but provide an additional source of information to evaluate workplace exposures.

OSHA, ACGIH, and NIOSH exposure limits are listed in Table 1 for select hazards, including lead, cadmium, and noise.

Table 1
Occupational Exposure Limits[1]

	LEAD ($\mu g/m^3$)	CADMIUM ($\mu g/m^3$)	BARIUM ($\mu g/m^3$)	BERYLLIUM ($\mu g/m^3$)
OSHA PEL	50	5.0	500	2[5]
OSHA ACTION LEVEL[2]	30	2.5	N/A	N/A
ACGIH TLV (Total Exposure)	50	10.0	500	0.05[4]
ACGIH TLV (Respirable Fraction)	N/A	2.0	N/A	N/A
NIOSH REL	50	*Ca*[3]	500	0.5

Notes:

1. All limits are based on an 8-hour time weighted average (TWA) exposure. NIOSH RELs are based on TWA concentrations of up to a 10-hour workday during a 40-hour workweek.
2. The action level is an exposure level (often around half of the PEL) that triggers certain actions, such as controls, monitoring, and/or medical surveillance under various OSHA standards.
3. *Ca* (Potential Occupational Carcinogen). NIOSH RELs for carcinogens are based on lowest levels that can be feasibly achieved through the use of engineering controls and measured by analytical techniques. [NIOSH 2005]
4. ACGIH TLV 2009 adoption.
5. OSHA also has 5 $\mu g/m^3$ ceiling and 25 $\mu g/m^3$ peak exposure limits.

In addition to establishing exposure limits, many OSHA standards contain a regimen of requirements that the employer must implement to address such issues as exposure control, employee training, employee notification and communication, hazard analysis, record keeping, compliance, and many others. These requirements are often quite specific and prescriptive in nature. To achieve compliance with OSHA standards, the employer must implement many additional measures than simply controlling exposures to below the PEL.

As discussed in Section 2.0, Background, the literature and other information sources identify the presence of lead, cadmium, and other toxic metals in the types of electronic equipment that are recycled at FCI Elkton. These toxic metals represent potential employee exposures. Other types of hazards such as noise are also factors.

Key OSHA standards and requirements that apply to FCI Elkton electronic equipment recycling are listed below.

- 29 CFR 1910.1025, Lead - delineates exposure limits, control actions, and other actions required when workers are exposed to lead.

- 29 CFR 1910.1027, Cadmium - delineates exposure limits, control actions, and other actions required when workers are exposed to cadmium.

- 29 CFR 1910.1000, Air Contaminants, Tables Z-1, Z-2, and Z-3 lists permissible exposure limits (PELs) for air contaminants.

- Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1), commonly referred to as the OSHA General Duty Clause defines the employer's obligation to provide for a workplace that is free from recognized hazards that are causing or are likely to cause death or serious physical harm. This clause applies to all workplace hazards, even those that are not specifically regulated by a substance specific standard.

- 29 CFR 1960, Basic Program Elements for Federal Employees requires Federal agencies to establish and maintain an effective and comprehensive occupational safety and health program. BOP has developed an ES&H program entitled Occupational Safety, Environmental Compliance, and Fire Protection, 1600.9. The policies established in this program statement apply to FCI Elkton and other UNICOR facilities.

- Other OSHA standards also apply such as standards for noise, hazard communication, respiratory protection, personal protective equipment, and hazard analysis.

Each of these OSHA standards is summarized or referenced below.

3.1.1 Lead and Cadmium Standards

The OSHA Lead and Cadmium standards apply to all occupational exposures to lead and cadmium. These standards mandate exposure limits, engineering and work practice controls, development of a compliance plan to reduce exposures to at or below the PELs, training, exposure monitoring, medical surveillance, personal and respiratory protective equipment, hygiene practices and facilities, record keeping, reporting, and other controls and actions.

3.1.2 Air Contaminant Standards for Other Metals

The Air Contaminant Tables Z-1 and Z-2 provide PELs for various metals (other than lead and cadmium). Examples include beryllium and barium. ACGIH TLVs supplement the PELs with more frequently updated, good practice exposure levels. In some cases, such as for strontium, no PEL or TLV has been established. In these cases control of coincident metals such as lead and cadmium would have the practical benefit of controlling other metals such as strontium.

Personal exposures to the hazards must be maintained at levels below the PEL. Should the PEL be exceeded, exposure controls shall be implemented. If feasible, engineering, work practice, and/or administrative controls are to be implemented preferentially over personal protection and respiratory protection controls.

3.1.3 OSHA General Duty Clause

The OSHA General Duty Clause requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. This clause essentially addresses the employer obligation to control worker exposure to hazards even if they are not covered by specific OSHA standards. In the case of FCI Elkton, this could include exposure to excessive heat, ergonomic hazards, or toxic metals for which no exposure limit has been established. The primary emphasis of this report is to address potential employee exposure to toxic metals; however, certain other potential hazards are discussed.

3.1.4 Basic Program Elements for Federal Employees

Under 29 CFR 1960 each federal agency is obligated to develop a comprehensive and effective safety and health program. The BOP has established an ES&H program entitled Occupational Safety, Environmental Compliance, and Fire Protection, (BOP Program Statement 1600.09). This policy provides general requirements for implementation of safety and health practices, but lacks details for implementing ES&H practices or OSHA requirements in the field.

3.1.5 Other OSHA Standards

Many other OSHA standards apply to e-waste recycling operations at FCI Elkton, such as noise, hazard communication, respiratory protection, personal protective equipment, and hazard analysis. It is beyond the scope of this report to provide a comprehensive review of all applicable standards. However, Section 6.5 references and discusses certain of these other applicable standards, as they apply to UNICOR and FCI Elkton.

3.2 U.S. EPA Regulations

As identified in the U.S. EPA's Multimedia Inspection Report (Attachment 5), environmental laws and regulations that apply to UNICOR's e-waste recycling operations at FCI Elkton include the following:

- Clean Water Act and its implementing regulations govern discharges to navigable waters. Lead and cadmium are potential hazardous materials in wastewater and storm water discharges.

- Clean Air Act and its implementing regulations govern emissions of pollutants to the ambient air. Lead and cadmium, among other hazardous materials and substances can be found in emissions from recycling operations.

- Resource Conservation and Recovery Act (RCRA) and its implementing regulations, govern the storage and disposal of hazardous wastes. Wastes that contain lead, cadmium, and other metals can be regulated under RCRA.

4.0 UNICOR E-WASTE RECYCLING FACILITIES AND OPERATIONS AT FCI ELKTON

The NIOSH/DART and NIOSH/DSHEFS/HETAB reports provide a description of UNICOR's e-waste recycling facilities, operations, and activities at FCI Elkton. These reports are referenced in Section 9.0 and provided as Attachments 1 and 3 to this report. This section consolidates information from these NIOSH reports. Floor plans for FCI Elkton's e-waste recycling operations are shown in Figures 6-9.

FCI Elkton opened in 1996, and began electronics recycling in early 1997. The recycling of electronic equipment components is performed in three buildings: the main factory located within the FCI main compound (referred to as the factory in this report); the Federal Satellite Low (FSL); and the warehouse. Diagrams of these work areas are also provided in the NIOSH/DART report (Attachment 1).

Figure 6
Diagram of the UNICOR Factory Located within the FCI Main Compound
(See Figure 9 for more detail of Glass Breaking Operation)

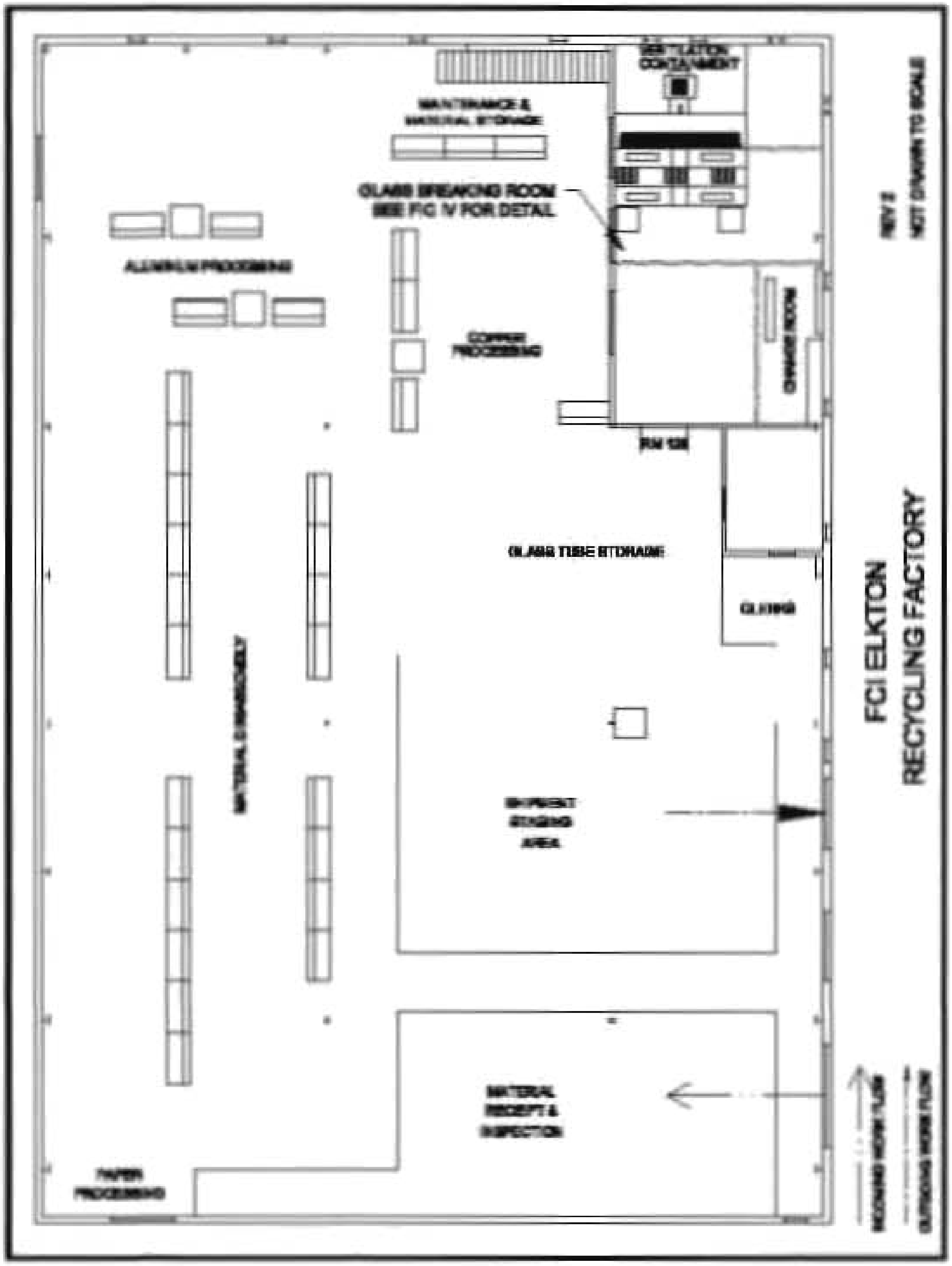


Figure 7
Diagram of the UNICOR Facility in the Federal Satellite Low (FSL)

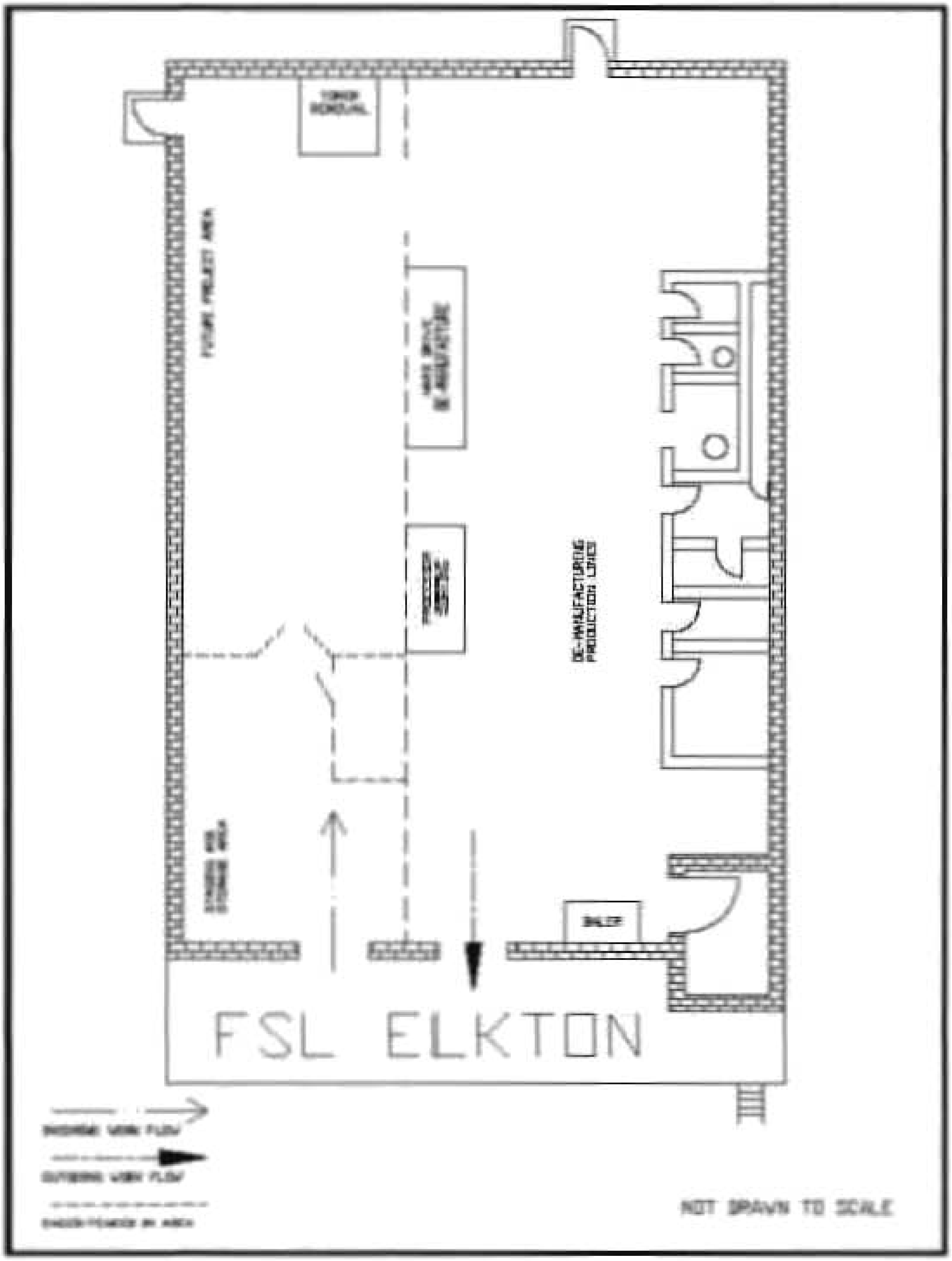


Figure 8
Diagram of the Warehouse for Electronics Recycling Operations

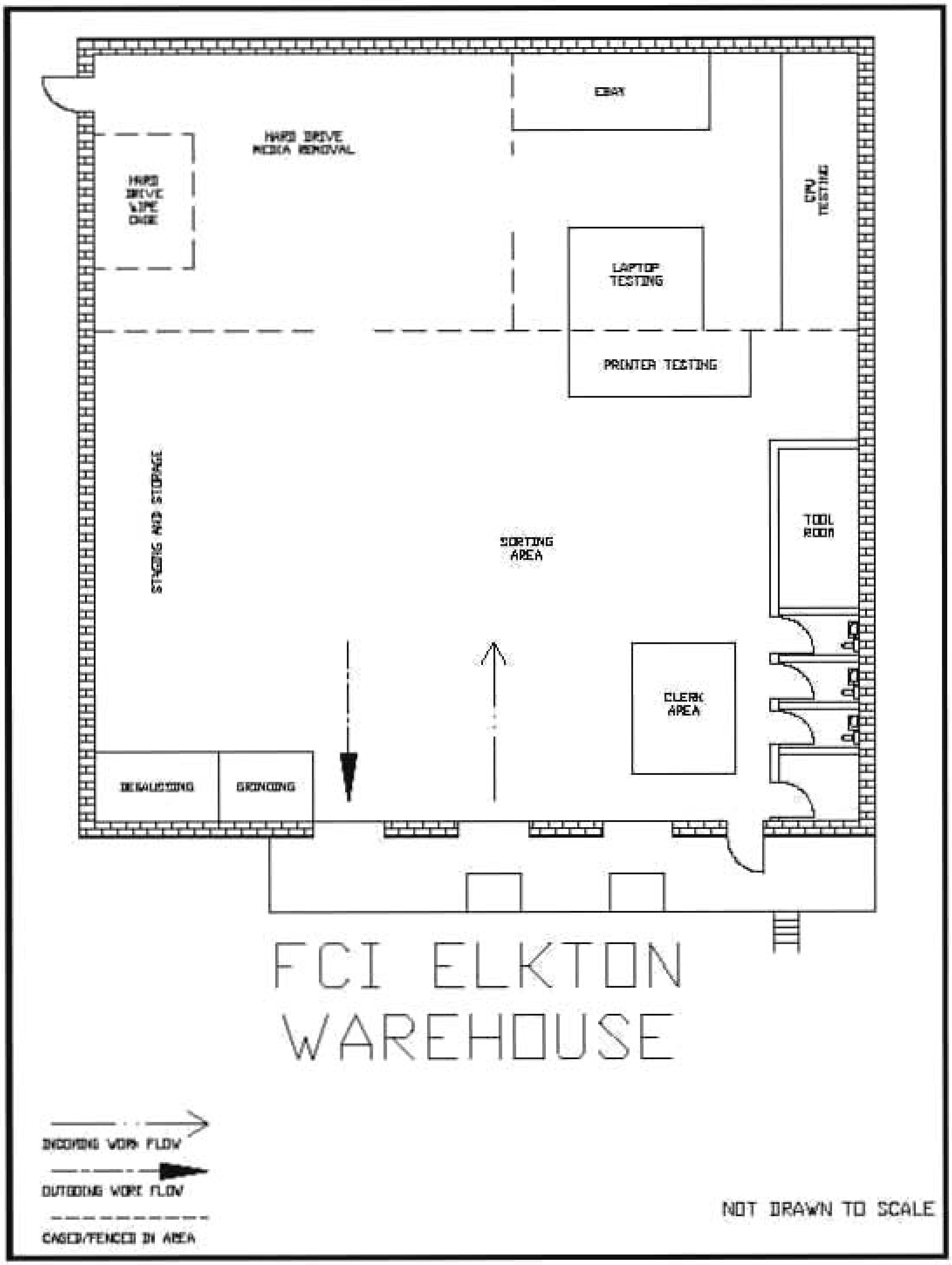
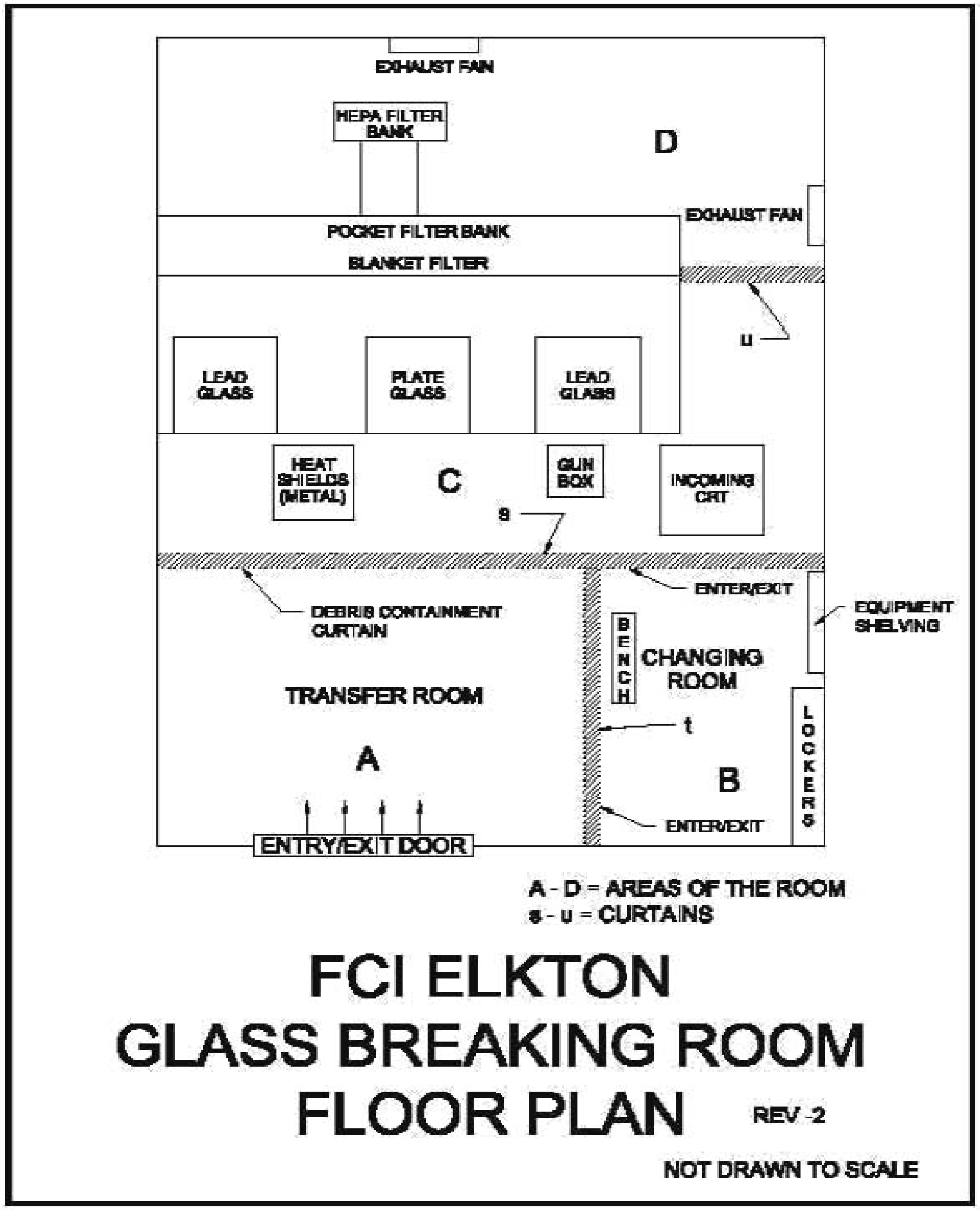


Figure 9
Diagram of the Glass Breaking Area within the FCI



The electronics recycling operations can be organized into four production processes: receiving and sorting; disassembly; glass breaking operations; and packaging and shipping. Each of these processes is described below as they were conducted at the time of the FOH/NIOSH site visits.

Incoming materials to be recycled are received at the warehouse where they are examined and sorted. After electronic memory devices (e.g., hard drives, discs, etc.) are removed and degaussed or shredded, computer central processing units (CPUs), servers and similar devices are sent for disassembly Monitors and other devices (e.g., televisions) that contain CRTs are separated and sent for disassembly and removal of the CRT. Printers, copy machines, and any device that could potentially contain toner, ink, or other expendables are segregated and inks and toners are removed prior to being sent to the disassembly area.

[redacted]

Image 1 View of FCI Elkton Recycling Factory Disassembly Area

In the disassembly process, external cabinets, usually plastic or metal, are removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing are removed and sorted by grade for further treatment if necessary. Components such as circuit boards or chips that may have value or may contain precious metals such as gold or silver are removed and sorted. With few exceptions each of the approximately 85 workers in the main factory performs all tasks associated with the disassembly of a piece of equipment.

In the glass breaking room, CRTs from computer monitors and TVs are processed for recycling. This is the only process where local exhaust ventilation (LEV) is utilized or where respiratory protection is in universal use. The LEV system consisted of a large walk-in hood, approximately 8 ft high, 16 ft wide, and 6 ft deep, with 2 or 3 workers positioned toward the front. Air is pulled from behind the workers, past the work area where contaminants are released, and through a filtration system. The filtration system consists of a blanket filter, a bank of pocket filters, and a high efficiency particulate air (HEPA) filter to remove progressively smaller particles from the air before exhausting into a storage area behind the hood. Finally, materials processed for recycling, disposal, or sale are packaged and prepared for shipment.

Image 2. Electron Gun Removal in Glass Breaking Operation

The operations/activities of greatest potential metals exposure are the routine glass breaking operation conducted daily in the glass breaking room and two periodic or non-routine activities that support glass breaking: weekly cleaning of the glass booth and monthly LEV HEPA filter maintenance. In addition, past operations involved a chip recovery and de-soldering process which also had potential for exposure to metals. These operations/activities are discussed in greater detail below.

4.1 Current Routine Glass Breaking Operations

Glass breaking operations are currently conducted only in the factory's glass breaking room, which was readied for use in April 2003. This room serves to isolate the glass breaking operation from the other operations in the factory by enclosing the room and equipping the operation with local exhaust ventilation. CRTs from computer monitors or televisions are processed for recycling in this area of the factory. The glass breaking room is divided into four areas by vinyl strip curtains hanging from the ceiling. The four areas include an entry area, the glass breaking work stations, the ventilation discharge area, and the "clean area" where inmates don and doff coveralls and other personal protective equipment (PPE). A walk-off mat is located immediately outside the entrance to the room to reduce dust carryout on shoes.

A LEV system adapted from a spray painting operation is installed in the room. Two inmate glass breakers, who stand facing each other at the ends of a rectangular grated work surface (table), are oriented at 90 degrees to the LEV airflow entering the prefilter. Each workstation has two small rectangular hoods and fans mounted behind and just below the work surface that are intended to capture airborne dust above the Gaylord boxes containing broken CRT glass. The fans/hoods are not ducted, but discharge, after HEPA filtration, into the work area approximately 2 ½ to 3 feet from the face of the retrofitted spray painting LEV system. The discharge is directed toward the face of the LEV system.

An inmate receives large open-top wooden and cardboard boxes with CRTs, and stages the boxes outside the glass breaking room. Periodically, the inmate uses a manual pallet jack to roll the boxes through the strip curtain into the area where the operation actually occurs and to remove Gaylord boxes of broken glass from the room.

Inmates who perform the glass breaking ("glass breakers") enter the clean area where they don cloth and/or Tyvek coveralls, gloves, and a hooded powered air purifying respirator (PAPR), and then enter the glass breaking area. CRTs are placed on the grate where they are manually shattered with hammers. The glass breakers reach through a strip curtain at opposite ends of the grate to break funnel glass at one work station, and panel glass at the other. Broken glass falls into Gaylord boxes positioned below the grate. When inmates finish breaking glass, they return to the clean area in their coveralls and PAPR, use a HEPA filtered vacuum on their coveralls before removing them, then remove their PPE and leave the area. Staff members enter the room only when there is no glass breaking underway to put away tools and search the area. Otherwise they observe the inmates in the glass breaking room through the window or vinyl curtains.

4.2 Current Periodic or Non-Routine Activities in Support of Glass Breaking

Periodic or non-routine activities are conducted in the factory to support the routine glass breaking operations conducted on a daily basis. These activities include weekly clean-up of the glass breaking room and monthly replacement or cleaning of filters associated with the LEV system.

Daily housekeeping is a routine activity of all production processes; however, a weekly extensive cleaning is conducted in the glass breaking area. During that operation no production takes place. All workers in this area remove settled dust by vacuuming and wet mopping. All surfaces, including walls, equipment, and floors are cleaned. The blanket pre-filter on the LEV system is vacuumed using the HEPA vacuum cleaner.

At approximately monthly intervals, the filters in the LEV system are removed and either cleaned or replaced. Prior to and during the evaluation by FOH and NIOSH in March

2007, filters were removed and cleaned by vacuuming, shaking, or banging on the floor to shake out dust. This took most of the work shift and reportedly created a thick cloud of dust within the enclosed glass breaking room. This process as conducted was not consistent with written procedures, and apparently UNICOR staff did not provide adequate supervision and oversight to ensure proper work practices. This process was changed after the FOH/NIOSH evaluation. Work practices now include a wetting process where the filters are wetted, removed, and bagged for disposal, and new filters are used as replacements.

4.3 Past Chip Recovery Project

A chip recovery and de-soldering program began at the FSL in October 2005, and ended in October 2006. Inmates removed computer chips from the mother board by holding the mother board over either a lead solder pot or a lead solder wave fountain. Although the solder temperature was supposed to be maintained just above the melting point (reportedly 400 to 600 degrees F), staff reported that the solder temperature was set subjectively (i.e., the temperature was not measured), which may have resulted in overheating, producing lead fume. There was no LEV for the first several months of this operation until what was described by staff as a "make-shift PVC system" was installed. This LEV system was replaced with another LEV system that appeared to be better designed. Despite the use of LEV at chip recovery stations, staff described a visible haze in the FSL, and expressed concern about exposure to lead fume from this operation.

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Images 3 and 4. Chip recovery stations showing use of LEV and PPE

PPE worn during this past operation included half facepiece air purifying respirators (APRs) for those working at pots and fountains and disposable dust masks for others. Inmates reported that filters for the APRs were not regularly changed, and that previously used dust masks were re-used at times.

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Image 5. LEV hoods and ductwork where chip recovery was performed

5.0 FIELD INVESTIGATIONS AND MONITORING RESULTS

FOH, NIOSH/DART, NIOSH/DSHEFS/HETAB, and U.S. EPA Region 5 conducted field investigations of UNICOR's e-waste recycling operations at FCI Elkton between February 2007 and March 2008. These investigations were coordinated efforts conducted at the request of the DOJ OIG. These investigations included personal exposure monitoring, surface wipe and bulk dust sampling, ambient area air monitoring, skin wipe sampling, exposure controls evaluation, work practices and facilities evaluations, and other field activities. These field investigations are listed in Figure 3 and are discussed in Section 2.3 of this report.

In addition, separate from the field activities described above, OSHA conducted an inspection of FCI Elkton starting in August 2005.

A summary of the field investigations and other contributions is provided below.

- NIOSH/DART performed personal exposure monitoring to determine exposures to toxic metals, surface wipe and bulk dust sampling, and particle size determinations. Controls to mitigate exposures were also reviewed. Noise exposures were evaluated. An initial site visit was performed in November 2006, and field work was conducted in February and March 2007. Follow-up field work was performed in December 2007.

- FOH conducted bulk dust and surface wipe sampling to determine levels of toxic metals contamination and the potential contribution to exposures. After an initial site visit in November 2006, this field work was conducted in February and March 2007.

- FOH followed up the dust and wipe sampling with area air monitoring for lead and cadmium, area particulate monitoring, personal monitoring in general work areas, and skin wipe analysis. This work was conducted in December 2007.

- NIOSH/DSHEFS/HETAB medical and industrial hygiene personnel evaluated FCI Elkton's lead and cadmium medical surveillance program relative to the OSHA lead, cadmium, and respiratory protection standards. They also evaluated the potential to spread contamination from work areas to homes or other areas of general occupancy. These investigations were performed in February and March 2008.

- OSHA conducted an on-site inspection, including lead and cadmium exposure monitoring, of UNICOR's recycling operations at FCI Elkton in August - November 2005.

- U.S. EPA Region 5 conducted a multi-media evaluation (i.e., wastewater discharges, air emissions, and hazardous waste storage and disposal) in December 2007 to determine compliance with environmental regulations.

Results for each of these evaluations are summarized in the subsections that follow. Complete reports for these evaluations are listed in Section 9.0, References, and are provided in Attachments 1 – 5.

5.1 NIOSH/DART Personal Exposure Monitoring for Toxic Metals and Noise

NIOSH/DART conducted a field investigation of the FCI Elkton electronic equipment recycling facilities to assess worker exposure to toxic metals and noise (see Attachment 1). Following an initial site visit in November 2006, the study was conducted from February 26 to March 2, 2007 with a follow-up survey conducted in December 2007. Personal exposure monitoring was conducted for 31 metals. Lead and cadmium were found to be the more significant exposures, but were generally maintained below the action levels and PELs of the lead and cadmium standards, with the exception of weekly glass breaking room cleaning and non-routine HEPA filter change-out activities. Yttrium was also initially found above the action level and PEL for the non-routine filter change-out activity. Exposure results for other metals were unremarkable (e.g., generally less than 10% of the applicable exposure limit). Exposure monitoring results from the NIOSH study are summarized below:

- All exposures for all metals monitored in locations outside the enclosed glass breaking room were well below the OSHA action levels and PELs.

- All exposures for all metals except lead and cadmium during routine glass breaking operations were well below OSHA PELs and/or below limits of detection (LOD).

- Lead and cadmium exposures during routine glass breaking operations were maintained below the action levels and PELs, but did indicate a potential for lead and cadmium exposure. The highest exposure result for lead was 18 $\mu g/m^3$ as compared to the action level of 30 $\mu g/m^3$ and the PEL of 50 $\mu g/m^3$. The highest exposure result for cadmium was 1 $\mu g/m^3$ as compared to the action level of 2.5 $\mu g/m^3$ and the PEL of 5 $\mu g/m^3$. As time weighted average (TWA) exposures, these levels were less than 20% of the lead and cadmium PELs. Respiratory protection was used during these operations and the above exposures are not adjusted based on the respiratory protection factor of 25.

- Cadmium exposure for a weekly glass breaking room cleaning activity was as high as 23 µg/m3 for a 79 minute sample. This calculates to an 8-hour time weighted average (TWA) of 3.8 $\mu g/m^3$, assuming that no additional exposure occurred for the work shift. [Note: This assumption is appropriate because glass breaking activities are not conducted on clean-up day.] This exposure is above the action level of 2.5 $\mu g/m^3$ and is 76% of the PEL of 5 $\mu g/m^3$. Respiratory protection with the appropriate protective capacity was in use.

- Lead and cadmium exposures detected in March 2007 during a non-routine maintenance activity (performed approximately monthly) that involved the change-out of HEPA filters associated with the glass breaking room's local exhaust ventilation (LEV) system (glass breaking booth) were far above the action levels and PELs. For lead, time weighted average (TWA) exposures were as high as 860 $\mu g/m^3$. For cadmium, TWA exposures were as high as 760 $\mu g/m^3$. These exposures are in the range of one to over two orders of magnitude higher than the PELs (up to 450 times the PEL (see Attachment 1). These levels of exposure far exceeded the protective capacity of the respiratory protection in use. Based on these results, UNICOR modified this procedure and follow-up monitoring conducted in December 2007 showed effective reduction and control of the lead and cadmium exposures. Although one cadmium result was still somewhat above the PEL as a TWA and another was above the action level, the exposures were well within the protective capacity of the respiratory protection in use. See Section 6.0. This maintenance activity is conducted approximately monthly and is about two to three hours in duration. Sample times were for the duration of the activity. In March 2007, UNICOR had a written procedure for this activity that apparently was not followed, but the procedure was not adequate and UNICOR staff did not provide adequate supervision and oversight to enforce proper work practices during the initial NIOSH monitoring episode.

- Based on one of the samples for airborne metals collected during the March 2007 non-routine filter change-out activity, Yttrium exposure was 76% of the PEL of 1,000 $\mu g/m^3$ as an 8-hour TWA. In addition, one personal impactor sample showed yttrium exposure to be 4,500 $\mu g/m^3$ for a five hour duration which corresponds to almost three times the PEL as an 8-hour TWA. These levels of exposure were well within the protective capacity of the respiratory protection used. Yttrium exposures in December 2007 after work practice improvements were implemented for the activity were less than 10% of the PEL as an 8-hour TWA. This indicates that work practice improvements effectively reduced and controlled yttrium exposure for this activity.

- Beryllium exposures during routine glass breaking operations were consistently below the limit of detection (LOD) or very close to the LOD and well below exposure limits. Beryllium exposures were also below the LOD during the non-routine HEPA filter change-out activities associated with the glass booth.

- Barium exposures during routine glass breaking operations were well below exposure limits and at unremarkable levels for all routine FCI Elkton activities. For the non-routine filter change-out activity, barium exposures ranged from 1 to 460 $\mu g/m^3$. The highest exposure was very close to the PEL of 500 $\mu g/m^3$. Implementation of modified work practices reduced barium exposure to below the LOD for this activity.

- Dust samples from various surfaces near recycling operations in both the main factory and warehouse were evaluated for particle size. All samples showed 90% of particles below 10 μm in diameter and 40% were in the 1 μm – 2 μm range. Particles in this range remain airborne for relatively long periods of time and can travel long distances, eventually being deposited as contamination on surfaces some distance from the point of generation. This finding supports the FOH results in Section 5.2 which show extensive surface contamination on structures at elevated heights and long distances from glass breaking. Small particles also have potential for penetration deeper into the pulmonary system and for greater absorption into the body. Smaller ("respirable") particles are of particular importance for cadmium and lead exposure.

- NIOSH/DART also conducted noise dosimetry during its studies in 2007. Inmates working in the glass breaking room and disassembly areas were monitored. Several noise exposure measurements in the glass breaking area were above 85 dBA as a TWA. This is the level above which OSHA requires workers be placed into a hearing conservation program. This level is also the ACGIH

TLV. The OSHA PEL is 90 dBA. One of several measurements approached this level at 82% of the allowable dose, and one exceeded this level at 137% of the allowable dose.

NIOSH/DART also evaluated the air flow in the glass breaking room that is served by a local exhaust ventilation (LEV) system designed to capture toxic metals emissions. Personal protective equipment is also used for glass breaking activities. Results and information include:

- Qualitative smoke tests indicated that the LEV system was generally effective in capturing airborne emissions; however, one area was noted to be less than completely efficient. The right side of the booth exhibited some back flow within the booth when smoke was released at the level of the grille. A small portion of the smoke was seen to travel to areas where inmate workers were present.

- Workers performing glass breaking wore hooded powered air-purifying respirators (PAPRs) with a protection factor of 25 (i.e., the assigned protection factor of a respirator reflects the level of protection that a properly functioning respirator would be expected to provide to a population of properly fitted and trained users. [Note: OSHA requires that many controls and other actions be taken based on exposures regardless of respiratory protection.]

Based on these results, it is apparent that lead and cadmium represent potential exposures to staff and inmates during normal glass breaking, weekly glass breaking room cleaning, and non-routine filter maintenance. The high levels of lead and cadmium on the LEV HEPA filters serving the glass breaking booth indicates extensive release of airborne lead and cadmium during glass breaking and, therefore, potential exposure that requires effective hazard controls and on-going evaluation through exposure monitoring to verify the effectiveness of control measures.

Routine activities conducted outside of the glass breaking room did not demonstrate potential for lead or cadmium exposures above the action levels or PELs.

Except for the weekly glass breaking room cleaning and monthly HEPA filter change-out procedure, the results also show that FCI Elkton is controlling exposures below the OSHA action level and PEL which is the objective of control actions. However, these limited monitoring episodes are not sufficient to confirm consistent exposure control over time. Also see results discussed in Section 5.4 regarding FCI Elkton's past exposure monitoring reviewed by NIOSH/DSHEFS/HETAB and Section 5.5 regarding compliance exposure monitoring conducted by OSHA. These exposure monitoring episodes show that, at times, exposures are above the action levels and/or PELs for lead and cadmium since the glass breaking room has been in operation. Section 6.2.1 discusses the types and frequency of exposure monitoring that is required by the OSHA lead and cadmium standards to verify that exposures are consistently controlled.

A partial summary of exposure monitoring results is shown in Table 2. This table lists only lead and cadmium exposure results for glass breaking, cleaning of the glass breaking room, and HEPA filter change-out.

Table 2
Personal Exposure Monitoring Results
NIOSH/DART

GLASS BREAKING ROOM ACTIVITY	DATE	DESCRIPTION	SAMPLE DURATION (MIN)	LEAD ($\mu g/m^3$)	CADMIUM ($\mu g/m^3$)
Glass Breaking ECM TFT 12	2/27/07	Area Sample	420	1	<0.1
Glass Breaking ECM WFT1	2/28/07	Glass Breaker	208	9.5	0.2
Glass Breaking ECM WFT2	2/28/07	Glass Breaker	305	8.9	0.6
Glass Breaking ECM WFT3	2/28/07	Feeder	258	7.5	0.3
Glass Breaking ECM WFT4	2/28/07	Glass Breaking Coordinator	412	18.0	0.8
Cleaning – Weekly ECM HF1	3/1/07	GBO Worker	79	5.7	23.3
Cleaning – Weekly ECM HF2	3/1/07	GBO Worker	72	2.02	4.7
LEV Filter Change ECM FF04B	3/2/07	Worker Changing Filter	91	25	18
LEV Filter Change ECM FF03A	3/2/07	Worker Changing Filter	128	2,700	2,400
LEV Filter Change ECM FF03B	3/2/07	Worker Changing Filter	90	760	650
LEV Filter Change ECM FF04A	3/2/07	Working Changing Filter	114	890	690
LEV Filter Change E2CMHT-02	12/13/07	Filter change revised practice	215	0.31	7.83
LEV Filter Change E2CMHT-03	12/13/07	Filter change revised practice	225	0.31	12.93
LEV Filter Change E2CMHR-03	12/13/07	Filter change revised practice	220	0.31	<0.04
LEV Filter Change E2CMHR-04	12/13/07	Filter change revised practice	229	0.31	0.11

Notes:

1. These are select results from the NIOSH/DART report. See Attachment 1 for complete results.
2. Results are for the duration of the sample and are not presented as 8-hour TWA exposures.

5.2 FOH Dust and Wipe Sampling for Lead and Cadmium

The FOH Investigative Team collected bulk dust and surface wipe samples from FCI Elkton electronic equipment recycling facilities in early 2007 to help determine potential exposure to toxic metals and determine the need for decontamination. This investigation supplemented the NIOSH/DART investigation by providing more comprehensive sampling across multiple facilities and facility components such as ventilation systems, roof areas, beams, and working areas. This study considered contamination from both current operations and legacy operations that have been discontinued.

These samples were analyzed for lead and cadmium, along with other metals. Wipe samples were analyzed for total lead and cadmium. Bulk dust samples were analyzed for total lead and cadmium and/or Toxic Characteristic Leaching Procedure (TCLP) lead and cadmium. Data indicated the presence of significant lead and cadmium on many surfaces of the FCI Elkton recycling factory and associated facilities. FOH issued an interim report to present and discuss the results, recommend interim measures to prevent exposure to the contamination, and recommend clean-up and decontamination guidelines (see Attachment 2).

Results from the FOH study are summarized as follows for the FCI Elkton recycling factory:

- Significant lead and cadmium contamination was found on surfaces inside the ventilation systems near 20' high ceilings and on elevated and non-elevated building surfaces. It is likely that this contamination emanated from CRT glass breaking operations that were performed in unenclosed locations on the factory floor in past years.

- The contamination was found at distances well away from current and former glass breaking areas, which indicates extensive migration of hazardous dusts. Levels were well above non-regulatory surface contamination guidelines for lead. See the FOH report, Attachment 2, for a discussion of surface contamination guidelines.

- Surface contamination inside the current glass breaking area was also high. Even with the current engineering controls, it is apparent that metals dusts are distributed within the currently enclosed glass breaking area. Periodic housekeeping measures are used to clean up this contamination.

- Some contamination of lesser amounts was found outside the current glass breaking area on workbenches and in the change rooms. This indicates that some migration of metals dusts occurs from the enclosed area. This also indicates that the current LEV system and change areas should be improved to further contain lead and cadmium dusts generated during glass breaking. Routine cleaning helps keep these contamination levels in check.

- Bulk samples of settled dust from various locations outside the current glass breaking area (e.g., ductwork, roof top near air handler) contained significant lead and cadmium.

Results from other FCI Elkton facilities associated with the recycling operations are as follows:

- The Warehouse had surface lead and cadmium contamination in the area designated "Warehouse Sorting Area." Reportedly, some glass breaking was performed in this area starting 1998; therefore, this contamination may be due to legacy activities. Warehouse contamination away from the sorting area had much less contamination.

- The FSL samples showed lead contamination on various surfaces and, to a lesser extent, some cadmium. Surfaces in or near the former chip recovery/de-soldering area had extremely high concentrations of lead. Other surfaces within offices on the opposite end of the building were low. Inner surfaces of LEV ducts and dampers showed extremely high concentrations of lead, which indicates lead releases during legacy de-soldering operations. Surfaces of existing exhaust dampers also showed high lead contamination, which indicates that airborne lead was previously exhausted to outdoor areas. Floors, work tables, and machines had some, but lower lead levels which indicates some but limited contribution to exposure and also suggests that current housekeeping helps keep these levels in check.

The bulk dust and wipe samples indicate that existing lead and cadmium contamination represents a potential exposure concern should the contamination become airborne or result in ingestion (e.g., through hand-to-mouth contact). Metals dusts from past glass breaking operations and de-soldering operations were apparently not effectively captured or mitigated through the use of engineering controls. Current glass breaking operations benefit from the use of LEV, but still have the potential for some but limited lead and cadmium migration outside the enclosed area.

In addition to FOH surface wipe and bulk dust sampling, past UNICOR testing of air filters used in the buildings' HVAC (general ventilation) systems serving the electronics factory workspaces have shown high levels of lead and cadmium. In addition TCLP analyses have shown that these filters exceeded EPA criteria for lead and cadmium and, therefore, must be treated as hazardous waste. This provides further indications that past uncontrolled releases of lead and cadmium dust had occurred from past recycling activities.

In light of these findings, the BOP has retained a contractor to remediate legacy contamination from past FCI Elkton recycling activities. Activities that could disturb existing contamination have been suspended pending decontamination work. In addition, these results indicate the importance of applying lead and cadmium controls and complying with the requirements of the OSHA standards.

Select data from the FOH study is compiled in Table 3. This partial data set is provided to show relative contamination levels in various areas.

Table 3
FOH Surface Wipe/Bulk Dust Sample Data

Row	Sample #	Date & Who Collected	Sample Type W–Wipe B– Bulk TCLP	Building Name	Snrface/ Item	Elevation (feet)	Description	Lead		Cadmium	
								μg/ft²	mg/kg	μg/ft²	mg/kg
1	1-ELK	2/27/2007 (FOH)	W	Warehouse	Top of Fluorescent Light Fixture	~20 (~2' from ceiling)	Black dust quite evideut	3,120		3,120	
2	2-ELK	2/27/2007 (FOH)	W	Warehouse	Top of Cold Water Pipe	~ 17' (~5' from ceiling)	Black dust quite evideut	4,220		4,180	
3	3-ELK	2/27/2007 (FOH)	W	Warehouse	Top of Return Duct	~ 20'	Top surface of duct by ceiling	3,460		3,740	
4	4-ELK	2/27/2007 (FOH)	B	Warehouse	Ledge above middle bay door	~ 10'	Ledge with copious amounts of dust/particles		410		580
5	6-ELK	2/27/2007 (FOH)	W	Warehouse	Floor at base of steel column	0		220		13	
6	7-ELK	2/27/2007 (FOH)	W	Warehouse	Floor	0	From corner under stairs	377		106	
7	8-ELK	2/27/2007 (FOH)	B	Warehouse	On 3" steel ledge under top of stairs	8.5'			300		380
8	9-ELK	2/27/2007 (FOH)	W	Warehouse	Stair rise (uuderside) by wall	6'		440		80	
9	10-ELK	2/27/2007 (FOH)	W	FSL	Beam support at column top	~ 20'	From angle irou support running; ~ 4' from ceiling	2,200		73	
10	11-ELK	2/27/2007 (FOH)	B	FSL	Ledge of ciuder block wall	~ 17'	Bulk debris/dust from corner ledge		910		98
11	12-ELK	2/27/2007 (FOH)	W	FSL	Wall uotch	~ 5'	Notch formed by the abutting poured coucrete sections	720		5	
12	13-ELK	2/27/2007 (FOH)	W	FSL	Floor at base of column 1	0		14		1	
13	14-ELK	2/27/2007 (FOH)	W	FSL	Wall	15'	Ledge midway between col. 1 and col. A between poured coucrete sectious	309		3	
14	15-ELK	2/27/2007 (FOH)	W	FSL	Beam by column A at wall	~ 20'	Top surface of beam at wall	38,800		127	
15	16-ELK	2/27/2007 (FOH)	W	FSL	Ledge	~ 15'	Ledge ou cinder block	33,000		57	
16	17-ELK	2/27/2007 (FOH)	W	FSL	Ledge ou wall	5'	Ledge between coucrete slabs forming wall	5,760		9	
17	18-ELK	2/27/2007 (FOH)	W	FSL	Floor at base of column A	0		11,700		17	
18	19-ELK	2/27/2007 (FOH)	W	FSL	Steel support beam aloug wall	~ 20'		124,000		96	
19	20-ELK	2/27/2007 (FOH)	W	FSL	Ledge ou wall	~ 11'	Top surface of channel	3,260		58	
20	21-ELK	2/27/2007 (FOH)	W	FSL	Ledge ou wall	~ 5'	Ledge where poured coucrete sections about	370,000		64	

Row	Sample #	Date & Who Collected	Sample Type W– Wipe B– Bulk TCLP	Building Name	Surface/ Item	Elevation (feet)	Description	Lead		Cadmium	
								µg/ft²	mg/kg	µg/ft²	mg/kg
21	22-ELK	2/27/2007 (FOH)	W	FSL	Floor	0	At base of column 2	9,110		18	
22	23-ELK	2/27/2007 (FOH)	W	FSL	Beam at ceiling (in middle of floor)	~ 20'		1,250		33	
23	24-ELK	2/27/2007 (FOH)	W	FSL	Top of return air duct at ceiling	~ 20'		2,110		31	
24	25-ELK	2/27/2007 (FOH)	W	FSL	Steel support beam at wall by col. 3	~ 20'		18,800		269	
25	27-ELK	2/27/2007 (FOH)	W	FSL	Surface of beam on wall ~ 4' from col. 2 by door	3'		2,540		19	
26	28-ELK	2/27/2007 (FOH)	W	FSL	Floor	0	Base of column 3	10,100		21	
27	29-ELK	2/27/2007 (FOH)	W	FSL	Beam at ceiling	~ 20'	Near column B	4,460		27	
28	30-ELK	2/27/2007 (FOH)	W	FSL	Floor by base of column B	0		43,200		34	
29	31-ELK	2/27/2007 (FOH)	W	FSL	Book shelf by column B	2'	Wooden shelves	56		5	
30	32-ELK	2/27/2007 (FOH)	W	FSL	Steel Beam by column C	~ 20'		30,200		36	
31	33-ELK	2/27/2007 (FOH)	W	FSL	Beam/ceiling by Column D	~ 20'		20,700		27	
32	34-ELK	2/27/2007 (FOH)	W	FSL	Floor	0	Base at column C	480		80	
33	35-ELK	2/27/2007 (FOH)	W	FSL	Floor base of column D	0		453		69	
34	36-ELK	2/27/2007 (FOH)	W	FSL	Beam / ceiling column E	~ 20'		1,830		30	
35	37-ELK	2/27/2007 (FOH)	W	FSL	Floor by column E	0		807		48	
36	38-ELK	2/27/2007 (FOH)	W	FSL	Top surface of supply duct diffuser	~ 18'	Between Column E and Column 4	240,000		31	
37	39-ELK	2/27/2007 (FOH)	W	FSL	Steel bam support on wall	~ 18'		23,700		80	
38	40-ELK	2/27/2007 (FOH)	W	FSL	Top of old exhaust duct	~ 15'	By column 4	5,520		24	
39	41-ELK	2/27/2007 (FOH)	W	FSL	Beam on wall	~ 3'		1,170		12	
40	42-ELK	2/27/2007 (FOH)	W	FSL	Floor by column 4	0		98,200		39	
41	43-ELK	2/27/2007 (FOH)	W	FSL	Beam / ceiling by column F	~ 20'		400		35	
42	44-ELK	2/27/2007 (FOH)	W	FSL	Blank			<10		<1	
43	45-ELK	2/27/2007 (FOH)	W	FSL	Beam on far wall by bay door	8'		640		116	
44	46-ELK	2/27/2007 (FOH)	W	FSL	Inside surface of discarded duct opening with air damper	None given		219,000		21	
45	47-ELK	2/27/2007 (FOH)	W	FSL	Inside surface of discarded duct opening in hood with air damper	None given		120,000		28	
46	48-ELK	2/27/2007 (FOH)	W	FSL	Discarded duct opening	None given	Where exhaust duct leaves top of hood	32,400		54	
47	49-ELK	2/27/2007 (FOH)	W	FSL	Top surface of 1" pipe in office	2'	In office 103	178		14	
48	50-ELK	2/27/2007 (FOH)	W	FSL	Floor	0	Behind office door office 103	120		9	
49	51-ELK	2/27/2007 (FOH)	W	FSL	Ledge of window sill	3	Inmate clerk office area	288		28	
50	52-ELK	2/27/2007 (FOH)	B	FSL	Scraped from floor around column 3 at door	0			160,000		38

Row	Sample #	Date & Who Collected	Sample Type W–Wipe B– Bulk TCLP	Building Name	Surface/ Item	Elevation (feet)	Description	Lead		Cadmium	
								µg/ft²	mg/kg	µg/ft²	mg/kg
51	55-ELK	2/28/2007 (FOH)	W	Recycling Factory	Top side of blade of fan inside exhaust duct	~ 18'		10,100		2,350	
52	57-ELK	2/28/2007 (FOH)	B	Recycling Factory	Top of return air duct	~ 20'			3,600		6,000
53	58-ELK	2/28/2007 (FOH)	W	Recycling Factory	Top of return air duct over material disassembly area	~ 20'	Return air duct in NE corner of room	30,800		12,800	
54	59-ELK	2/28/2007 (FOH)	W	Recycling Factory	Top of return air duct over shipment area (near bay door)	~ 20'		123,000		3,770	
55	60-ELK	2/28/2007 (FOH)	W	Recycling Factory (roof)	Beam by window	~ 20'	On platform above gb area	28,500		735	
56	61-ELK	2/28/2007 (FOH)	B	Recycling Factory	In stone (ballast) directly beneath exhaust fan on roof	Roof	On SW corner of exhaust fan		8,800		900
57	62-ELK	2/28/2007 (FOH)	B	Recycling Factory	Filter	None given	2" x 3" filter section HV5 south part of Roof		370		140
58	63-ELK	2/28/2007 (FOH)	W	Recycling Factory	Top of electrical inverter	~ 18'	On platform on SW side of factory floor	12,400		173	
59	64-ELK	2/28/2007 (FOH)	W	FSL	Louver on exterior of building	~ 11"	Where fountains were vented to exterior	64,000		21	
60	65-ELK	2/28/2007 (FOH)	W	FSL	Inside duct behind louvers on exterior of building	5'	Where pots were vented to exterior	403,000		202	

5.3 FOH Ambient Air, Particulate, Skin Wipe, and Other Exposure Monitoring

FOH followed-up bulk dust and surface wipe sampling with additional sampling in December 2007 to determine whether the legacy contamination in the recycling area was contributing to lead and cadmium exposures on the general factory floor and adjacent work areas. Potential exposures from both the inhalation route and the ingestion route (i.e., hand-to-mouth contact) were also evaluated. This sampling included:

- General area air sampling (lead and cadmium) in locations where legacy contamination had been previously found (Electronics Recycling Factory, FSL, and Warehouse);

- Personal breathing zone air sampling (lead and cadmium) of workers engaged in work activities (e.g., electronics disassembly, material handling, etc. and not glass breaking) on the general factory floors (Electronics Recycling Factory, Warehouse);

- Airborne particulate concentration monitoring using a real time, direct reading instrument; and

- Skin wipe sampling (lead and cadmium) of workers' hands involved in various electronics recycling activities.

Partial results from this follow-up investigation are summarized as follows and in Tables 4 and 5:

- All area air samples and personal exposure monitoring samples were well below PELs for lead and cadmium. Only one personal sample was above the LOD and it was approximately 100 times less than the PELs.

- Air monitoring for total dust using a real-time, direct reading instrument showed that no significant dust concentrations were being released to the general environment from the forced air ventilation systems (i.e., heating, ventilating, and air conditioning, (HVAC) systems) or the various operations and activities monitored.

- Area air and personal monitoring data showed that inhalation was not a significant route of exposure among workers performing normal duties on the general factory floors (recycling factory and warehouse) and FSL.

- Area air and personal monitoring data showed that routine recycling activities do not create an airborne exposure hazard by disturbing legacy contamination.

- Hand (skin) wipe samples collected during the work shift from inmates performing tasks in the warehouse and factory found that the highest levels of contamination were not excessively high and most were rather low. However, the results indicated that the hand-to-mouth route of exposure through ingestion could contribute to total exposure for at least some workers.

Table 4
Summary of Air Sampling Results, FOH

Sample #	Date Collected	Building	Sample Information (Location; activities performed, etc.)	Air Volume Collected (L)	Sample Duration (min.)	Lead Mg/m^3	Cadmium Mg/m^3
(6 samples)	12/10/07	Warehouse	Various workers and areas	435-489	146-240	All ND	All ND
(7 samples)	12/11/07	FSL	Area: Various areas	1067-1145	226-378	All ND	All ND
(5 samples)	12/12/07	E-recycling Factory	Personal: Various workers	727-927	244-309	0.0006 (One) All others ND	0.0001 (One) All others ND
(5 samples)	12/12/07	E-recycling Factory	Area: Various areas	509-1190	168-385	All ND	All ND

Notes:
1. Warehouse samples were collected during afternoon shift only (after lunch).
2. FSL samples collected during period of building vacancy-- no work was taking place due to halted operations; However, forced air ventilation was on (i.e., heated air was being provided to spaces via ceiling ductwork).
3. E-Recycling Factory samples were collected on a day when it was reported that 265 CRTs were broken in the morning. CRT breaking was halted in the afternoon to allow for the NIOSH-requested clean-up. All samples ran during both morning and afternoon shifts, although the personal samples (only) were turned off for ~1.5 hours while inmates went to lunch. Personal samples were left running during 15 minute breaks (morning and afternoon). Bay door were kept closed in the morning but were left open about 1/4 time in the afternoon.
4. Detection limits: 'ND' denotes 'None detected' or <0.2 µg Pb/sample (equivalent to 0.0004 mg/m^3 based on 500 liters of air sampled) and <0.04 µg/sample Cd (equivalent to 0.00008 mg/m^3 based on 500 liters of air sampled).

Table 5
Elkton Hand Wipe Data Table, FOH

Sample #	Date Collected	Sample Type H=Hand Wipe	Building	Lead µg/ Both Hands	Cadmium µg/ Both Hands	Notes:
2	12/10/2007	H	Warehouse	1.5	0.1	General duties throughout Warehouse recycling areas
3	12/10/2007	H	Warehouse	0.4	0.1	General duties throughout Warehouse recycling areas
4	12/10/2007	H	Warehouse	0.8	0.4	General duties throughout Warehouse recycling areas
5	12/10/2007	H	Warehouse	1.8	0.0	General duties throughout Warehouse recycling areas
1	12/12/2007	H	Recycling Factory	38.7	6.4	Breakdown area. Only one work glove was consistently worn.
2	12/12/2007	H	Recycling Factory	3.4	0.2	Breakdown area. Two gloves consistently worn (but occasionally only one).
3	12/12/2007	H	Recycling Factory	1.5	0.1	Clerk station. No gloves worn.
4	12/12/2007	H	Recycling Factory	3.4	0.2	Gloves worn all day.
5	12/12/2007	H	Recycling Factory	34.7	27.0	Breakdown area. Work gloves worn most of the day (but not all day).

Notes:

1. Hand (skin) wipe samples were collected from selected inmates working in the E-Recycling Factory and the Warehouse (the FSL was unoccupied since work operations had been halted ~July 2007).
2. Sampling was conducted for both right and left hands individually, but only the total results for both hands are provided in this table.

5.4 NIOSH/DSHEFS/HETAB Medical Surveillance Assessment and Industrial Hygiene Survey

After receiving preliminary findings of NIOSH/DART and FOH, as well as the results of an interim report on exposure monitoring and surface contamination levels at FCI Elkton (see Sections 5.1 and 5.2), the OIG requested that NIOSH's Division of Hazard Evaluations and Field Studies/Hazard Evaluations and Technical Assistance Branch (DSHEFS/HETAB) conduct an assessment of FCI Elkton's medical surveillance program. In February and March 2007, NIOSH/DSHEFS/HETAB conducted site visits to assess FCI Elkton's medical surveillance program for staff and inmates exposed to lead and cadmium during electronics recycling. As part of this assessment, NIOSH/DSHEFS/HETAB conducted an industrial hygiene survey to further evaluate the extent of migration of lead and cadmium containing dusts, which included collecting evidence of any "take-home" contamination to inmate housing and privately owned staff vehicles. This information complements the body of industrial hygiene data collected previously by FOH and NIOSH/DART. Results for the medical surveillance assessment and industrial hygiene survey are summarized below and detailed in the NIOSH/DSHEFS/HETAB report (see Attachment 3).

5.4.1 NIOSH/DSHEFS/HETAB Medical Surveillance Assessment Results

FCI Elkton and UNICOR did not provide occupational medical surveillance for UNICOR personnel and inmates between 1997 and March 2003. Occupational medical surveillance started in March 2003 for inmates performing glass breaking and disassembly and for staff. This was immediately prior to the installation of the glass breaking room. A summary of NIOSH/DSHEFS/HETAB assessment results follows:

- FCI Elkton's occupational medical surveillance is performed annually and includes limited biological monitoring but no physical examination. This is not consistent with the OSHA lead and cadmium standards.

- FCI Elkton performs biological monitoring for various staff and inmates. Determination of who receives monitoring does not appear to be based on exposure results.

- Biological monitoring consists of blood lead levels (BLL), blood cadmium (CdB), urine cadmium (CdU), and urine beta-2-microglobulin (B-2-M). Not all inmates involved in glass breaking and disassembly received all of these tests. In addition, some inmates had other tests, none of which seem to have been based upon work exposures or indicated by work history.

- Recordkeeping and employee notification of results is not consistent with requirements of the OSHA lead and cadmium standards.

- Although start dates were not available for all inmates working in the glass breaking room, it does not appear that any inmate had biological monitoring performed pre-placement, as required by OSHA. Inmates in the glass breaking room have been shown to have exposures above the action levels for lead and cadmium; therefore, pre-placement biological monitoring is needed, especially for cadmium.

- In general BLLs for inmates working in the glass breaking area declined over time (2003 – 2007). Mean BLLs declined progressively from 5.6 µg/dL in 2003 to 1.7 µg/dL in 2007. The March and April 2003 results may reflect lead exposures prior to installation of the glass breaking room, but do not reflect exposures prior to the installation of the "saw dust ventilation system" in 2001 and the use of some type of respiratory protection also in 2001. See Table 6.

Table 6
Blood Lead Levels of Inmates Doing Glass Breaking, By Year
Federal Bureau of Prisons, FCI Elkton, OH

Year	Mean BLL (µg/dL)	Median BLL (µg/dL)	Range (µg/dL)	Number sampled
2003	5.6	4.5	3-9	7
2004	3.7	3.0	2-7	7
2005	3.7	3.9	2-10	12
2006	2.3	2.0	1-5	13
2007	1.7	1.5	1-4	10

- CdB, CdU, and B-2-M results for inmates working in the glass breaking area were relatively low and were well below the levels that would trigger the requirement for a full medical examination or medical removal. Of 50 CdB tests, 27 were below the limit of detection (LOD) and the others ranged from 0.5 – 1.2 µg/L. Of 28 CdU measurements, 23 were below the LOD, with the remainder from 0.5 – 1.0 µg/g/Cr. June 2003 results for CdB reflect cadmium exposures prior to the installation of the glass breaking room, but do not reflect exposures prior to the installation of the saw dust ventilation system in 2001 and the use of some type of respiratory protection also in 2001.

- An inmate performing cleaning and filter change-outs in the glass breaking room from 2003 – 2007 had BLLs with a progressive decline over time (10 – 4 µg/dL). CdB and CdU levels were relatively low and undetectable, respectively.

- One staff member showed a BLL at 10 µg/dL, which was one of the higher levels measured, but still well below OSHA medical removal criteria. In addition, the cadmium indicator, B-2-M, was elevated during the same monitoring episode. All biological monitoring results for the same staff member that were taken both before and after this single episode were low. The data from the single sample set is, therefore, inconclusive and unconfirmed. Laboratory error can not be ruled out.

- Because UNICOR only started biological monitoring in 2003, more than five years after recycling operations commenced at FCI Elkton, results from that blood lead and blood cadmium monitoring cannot be used to determine lead or cadmium exposures from early e-waste recycling activities (e.g., prior to the installation of the "saw dust ventilation system" and some form of respiratory protection in 2001). The retention of these metals in blood is too short to draw any such conclusions (i.e., 1 – 2 month half-life for lead and 100 days for the first cadmium half-life, after which half lifes grow longer]. Cadmium urine measurements do integrate exposure over time because the half-life of cadmium in urine is years to decades. However, only one of the inmates monitored worked in glass breaking operations prior to May 2001 and his CdU was less than 1 μg/L. (See the Results and Discussion Section and the Appendix in the NIOSH/DSHEFS/HETAB report, Attachment 3, for further information on half–lifes and health effects associated with lead and cadmium exposure).

- Biological monitoring results for staff and inmates not involved in glass breaking and for staff are detailed in the NIOSH/DSHEFS/HETAB report. Review of these results, records, and current operations indicates that medical surveillance can be discontinued for inmates who do not perform glass breaking, as well as staff. Some former inmates and/or staff may require surveillance under the OSHA cadmium standard.

The highest annual mean BLL for inmates doing glass breaking was measured at 5.6 μg/dL in 2003. These biological monitoring results indicate some bodily uptake of lead. These BLLs are well below levels that would warrant medical removal protection under the OSHA standard, however, subclinical adverse health effects at BLLs of <10 μg/dL have been reported in the literature (see Attachment 3). The BLLs have generally declined over time from 2003 – 2007, indicating that exposures have likely similarly decreased. The blood and urine cadmium results from 2003 – 2007 were well below levels that would warrant medical removal protection under the OSHA standard. No biological monitoring results were available for inmates doing glass breaking from 1997 – 2003, when exposures were likely higher. The NIOSH/DSHEFS/HETAB report provides an Appendix with detailed information on lead and cadmium occupational exposure limits and health effects (see Attachment 3).

In summary, UNICOR's and the BOP's medical surveillance at FCI Elkton has not complied with OSHA standards in the past and is not currently in compliance (see Section 6.2.2 for details). At present, only inmates performing glass breaking have the potential for exposure above the lead and cadmium action levels, and these inmates require continued and compliant medical surveillance. Biological monitoring records indicate that glass breaking operations prior to the installation of the glass breaking booth produced exposures at greater levels than current operations. However, blood lead has a relatively short half-life, therefore, exposure levels much before than March 2003 cannot be estimated.

An appendix entitled "Occupational Exposure Limits and Health Effects" is included in the NIOSH/DSHEFS/HETAB's report and provides additional information regarding health effects related to exposures, half-life of biological levels, background levels, contributing life style contributions to exposure such as smoking, and other factors.

5.4.2 NIOSH/DSHEFS/HETAB Industrial Hygiene Survey and Records Review Results

NIOSH/DSHEFS/HETAB reviewed records from past consultant reports and monitoring studies. [Note: Exposure monitoring conducted by consultants after installation of the glass breaking room in 2003 is considered to be reflective of current exposure potential.] In addition, NIOSH/DSHEFS/HETAB performed surface wipe, dust, skin wipe, and area air sampling to determine the migration of contamination from existing operations to adjacent and living areas. Results are summarized below and detailed in the NIOSH/DSHEFS/HETAB report (see Attachment 3).

- Laboratory reports from 2001 and 2003 sampling episodes were so incomplete that they are of little if any value to indicate employee exposures during these periods.

- Consultant reports from 2004 showed that personal breathing zone samples collected on June 2 for three glass breakers and one feeder as well as four area samples were below the action level for lead and cadmium. Breathing zone samples collected on June 18 were reported as "no overexposure;" however, results in the sample summary sheet showed that a breathing zone cadmium exposure for one of three glass breakers was at 7.99 $\mu g/m^3$ for the 283 minute sampling duration. When calculated as an 8-hour TWA, the result was 4.7 $\mu g/m^3$, slightly below the OSHA PEL of 5 $\mu g/m^3$. A cadmium area sample was also measured at 5 $\mu g/m^3$. The report did not indicate that the action level of 2.5 $\mu g/m^3$ was exceeded and did not indicate if further exposure during the shift could have occurred that would have added to the measured exposure and resulted in exposure above the cadmium PEL. This report also had other deficiencies.

- An OSHA inspection conducted in 2005 found cadmium exposure to be above the action level and PEL for one glass breaker and the lead exposure to be above the action level but below the PEL (see Section 5.5, below for further information on this OSHA inspection).

- Consultant reports from 2006 and 2007 varied in their quality and usefulness. For instance, some reports from 2006 showed that cadmium action levels and/or PELs were exceeded, but did not provide guidance or information on actions or requirements that these levels trigger under the OSHA standards. In addition, workers identified as "handlers" or "floor workers" who worked in the glass breaking booth often had higher exposures than glass breakers. The reports provided no discussion of the cause for this, did not recommend corrective actions, and did not document respiratory protection measures. In contrast, a 2007 report, showed cadmium exposure in the glass breaking room to be above the action level and nearly above the PEL. The report contained numerous recommendations to repair and maintain the LEV and improve work practices and PPE. A later 2007 report showed that exposures were then below action levels and PELs.

- In combination, the exposure monitoring results from consultant monitoring episodes showed that glass breaking conducted in the glass breaking room has the potential to exceed the OSHA action levels and/or PELs for lead and/or cadmium at times. Some exposures are below these levels, while, at times, exposures approach or exceed these levels. (See the NIOSH/DSHEFS/HETAB report, Attachment 3, for further details on personal exposure, wipe, and surface samples collected by consultants since 2001).

- Surface wipe and bulk dust samples were collected by NIOSH/DSHEFS/HETAB in various locations, such as HVAC systems and components, air handlers, ledges, and roofs. These data are consistent with the FOH data discussed in Section 5.2. This contamination is most likely associated with glass breaking and chip recovery practices prior to the implementation of the glass breaking room and other engineering controls.

- Hand wipe samples collected after hand washing by inmates showed lead contamination ranging from 1.5 to 130 µg/wipe. These data demonstrate the need for improvements in hand washing.

- Some lead and cadmium was found on the floor of inmate cubicles where shoes are kept and on the soles of shoes, which indicates that some lead and cadmium is being tracked out of the glass breaking room.

- Lead and cadmium contamination in two staff personal vehicles was generally below the limits of detection; however, some lead contamination was detected on one steering wheel. This indicates a potential for take-home contamination, but the concentration is minimal.

- Area air samples collected at locations outside of the glass breaking room were found to be at low, trace, or undetectable levels for lead and cadmium. This is consistent with FOH results discussed in Section 5.3.

Based on prior exposure monitoring performed by consultants at FCI Elkton, NIOSH/DSHEFS/HETAB found that current glass breaking operations have the potential to exceed the OSHA lead and cadmium action levels and possibly PELs at times. However, UNICOR's use of respiratory protection for routine glass breaking at FCI Elkton is sufficient to protect against the excursions above the PEL. OSHA requires UNICOR to implement or improve engineering controls and work practices to maintain exposures below the PEL and also requires that UNICOR provide (to workers) a description of the corrective action to be taken.

NIOSH/DSHEFS/HETAB further determined that the exposure monitoring performed by the BOP's consultants has varied in quality. While more recent reports have improved, other reports have not adequately presented and described results and have not recommended corrective actions when action levels or PELs have been exceeded.

NIOSH/DSHEFS/HETAB also noted that contamination of inmate housing and staff vehicles occurs, but is minimal. Hand washing practices should be improved.

5.5 OSHA Inspection

In the year prior to and separate from the initiation of the DOJ/OIG investigation, OSHA's Cleveland Area Office conducted on-site inspections of FCI Elkton's recycling facilities between August and November 2005 (see Attachment 4). One of two samples taken for glass breakers showed lead exposure above the action level and cadmium exposure above both the action level and PEL. OSHA issued a citation to FCI Elkton in December 2005 identifying the cadmium overexposure and lack of adequate engineering and work practice controls to reduce and maintain the exposure at or below the PEL.

FCI Elkton provided a response to the citation in February 2006 stating that the inmate glass breaker had used inappropriate practices by pushing plastic barriers aside during the OSHA monitoring. FCI Elkton also stated the glass breakers were given additional and documented training to ensure that engineering controls are in place and used appropriately. In addition, FCI Elkton stated that some additional adjustments to work practices and engineering controls were implemented.

After receiving the response, OSHA closed its file and stated that no further action was anticipated at that time, while leaving open the possibility of a follow-up inspection.

5.6 U.S. EPA Region 5 Multi-Media Environmental Compliance Inspection

At the request of DOJ OIG, U.S. EPA Region 5 conducted a Multimedia Inspection at FCI Elkton on December 10 – 13, 2007 (see Attachment 5). The specific objective of the investigation was to determine compliance with:

- NPDES Permit requirements under the Clean Water Act;
- Air Pollution Control regulations under the Clean Air Act (CAA) and the Federally approved portions of the Ohio's State Implementation Plan; and
- Hazardous waste management regulations under the Resource Conservation and Recovery Act (RCRA) and Rules adopted under the State of Ohio's hazardous waste program.

U.S. EPA's inspection and sampling results from wastewater and storm water sources are summarized as follows:

- Wastewater samples from mopping of floor and equipment surfaces inside the glass breaking booth revealed high concentrations of total lead (14.0 – 33.1 mg/l), total cadmium (1.30 – 2.43 mg/l), and total zinc (17.7 – 40.3 mg/l). When analyzed for Toxic Characteristic Leaching Procedure (TCLP) metals, the samples indicate that lead and cadmium are below detection levels, and all metals are below RCRA regulatory levels.

- Electronic waste materials stored outdoors near the warehouse building can create storm water discharges associated with industrial activity. The storm water generated in this area may require UNICOR or FCI Elkton to apply to Ohio EPA for a NPDES permit or a "no exposure permit exemption." No permit has been applied for nor has one been issued.

U.S. EPA inspection results regarding air emissions under the Clean Air Act include:

- UNICOR was not able to demonstrate notification to authorities of past or present air emission sources. Permits for air emission sources are not currently in place and have not been in place for past operations. Exemptions from permits have not been demonstrated.

- A UNICOR response to U.S. EPA's Clean Air Act 114 request may be inaccurate.

U.S. EPA RCRA inspection results are summarized as follows:

- The trailer where boxes of waste filters from the glass breaking booth were being stored was observed to be leaking. Rain water and snow melt water were found in the trailer during the inspection. The filters have been tested by UNICOR and the TCLP value is above the RCRA regulatory level for lead.

- Wastewater being generated at the glass breaking booth by mopping operations indicated that the TCLP metals results were below the RCRA regulatory limit for lead and cadmium.

- Currently UNICOR is using a RCRA ID number issued to FCI Elkton to ship hazardous waste off-site. Since UNICOR operates as a separate agency, it may need its own RCRA ID, if required for waste shipments based upon its generator status.

- Wastes generated at FCI Elkton may need to be characterized. Under both federal and state law, all wastes generated in Ohio must be evaluated to determine if it is a hazardous waste.

- BOP personnel were unable to detail how used fluorescent light bulbs are being disposed or who has responsibility for the fluorescent light bulbs at the site.

- The manifests used to ship waste glass booth filters from UNICOR to a disposal site in Michigan were reviewed. All of the manifests included a RCRA ID number that was incorrect.

Overall, U.S. EPA's inspection determined that FCI Elkton had not adequately evaluated its wastewater, air emissions, and hazardous waste streams for compliance with applicable environmental standards, and that the BOP and UNICOR may need to better coordinate their environmental control efforts.

In 2008 subsequent to the U.S. EPA inspection, the BOP provided the OIG with a description of the actions it intends to take to correct the deficiencies identified during U.S. EPA's investigation.

6.0 REGULATORY COMPLIANCE EVALUATION

This Section provides an analysis of exposure results and an evaluation of compliance status with various OSHA and EPA regulations for FCI Elkton's e-waste equipment recycling operations. This evaluation is largely based on the status of operations as reviewed by the various federal agencies assisting the OIG, including FOH, NIOSH/DART, NIOSH/DSHEFS/HETAB, OSHA, and U.S. EPA Region 5 during calendar years 2007 and 2008. This evaluation primarily addresses current recycling conditions at FCI Elkton. Because the OIG's investigation is ongoing, this assessment is not final.

Exposure results and/or compliance status are discussed for the following hazards, standards, and regulations

- Occupational Exposure to Lead and Cadmium;
- OSHA Lead and Cadmium Standards;
- Occupational Exposure to Air Contaminants other than Lead and Cadmium;
- OSHA General Duty Clause;
- Other OSHA Standards ;
- Basic Program Elements for Federal Employees; and
- Water, Air, and Hazardous Waste Regulations.

6.1 Analysis of Occupational Exposure to Lead and Cadmium

Occupational exposures to lead and cadmium are evaluated in this section for current UNICOR recycling operations at FCI Elkton. Glass breaking operations that have been conducted utilizing the existing, enclosed glass breaking room and LEV system are considered to be representative of current operations. Therefore, exposures are evaluated from early 2003 (date of glass breaking room implementation) through the 2007/2008 period when the field activities associated with the OIG investigation were conducted.

The analysis of exposure is presented in two subsections below:

- Section 6.1.1 analyzes exposures for current practices that results from releases of lead and cadmium during glass breaking and associated activities; and

- Section 6.1.2 analyzes the contribution (if any) of legacy lead and cadmium surface and building system contamination to current exposures.

Exposures from past operations prior to early 2003 are not evaluated in this report. The OIG's final report will address this issue.

6.1.1 Lead and Cadmium Exposures and Controls for Current Practices

The analysis of potential occupational exposures to lead and cadmium for FCI Elkton's current recycling operations is discussed by specific operation or activity. This exposure analysis is broken down and presented as follows:

- Glass breaking in the glass breaking room, conducted daily: This operation is expected to have the highest exposure potential to lead and cadmium for a routine operation.

- Glass breaking room cleaning activity conducted weekly: Performed in the glass breaking room, this activity also has the potential for exposure to lead and cadmium above the action levels and/or PELs.

- LEV HEPA filter change-out activity conducted monthly: This non-routine maintenance activity includes cleaning the LEV filters where accumulations of lead and cadmium contamination are collected. Exposure potential at levels well above the lead and cadmium PELs exists for this activity.

- Routine activities in other recycling areas that are conducted daily, but where glass breaking is not performed: Routine support and demanufacturing activities such as sorting, material and equipment handling disassembly, and material staging do not involve significant disruption of electronic components, therefore, release of contamination and resultant exposures would be expected to be relatively low.

A discussion of exposures for each of the above operations and activities follows.

6.1.1.1 Glass Breaking Area

With respect to routine, daily operations and activities, the CRT glass breaking operations conducted in the enclosed glass breaking room have the greatest potential to generate exposures to lead and cadmium. The enclosed glass breaking room and LEV system were implemented starting in April 2003. NIOSH/DSHEFS/HETAB evaluated available reports for exposure monitoring in the glass breaking area since 2001 (see Section 5.4.2

and Attachment 3). The results are presented below. The 2001 results are not listed, due to incompleteness and because they do not reflect current exposure conditions.

- 2003: A FCI Elkton consultant report contained insufficient information to conclusively determine exposure. For instance, sampling times and flow rates were omitted. NIOSH/DSHEFS/HETAB concluded that exposures could have been above or below the PELs, depending on sampling times, sampling rates, and other factors.

- 2004: One FCI consultant report showed exposures below the action levels, while a second report showed some cadmium exposures to be at the PEL.

- 2005: OSHA Cleveland Area Office measured exposures and issued a citation for cadmium exposure above the PEL. Lead exposure was above the action level for one of two samples.

- 2006: Of three FCI Elkton consultant reports, two showed cadmium exposures below the action level and one showed cadmium exposure above the action level and/or above the PEL.

- 2007: FCI Elkton consultant reports showed some cadmium exposures to be either approaching or above the action level, but below the PELs.

- 2007: NIOSH/DART found that exposures were below the action levels as TWAs during routine activities.

These exposure monitoring results indicate that even with the current glass breaking room and LEV system, lead and particularly cadmium exposures during routine glass breaking have the potential to exceed the action levels and/or possibly PELs, when the use of respiratory protection is not considered. UNICOR provides and requires hooded powered air purifying respirators (PAPRs) in the glass breaking room. These respirators have a protection factor of 25. These respirators are capable of protecting against all of the exposure excursions above the PEL that were reviewed between 2003 and 2007.

OSHA, however, requires that lead and cadmium exposures for routine operations be controlled and maintained below the PELs through the use of engineering controls (i.e., the LEV system) and work practices. Therefore, implementation of improvements in FCI Elkton's engineering controls and/or work practice controls are required. See Section 8.0, Recommendations.

All lead and cadmium exposures determined in 2007 by FCI Elkton consultants and NIOSH/DART were less than the PELs during routine activities. This represents a notable improvement over past years, but additional monitoring episodes are necessary to determine conclusively whether this is a consistent condition that is maintained over time.

The NIOSH/DART exposure monitoring conducted in 2007 represents the most extensive set of data generated. Exposures as determined by NIOSH/DART for routine glass breaking were below the OSHA PELs and action levels. During glass breaking, the highest exposures measured by NIOSH/DART were 36% of the PEL for lead and 20% of the PEL for cadmium (assuming equivalent exposure over a full 8-hour work shift). These exposures are somewhat lower (and below the action levels) as TWAs because less than an 8-hour shift was worked. These results indicate that lead and cadmium exposures are fairly well controlled through use of the LEV system (an engineering control). Work practices, housekeeping, personal protective equipment, and respiratory protection are additional and necessary controls implemented by FCI Elkton to mitigate exposure.

Although NIOSH/DART results showed lead and cadmium exposures below the PELs, exposures were significant enough to indicate that without the use of the LEV system, it is likely that exposures would exceed the PELs. This is supported by past FCI Elkton and OSHA monitoring results. In addition, although effective, it is clear that the LEV system is not fully efficient in capturing lead and cadmium dusts or in preventing dusts from entering the breathing zone of workers. LEV smoke tests conducted by NIOSH/DART and glass breaking room surface contamination support this conclusion. FCI Elkton's use of the other control measures, therefore, is important to ensure worker protection.

Exposures measured during the NIOSH/DART investigation represent only the conditions at the time of this monitoring. Consistency of exposures over time cannot be estimated based on the NIOSH/DART monitoring alone, but past exposure results from FCI Elkton consultants and OSHA indicate variable exposure potential with excursions above the PEL. Exposures could vary based on quantity of materials processed, pace of work, consistency of work practices, efficiency of housekeeping practices, maintenance status of the LEV system, types of CRTs processed, variations in CRT compositions over time, and certain human factors such as body position and degree of care.

The exposures measured and the potential for variable exposures point to the importance of generating exposure monitoring data over time to ensure that exposures are consistently controlled and maintained below the PELs. It is important for FCI Elkton to implement a regular exposure monitoring program for glass breaking operations. If exposures are demonstrated to be consistently below PELs and action levels, then the frequency of monitoring could be decreased. See Section 6.2.1 for details on requirements for an exposure monitoring program.

6.1.1.2 Weekly Glass Breaking Room Cleaning Activity

Cadmium exposure for a weekly glass breaking room cleaning activity assessed in March 2007 was as high as 23 $\mu g/m^3$ for a 79 minute sample. This calculates to an 8-hour time weighted average (TWA) exposure of 3.8 $\mu g/m^3$ assuming no additional exposure occurred for the work shift (this is likely because all glass breaking is suspended on the clean-up day). This exposure is above the action level of 2.5 $\mu g/m^3$ and is 76% of the

PEL of 5 μg/m^3. Respiratory protection was worn during this activity and had an appropriate protection factor to control the exposure up to 25 times the PEL.

With the exposures up to 76% of the PEL, the potential for exposure above the PEL, at times, cannot be ruled out. Any variation in work practice, clean-up technique, or clean-up duration, could impact exposure levels. UNICOR should conduct additional exposure monitoring of this activity. Any lead or cadmium exposure above the PEL for more than 30 days per year should be controlled using engineering and work practice controls, regardless of respiratory protection.

6.1.1.3 LEV HEPA Filter Change-out Activity

In March 2007, NIOSH/DART observed a non-routine maintenance activity involving the change-out of HEPA filters from the LEV system. Exposure monitoring was conducted for the activity (see Attachment 1). Exposures were far above the action levels and PELs for both lead and cadmium. Time weighted average (TWA) exposures were in the range of one to over two orders of magnitude higher than the PELs (see Section 5.1). Although respirators were used, they did not have adequate protection factors to properly protect workers against exposure.

Based on these results, work practices were modified to include wetting the filter prior to change-out, as well as other improvements. NIOSH conducted follow-up monitoring of the activity in December 2007. Monitoring results for the revised activity showed dramatic reduction of the lead and cadmium exposures. Lead exposure was reduced to well below the PEL. One personal cadmium exposure result was still somewhat above the PEL as an 8-hour TWA (6.1 μg/m^3 versus the PEL of 5.0 μg/m$^{3)}$. Another cadmium result was above the action level but below the PEL. The respiratory protection used was adequate to control these levels of exposure, including even the cadmium exposure that exceeded the PEL.

Engineering, work practice, and/or administrative controls are the primary and preferred means that should be used to control lead and cadmium exposures. UNICOR should attempt further refinements and improvements in work practices or engineering controls at FCI Elkton to reduce cadmium to below the PEL, regardless of respiratory protection. However, because this activity is not conducted for more than 30 days per year, OSHA standards allow for the use of respiratory protection to control any incremental exposures above the PEL should additional engineering and work practice controls not be feasible to implement for this non-routine maintenance activity.

Future exposure monitoring of the filter change-out activity is essential to ensure that controls remain effective and continue to limit or further reduce exposures. UNICOR should conduct exposure monitoring every time this activity is conducted until it is satisfied and can conclusively demonstrate that work practices and controls are consistently effective.

Several points can be taken away from this filter change-out experience:

- Initial exposures were unacceptably high. However the response action to bring exposures within levels to ensure worker protection was highly successful.

- The approach of exposure monitoring followed by implementation of additional control actions, as warranted, should be applied on an on-going basis, especially for non-routine or new activities, or when changes in work processes occur. This approach is consistent with OSHA standards.

- Non-routine activities often pose different hazards or different degrees of hazards than routine operations. Work for these non-routine activities should be planned in a manner that anticipates hazards and potential exposures. Controls should then be specified and implemented prior to beginning work. Monitoring should be used to verify the adequacy of controls. Future control modifications should be made, if warranted (i.e., either strengthening or relaxing of control measures based on results). When process changes occur, a similar approach should be taken.

- Exposure monitoring is fundamental to a successful lead and cadmium control program. It is reasonable to assume that without the FOH/NIOSH investigation and exposure monitoring, FCI Elkton would not be aware that exposures were extremely high, and corrective work practices would not have been implemented. The high exposures would likely still be occurring.

- UNICOR officials stated that, although not adequate, a procedure was in place for this activity that specified gentle handling of the filters, that training was provided in the procedure, and that workers did not properly follow the procedure during the March 2, 2007 monitoring episode. However, FOH notes that proper supervision and oversight for hazardous, non-routine activities are essential to ensure safe work practices, and apparently UNICOR staff did not effectively conduct oversight and supervision and did not enforce the use of proper work practices during the initial filter change-out monitored by NIOSH/DART.

Based on the results of the December 2007 filter change-out results, FCI Elkton's current approach to this activity is effective in protecting workers against exposure to lead and cadmium. Because past exposures for this activity were excessive, confirmation of the current more controlled exposures is necessary by conducting exposure monitoring during future filter change-out activities. Additional improvements in controls to reduce cadmium exposure should also be implemented.

6.1.1.4 Other FCI Elkton Recycling Areas

Lead and cadmium exposures were measured in other areas of the FCI Elkton recycling facilities including the FSL Building and the Warehouse.

- In the FSL building, cadmium exposure ranged from 0.1 to 0.5 μg/m^3, and lead was below 1 μg/m^3.

- In the Warehouse cadmium ranged from <0.1 to 0.4 μg/m^3, and lead was at or below the limit of detection (LOD).

When compared to the cadmium PEL of 5 μg/m^3 and the lead PEL of 50 μg/m^3, it is apparent that these exposures were unremarkable.

6.1.2 Evaluation of Current Exposure Potential from Legacy Lead and Cadmium Surface Contamination

Bulk dust and surface wipe samples collected by FOH in early 2007 showed that significant lead and cadmium contamination is present on various building surfaces including walls, floors, inner and outer surfaces of ductwork, and equipment (see Attachment 2). This contamination is widely distributed throughout various FCI Elkton recycling areas and associated facilities. The source of much of the contamination is legacy glass breaking and chip removal/de-soldering activities that in past years produced uncontrolled or poorly controlled emissions of lead and cadmium dusts and fumes. Section 5.0 summarizes these results.

FOH followed-up bulk dust and surface wipe sampling with additional sampling in December 2007 to determine whether this legacy contamination is currently contributing to significant lead and cadmium exposures on the general factory floor and adjacent work areas. Potential exposures from both the inhalation route and the ingestion route (i.e., hand-to-mouth contact) were evaluated. These data provide information to evaluate whether staff and inmates have a potential risk of exposure from existing contamination that remains from legacy activities.

As noted in Section 5.1, particle sizes of surface dusts are small and are of the size to be distributed for some distances and remain airborne for relatively long periods of time. Therefore, should these dusts be disturbed and re-suspended into the air, potential exists for personal exposure in work areas.

FOH found that no significant dust concentrations were being released to the general environment from the forced air ventilation (i.e., HVAC) systems or the various operations and activities monitored. Lead and cadmium dust inhalation was not a significant route of exposure among workers performing normal duties on the general factory floors (recycling factory and warehouse) and FSL. The ingestion route of exposure from hand-to-mouth contact could contribute to total exposure for some workers; however, measures such as regular hand washing would be effective in mitigating this potential exposure route.

Normal activities do not create an airborne exposure hazard by disturbing legacy contamination. However, non-routine activities that may dislodge legacy surface contamination and create airborne releases should be avoided, unless appropriate control measures are applied that contain any potential releases. FOH did not conduct monitoring of non-routine activities.

Even though the legacy contamination was shown not to be an immediate risk to staff and inmates performing routine activities on the factory floors, disturbances of existing bulk and surface dust have the potential to create airborne releases and inhalation hazards, as well as skin contact and ingestion hazards. Clean-up of this legacy contamination is the ultimate solution that will result in eliminating the lead and cadmium contamination from past practices. Planning is underway for facility decontamination, which according to the BOP will commence in October 2008.

Based on the FOH sampling results, continued occupancy and the performance of normal work activities under current UNICOR controls and work practices do not present a significant exposure hazard to lead and cadmium. FCI Elkton should implement measures to ensure continued control of legacy contamination and should specifically control any non-routine activities that could disturb legacy contamination, pending completion of decontamination activities. The FOH report in Attachment 2 contains guidance for the implementation of an operations and maintenance (O&M) plan designed to control exposure to legacy contamination prior to the ultimate clean-up of this contamination.

6.2 Compliance with the Lead and Cadmium Standards

Exposure monitoring data, bulk dust and surface wipe sampling data, MSDSs, other information sheets, and industrial hygiene literature clearly indicate the importance and necessity to implement and comply with the OSHA lead and cadmium standards. Important elements of these standards along with UNICOR's compliance status are discussed below. Elements included in this discussion are not intended to be all-inclusive of the standards' requirements. These issues will be discussed more fully in the OIG's final investigative report.

The OSHA lead and cadmium standards, 29 CFR 1910.1025, Lead and 29 CFR.1910.1027, Cadmium, are similar in their requirements. Exposure limits vary, but the essence of requirements for evaluating and controlling hazards are similar.

6.2.1 Exposure Monitoring

Exposure monitoring is required under the lead and cadmium standards. "Initial" monitoring is required for any workplace or operation covered by the standard to determine if exposures are at or above the action level or PEL. Depending on results and consistency of operations, quarterly, semi-annual, additional, and/or periodic monitoring may be required.

Employees monitored and all employees with representative exposures must be notified of monitoring results. If exposures exceed the PEL (without regard to respiratory protection) then the notification must include a statement describing actions to be taken to reduce the exposure to below the PEL.

Although some monitoring has been performed by FCI Elkton consultants, UNICOR has not performed exposure monitoring consistent with the standards' requirements.[6] Several deficiencies are noted as follows:

- The OSHA standards require that an "initial" monitoring be conducted to determine if exposures are above the action levels or PELs. "Additional" monitoring is also required when there is a production, process, or control change that could affect exposure. UNICOR did not conduct initial monitoring of FCI Elkton' factory operations when recycling began in 1997. UNICOR conducted a monitoring episode in 2001 and another in 2003 that could be considered as either "initial" monitoring or "additional" monitoring based on a process and control change in June 2003 shortly after the implementation of the glass breaking room and LEV system. NIOSH/DSHEFS/HETAB reviewed these results. These reports were so incomplete that NIOSH/DSHEFS/HETAB could not conclusively determine exposures from the reports (see Section 5.4.2 and Attachment 3). Based on necessary assumptions made by NIOSH/DSHEFS/HETAB, exposure measured in 2003 could have been above or below the PELs. Based on the quality of this report, FCI Elkton could not have determined the actual exposure and could not have implemented corrective actions, if warranted.

- The OSHA standards require that if PELs are exceeded based on initial, additional, or other monitoring, then monitoring shall be repeated on a quarterly basis, until two consecutive monitoring episodes show exposures to be below the PELs. If quarterly monitoring shows exposures to be reduced to below the PEL but above the action levels, then monitoring can be reduced to a frequency of every six months. If quarterly monitoring shows exposures to be below the action levels for two consecutive episodes, then monitoring can be discontinued, unless "additional" monitoring is required based on process or other changes. FCI Elkton or OSHA monitoring conducted in 2004, 2005, 2006, and 2007 showed exposures to be at or above the action levels and/or PELs for lead and/or cadmium. However, FCI Elkton did not follow up these results with monitoring performed at the prescribed quarterly or semi-annual frequency. Any corrective actions taken based on the results were generally not apparent.

- As of December 2007, UNICOR has not performed exposure monitoring for the weekly glass breaking room cleaning activity or the monthly non-routine HEPA filter change-out activity. NIOSH/DART exposure monitoring showed exposures

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[6] UNICOR retained a consulting firm to conduct exposure monitoring at FCI Englewood in 1997. This monitoring cannot be considered as initial monitoring under the OSHA lead and cadmium standards and is not considered to be representative of personal exposures during e-waste recycling for the following reasons, among others. The work was staged. It was not representative of recycling work as conducted at FCI Englewood or FCI Elkton. Key information was not recorded, such as work practices, work environment, PPE, and ventilation. The number of samples was very limited. Although portrayed as worst case exposure, this statement is highly questionable.

above the PEL for both of these activities, and far above the PEL for the filter change-out activity prior to the implementation of work practice modifications. Even after modification, NIOSH/DART found cadmium exposure to be above the PEL. Periodic or non-routine activities with potential for exposure, such as these activities, should be a priority for hazard analysis, exposure monitoring, and exposure control. FCI Elkton did not conduct initial, additional, or periodic monitoring for these activities.

- The OSHA standards require that UNICOR notify workers (and all workers with representative exposure) of the exposure results within 15 working days after receipt of results. In addition, the notification must include a description of corrective actions when the PEL is exceeded. UNICOR has not consistently complied with these requirements.

UNICOR's deficiencies in exposure monitoring have resulted in elevated exposures to lead and cadmium, such as during the filter change-out activity. Correction of exposure monitoring deficiencies is a priority. UNICOR and FCI Elkton should not rely on the NIOSH/DART monitoring to fulfill any aspect of its monitoring requirements. NIOSH/DART results provide UNICOR with useful information for a point in time, but UNICOR and FCI Elkton should implement an exposure monitoring program to fully evaluate and control exposures.

The OSHA inspection (see Section 5.5) further demonstrates the potential for exposure to lead and/or cadmium above the action levels and/or PELs. Furthermore, as reported above in Section 5.4.2, FCI Elkton consultant exposure monitoring in 2006 (after FCI Elkton's implementation of actions resulting from the OSHA inspection) also showed elevated exposures for cadmium. These 2005 and 2006 exposure monitoring episodes conclusively demonstrate the need for an exposure monitoring program with documented corrective actions to ensure that exposures are consistently controlled at levels below the PEL.

6.2.2 Methods of Compliance

The OSHA standards (29 CFR 1910.1025, Lead and 29 CFR 1910.1027, Cadmium) state that when employee exposures are above the PEL for more than 30 days per year, implementation of engineering and work practice controls are required to reduce exposures. Examples of such controls include LEV systems, barriers and containments, isolation areas or devices, defined work procedures and practices, defined tools and their use, and many others. [Note: UNICOR should presume that glass breaking activities would be above the PEL for more than 30 days per year if the current LEV system were not in place, therefore, engineering and work practice controls are required for FCI Elkton recycling.]

UNICOR has implemented engineering and work practice controls for current, routine glass breaking activities at FCI Elkton. These include the LEV system with HEPA filtration, plastic curtains placed between the worker and the glass breaking surface, housekeeping and cleaning requirements, glass breaking instructions, defined use of tools, sequencing of work, and others. Despite these controls, UNICOR consultants have determined that exposures have been above PELs at times from 2004 through 2007 (see discussion of consultant report in Sections 5.4.2, 6,1,1, 6.2.1, and the NIOSH/DSHEFS/HETAB report, Attachment 3).

Based upon past exceedances of the action levels and PELs, UNICOR is not consistently in compliance with OSHA's requirement that exposures be maintained at or below the PELs through the implementation of engineering controls and work practices. Therefore, UNICOR must implement refinements and improvements to its engineering and work practice controls. (See Section 8.0, Recommendations for a discussion of these possible improvements). As improvements are made, UNICOR must conduct exposure monitoring to verify that the corrective action is successful and/or to implement further corrective actions.

In addition, the current LEV system does not fully meet OSHA requirements, and UNICOR does not conduct test measurements in a manner that demonstrates the effectiveness in controlling exposure. OSHA's lead standard, for instance, requires that measurements of mechanical ventilation systems be taken every three months to demonstrate effectiveness (and within five days of any production or process change). These measurements could include such items as capture velocity, duct velocity, and/or static pressure. Also, when air is recirculated into the workplace, the OSHA lead standard requires certain design features, lead monitoring of return air, and by-pass systems in case of failure. (See 29 CFR 1910.1025(e)(4)(i)(ii) for details).

The OSHA standards also require that respiratory protection must be provided to supplement engineering and work practice controls when the PEL may still be exceeded. UNICOR requires respiratory protection in the glass breaking room and makes it available in certain other areas. The type of respiratory protection and the protection factors are adequate to control normal glass breaking exposures even when PELs are exceeded as determined by past monitoring. Even though effective respiratory protection is used, UNICOR must improve engineering and work practice controls to reduce and maintain exposures below the PEL, without consideration of the protection factor of the respiratory protection.

A somewhat different exposure control and compliance approach to the LEV HEPA filter change-out activity can be implemented because of its non-routine nature. To recap, initial NIOSH monitoring showed lead and cadmium levels well above the OSHA PELs. A work practice change was implemented and this greatly reduced exposure, but cadmium was still somewhat above the PEL. Respiratory protection, however, was adequate to control the level of exposure above the PEL. Therefore, even though exposures were initially very high, this monitoring and corrective action process is an example of a successful corrective action. For this non-routine activity, conducted less than 30 days per year, respiratory protection can be relied upon to supplement engineering and work practice controls and achieve compliance with exposure limits. Therefore, the latest modified approach to this activity that combines improved work practices, engineering controls, and respiratory protection is in compliance with OSHA standards. However, UNICOR must conduct exposure monitoring to verify that controls are and continue to be adequate for this non-routine activity. FCI Elkton is encouraged to implement additional engineering controls and work practice improvements to reduce exposures, if feasible.

OSHA standards also require a written compliance program to establish the means to reduce and maintain exposures below the PEL. This program is to include engineering and work practice controls, exposure monitoring, and other control information. See lead (29 CFR 1910.1025) and cadmium (29 CFR 1910.1027) standards for details. The compliance program should be modified to reflect any changes or improvements in control actions. UNICOR has not developed a written compliance program to address the exposure exceedances and necessary controls actions described in this report. This deficiency can be addressed by writing a program based on current practices and adding any additional actions required to address any deficiencies or newly adopted corrective measures.

6.2.3 Protective Work Clothing and Equipment and Respiratory Protection

OSHA standards require that employees be provided with personal protective equipment, such as coveralls, gloves, hats, shoes, shoe coverings, face shields, goggles, hearing protection, and others as appropriate. Cleaning, replacement, and laundering must also be provided. Employees must be provided with respiratory protection when requested and/or when engineering and work practice controls do not adequately control exposures. A respiratory protection program including training, fit testing, medical examination, and maintenance must be established.

UNICOR provides employees at FCI Elkton with personal protective equipment and respiratory protection. The adequacy of this equipment seems to be satisfactory. [Note: The type of respiratory protection used during the LEV HEPA filter change-out activity was not adequate as originally evaluated by NIOSH/DART in March 2007. Modifications to the controls for this activity were implemented. The respiratory protection was then adequate to protect workers from the resultant reduced exposures.] UNICOR, however, has not specified the prescribed equipment into a written compliance program, as described above. The OIG's final report will more fully address UNICOR's respiratory protection program.

6.2.4 Housekeeping

OSHA standards require that surfaces must be maintained as free as practicable of lead and cadmium contamination. UNICOR has implemented housekeeping procedures inside and outside of the glass breaking area. Some migration of lead and cadmium contamination occurs from the glass breaking area to other areas. Although minimal, this contamination should be reduced as much as reasonably feasible. Recommendations to reduce the migration of contamination are provided in Section 8.0.

6.2.5 Hygiene Facilities and Practices

OSHA standards require that hygiene facilities be provided to include change rooms, showers, lunchrooms, and lavatories. Food and beverage consumption and tobacco and cosmetic use are not allowed in work areas, except for change rooms and lunchrooms.

OSHA standards also require that showers be provided and that showering must be conducted at the end of the work shift when the PEL is exceeded, without regard to respiratory protection. FCI Elkton does not provide showers in the work area. Although this is not specifically required, OSHA does require that workers do not leave the work area wearing any clothing or equipment that was worn during the work shift. Except for the filter change-out activity, NIOSH monitoring data did not show exceedance of the PEL for glass breaking activities; however, NIOSH/DSHEFS/HETAB reported that some past consultant monitoring data for glass breaking activities has shown exposures to be above the PELs. Showering after the filter change-out activity and possibly weekly glass breaking room cleaning is necessary for compliance. Regarding routine glass breaking activities, UNICOR needs to conduct additional monitoring to determine if the showering requirement is necessary for compliance with the standard.

Positive pressure lunchrooms with a filtered air supply are required when the PEL is exceeded. Change rooms must be designed to separate street clothing from protective work clothing to avoid cross-contamination. FCI Elkton has lunchrooms and change rooms available to employees. As UNICOR implements recommendations in this report regarding exposure monitoring and engineering controls, UNICOR should evaluate its change rooms and lunch rooms relative to the OSHA lead and cadmium standards to determine whether improvements are required.

6.2.6 Medical Surveillance and Removal Protection

OSHA standards require that a medical surveillance program be provided to all employees who are or may be exposed above the action level for more than 30 days per year. This program includes biological monitoring as prescribed by the standards to be conducted at appropriate intervals, depending on exposures and test results. It also includes thorough medical examinations.

As identified by NIOSH/DSHEFS/HETAB, the medical surveillance that FCI Elkton provides to inmates and staff is not in compliance with the OSHA lead and cadmium standard (see Attachment 3). No medical exams (including physical examinations) are done on inmates, as required by OSHA standards. Staff members receive inconsistent examinations and biological monitoring by their personal physicians. Biological monitoring for lead is not done at established six month intervals required by OSHA standards, and results are not consistently communicated to the inmates. Inappropriate biological monitoring tests have been done. Records of medical surveillance are not maintained by the employer for the appropriate length of time.

6.2.7 Employee Information and Training

OSHA standards require that training be provided to workers exposed to lead or cadmium at any level. Training is to be provided at least annually. Other information such as warning signage is also required. Training information will be provided in the OIG's final report.

6.2.8 Recordkeeping

OSHA standards require that records be maintained regarding employee exposure monitoring, medical surveillance, and other information.

As reported by NIOSH/DSHEFS/HETAB medical surveillance records are not maintained for the appropriate length of time and could not be readily located by FCI Elkton personnel. (See Attachment 3).

6.3 Air Contaminants other than Lead and Cadmium

Exposure standards for substances other than lead and cadmium are provided in 29 CFR 1910.1000, Air Contaminants, Tables Z-1, Z-2, and Z-3. These standards are supplemented by good practice ACGIH TLVs which provide exposure limits that are regularly updated and peer reviewed based on current information and other factors.

As part of the investigation, NIOSH/DART performed exposure monitoring of UNICOR's e-waste recycling operations at FCI Elkton and analyzed the samples for 29 metals in addition to lead and cadmium. Results are detailed in the referenced NIOSH/DART report (see Attachment 1). These exposure monitoring results are discussed in Section 5.0 of this report. An analysis of these results and compliance with the OSHA air contaminant standards is provided below for metals other than lead and cadmium.

- For routine glass breaking and weekly cleaning, the remaining 29 metals (i.e., excluding lead and cadmium) were found at levels below the OSHA PEL and ACGIH TLV, with a large number being either non-detectable or well below the PEL/TLV. Except for yttrium, the same exposure findings apply to the other metals during the non-routine HEPA filter change-out activity.

- Yttrium exposures were unremarkable during routine recycling activities. During the non-routine HEPA filter change-out activity, yttrium exposure was up to almost three times the PEL prior to implementation of improved work practices. This level was still within the protective capacity of the respirators used. Work practice improvements were effective in reducing yttrium exposures to less than 10% of the PEL. Assuming continued and effective implementation of improved work practices, yttrium exposure should be well controlled.

- Beryllium is not a component of CRTs, but can be found in other types of electronic components. Beryllium was of particular importance to evaluate because of its high toxicity, serious adverse health effects, and very low PEL/TLV. Only one of 25 monitoring results during normal operations was above the limit of detection (LOD), and this result was well below the PEL/TLV and only barely above the LOD. Bulk dust and surface wipe samples showed beryllium levels below the LOD. This would indicate that past operations did not release beryllium to the air. These data provide conclusive evidence that beryllium is not a hazard of concern or a compliance issue at FCI Elkton.

- Barium was one of the metals reported in the literature as a significant component of CRTs (see Section 2.0). Bulk dust and surface wipe samples also showed the presence of barium. Barium monitoring results were at unremarkable levels during normal activities. Barium was also measured during the filter change-out activity and found to be between 1 and 460 $\mu g/m^3$. Both the PEL and TLV are 500 $\mu g/m^3$. The highest result approached the PEL/TLV, but did not exceed it, and respirators were in use. In addition, work practices have since been modified that have greatly reduced exposures during this activity. Barium does not represent an exposure hazard or compliance issue at FCI Elkton

- Zinc was found by the U.S. EPA in high concentrations in glass booth mop wastewater. Bulk dust and surface wipe samples also showed significant presence of zinc. However, elemental zinc is not considered to be a significant health hazard. Zinc oxide fume is typically the zinc exposure hazard of concern. This fume is usually generated from hot work (e.g., welding) on galvanized or other zinc containing metals. Zinc oxide fume is not a factor at FCI Elkton. However, as a point of reference, zinc exposures were well below the PEL/TLV for even zinc oxide fume. Zinc is not an exposure concern during current operations at FCI Elkton.

- Strontium was one of the metals reported as a significant component of CRTs in the literature (see Section 2.0). The highest strontium exposure that was measured was only 1.63 $\mu g/m^3$ and this result was found during the filter change-out activity. Strontium is an example of a metal for which a PEL and TLV have not been established. However, the highest exposure level found is quite low as compared to most other metals of interest. More importantly, it is reasonable to conclude that effective control of lead and cadmium will also effectively control co-located metals such as strontium, which has no established exposure limit.

- All other metals were found to be at unremarkable exposure levels when compared to established PELs and TLVs.

In conclusion, no OSHA compliance issues or exposure hazards were identified for metals other than lead and cadmium.

6.4 OSHA "General Duty Clause"

The OSHA General Duty Clause requires that employers provide employees with a safe and healthful work place that is free from recognized hazards that are causing or are likely to cause death or serious physical harm. This clause is generally applied to ensure that employers control hazards that are not covered by specific OSHA standards. During the course of its investigations, the FOH Investigative Team identified that heat and ergonomic hazards are present at BOP UNICOR facilities. These hazards are not specifically addressed by OSHA standards, but the General Duty Clause is often used to enforce control of the hazards. Heat and ergonomic hazards are discussed below.

6.4.1 Heat Stress

OSHA and FOH identified heat as a possible hazard, particularly at FCI Marianna. FOH and NIOSH/DART then conducted a follow-up study of the heat stress hazard at FCI Mariana. This study concluded that workers were at risk from excessive heat and a report describing the results of the study and recommended actions was prepared and submitted.

The heat hazard at FCI Elkton may not be as severe as the hazard at FCI Marianna due to ambient and indoor environmental conditions. However, use of personal protective equipment and respiratory protection under even light to moderate workloads can present potential heat stress hazards.

UNICOR should evaluate its operations consistent with the recommendations of the FOH report for FCI Marianna and implement a heat stress program, if warranted.

6.4.2 Ergonomic Hazards

The FOH Investigative Team also observed potential ergonomic hazards during its investigation of operations of recycling operations at FCI Elkton. Although a formal ergonomic hazard analysis was not conducted, it was apparent that ergonomic issues from repetitive lifting of loads while twisting represented a potential hazard. Other ergonomic hazards may also be present. Training in proper lifting techniques is an example of a straight forward and effective means of mitigating the hazard of lifting loads.

UNICOR and FCI Elkton are encouraged to evaluate their operations for ergonomic hazards, including lifting tasks, and implement training and control actions as warranted. See the NIOSH Revised Lifting Equation (http://www.cdc.gov/niosh/dos/94-110/) for information on this topic.

6.5 Other OSHA Standards

Many other OSHA standards apply to UNICOR's operations at FCI Elkton, such as noise, hazard communication, respiratory protection, personal protective equipment, and hazard analysis. It is beyond the scope of this report to provide a comprehensive review of all applicable standards; however, several pertinent observations and comments are provided below for select OSHA standards:

- 29 CFR 1910.134 Respiratory Protection: The use of respiratory protection requires implementation of a written respiratory protection program. UNICOR should ensure that its respiratory protection program at FCI Elkton is in compliance with OSHA respirator program requirements such as training, fit testing, medical surveillance, cleaning and maintenance, among others.

- 29 CFR 1910.1200 Hazard Communication: Under the hazard communication standard, UNICOR has the obligation to transmit information to staff and inmates regarding chemical hazards in the workplace. The standard requires methods of labeling, material safety data sheets, employee training, and other means of warning such as signage to inform workers of hazards and proper means of hazard control. The OSHA lead and cadmium standards supplement the hazard communication standard's requirements with specific requirements for training, notification of monitoring results, and signage. UNICOR should ensure that the hazard communication program at FCI Elkton is in compliance with OSHA standards.

- 29 CFR 1910.95 Occupational Noise Exposure: Glass breaking operations at FCI Elkton have potential for noise exposure that triggers the need for hearing protection and other requirements of the OSHA Hearing Conservation Program. NIOSH/DART conducted noise dosimetry during its studies in 2007 and found that several noise exposures for glass breakers were above the level that OSHA requires workers to be placed into a Hearing Conservation Program, and one measurement exceeded the PEL for noise. This program requires audiometric testing, hearing protection, training, and periodic exposure monitoring. FCI Elkton has a hearing conservation program. However, an FOH industrial hygienist observed, as well as was informed by certain staff and inmates, that hearing protection was not consistently used during glass breaking. UNICOR should ensure that FCI Elkton's hearing conservation program is adequate and effectively implemented at FCI Elkton.

- Various OSHA Standards for Hazard Analysis: An effective hazard analysis process is essential to identify hazards, implement appropriate controls, and achieve regulatory compliance. This process is fundamental to most OSHA standards. It is specifically required, for instance, when specifying PPE or respiratory protection under 29 CFR 1910 Subpart I Personal Protective Equipment, as well as under the lead and cadmium standards. In general, UNICOR at FCI Elkton has not been effective in performing hazard analyses followed by implementing appropriate control measures and regulatory compliance actions. This is evident from various situations discussed in this report, such as the extreme exposures during filter change-out, lack of monitoring during weekly glass breaking room cleaning, and failure to identify and correct non-compliances. An effective hazard analysis process would allow UNICOR to self-identify applicable hazards and requirements and ensure a safe and healthful workplace.

6.6 29 CFR 1960 Basic Program Elements for Federal Employees

Under 29 CFR 1960 each federal agency is obligated to develop a comprehensive and effective safety and health program. Such programs establish requirements and processes for controlling occupational hazards and meeting federal occupational safety and health regulations.

The BOP has established an ES&H program entitled Occupational Safety, Environmental Compliance, and Fire Protection (BOP Program Statement 1600.09). UNICOR's compliance with this policy will be evaluated in the OIG's final report.

6.7 Environmental Compliance

U.S. EPA's inspection determined that UNICOR and FCI Elkton had not adequately evaluated their wastewater, stormwater, air emissions, and hazard waste streams for compliance with applicable environmental standards, and that the BOP and UNICOR may need to better coordinate their environmental control efforts. BOP has advised the OIG that it is committed to correcting any identified deficiencies, and has developed a compliance plan to address the deficiencies identified in the U.S. EPA's report.

7.0 CONCLUSIONS

Conclusions for the studies conducted by FOH, NIOSH/DART, NIOSH/DSHEFS/HETAB, U.S. EPA, and OSHA for the DOJ OIG concerning UNICOR's e-waste recycling operations at FCI Elkton are provided sequentially below under the following subdivisions:

- Heavy Metals Exposures;
- Medical Surveillance for Lead and Cadmium;
- Health and Safety Regulatory Compliance;
- Hazard Analysis and Controls;
- Environmental Compliance; and
- Exposures to Other Hazards.

These conclusions are supported by the results, findings, and analyses presented and discussed in Sections 5.0 and 6.0 of this report, as well as the reports referenced in Section 9.0 and provided in Attachments 1 – 5.

7.1 Heavy Metals Exposures

1. Exposures were evaluated for 31 toxic metals. Only lead and cadmium exposures have the potential, at times, to be above the action levels or PELs

for routine glass breaking operations and weekly glass breaking room cleaning, when conducted in the manner evaluated at the time of this investigation. Exposures to the other metals were well below the PELs.

2. Current lead and cadmium exposures were minimal (far below action levels) for work activities conducted on the general factory floor outside of the glass breaking room, and in other FCI Elkton recycling areas. Minimal and limited exposure potential exists outside the glass breaking room.

3. A non-routine activity involving the HEPA filter change-out demonstrated potential for very high lead and cadmium exposures without effective and consistent implementation of the improved work practice modifications evaluated in December 2007. Prior to the implementation of improved work practices, yttrium exposure was also above the PEL, but within the protective capacity of the respirators in use. The improved work practices dramatically reduced these exposures, although further improvements in controls for this activity are desirable.

4. Surface lead and cadmium contamination in various areas throughout the recycling facilities is elevated. In addition, past UNICOR testing of air filters used in the buildings' HVAC (general ventilation) systems serving the electronics factory workspaces have shown significant levels of lead and cadmium. TCLP analyses have shown that these filters exceeded EPA criteria for lead and cadmium and, therefore, must be treated as hazardous waste. These findings support the conclusion that uncontrolled releases of lead and cadmium occurred from past glass breaking and de-soldering operations. For current operations, this legacy contamination is not contributing significantly to staff and inmate exposures. Contractor activities are pending to remediate this legacy contamination.

5. Skin/hand wipe samples showed some potential for exposure to lead and cadmium via the ingestion route (e.g., from hand to mouth contact). Better and more consistent and thorough hand washing by inmate workers is needed. Some contamination of inmate housing and staff vehicles is also occurring, but is minimal.

6. Particle size determinations found that dusts released from the glass breaking activities were sufficiently small to allow for their release to the ambient air and breathing zone of workers. This result accounts for the build-up of legacy contamination that likely occurred during periods when engineering controls to contain emissions were not effectively applied. This also confirms the importance of maintaining effective engineering and work practice controls for current operations.

7. The current LEV system in the glass breaking room appears to be generally effective in capturing emissions from the glass breaking activity, however, in

certain areas, some emissions escape capture. Improvement of this system could further reduce lead and cadmium exposures and is needed to meet OSHA requirements for mechanical ventilation under the lead standard.

8. Since 2003, UNICOR has made progress in controlling exposure to lead and cadmium. Positive actions include installation of the enclosed glass breaking room, installation of LEV in the glass breaking room, implementation of work practice controls, use of personal protective equipment and hooded powered air purifying respiratory protection for glass breaking workers, implementation of housekeeping measures, and provision of a change room. Nevertheless, at times, exposures in the glass breaking room have exceeded action levels and PELs, particularly for cadmium, between 2003 and 2007. Although respiratory protection is used to control these exposures, OSHA requires the use of engineering and work practice controls. Further improvements in controls are, therefore, necessary.

7.2 Medical Surveillance for Lead and Cadmium

9. The highest annual mean BLL for inmates doing glass breaking was measured at 5.6 µg/dL in 2003. These biological monitoring results indicate some bodily uptake of lead. These BLLs are well below levels that would warrant medical removal protection under the OSHA standard, however, subclinical adverse health effects at BLLs of <10 µg/dL have been reported in the literature (see Attachment 3). The BLLs have generally declined over time from 2003 – 2007, indicating that exposures have likely similarly decreased. The blood and urine cadmium results from 2003 – 2007 were well below levels that would warrant medical removal protection under the OSHA standard. No biological monitoring results were available for inmates doing glass breaking from 1997 – 2003, when exposures were likely higher. [Note: One staff member showed a single BLL at 10 µg/dL and one cadmium indicator was at an elevated level during the same sampling episode. However, results were at low levels both before and after this sampling episode. This single data set is inconclusive and laboratory error cannot be ruled out.]

10. Medical surveillance provided to inmates and staff involved with glass breaking operations is not in compliance with OSHA standards. For instance, no medical exams (including physical examination) are performed on inmates; staff receive inconsistent examinations and biological monitoring by their personal physicians; biological monitoring for lead is not conducted at the prescribed six month intervals; and results have not been consistently communicated to workers. In addition, inappropriate biological monitoring tests have been performed. Records of medical surveillance are not maintained by UNICOR or FCI Elkton for the appropriate length of time.

11. The only persons with current potential for exposure to either lead or cadmium over the action levels are inmates who perform glass breaking, cleaning in the glass breaking room, or monthly filter change-outs. These inmates require continued medical surveillance. Medical surveillance can be discontinued for all other inmates and staff, although some former inmates and/or staff may require continued surveillance under the OSHA cadmium standard, because of potential past exposures.

12. Exposure to lead from the past chip recovery process cannot be conclusively determined because of the lack of biological monitoring and exposure data. Staff descriptions of work and one blood lead level taken for an inmate four months after the process ended indicate that exposure to lead did occur, but the degree of exposure cannot be estimated. No evidence was found that actions were taken to prevent exposure to lead at the outset of the process and no medical surveillance was performed until after the process ended. The same conclusion applies regarding lead exposures from general recycling activities prior to 2003.

7.3 Health and Safety Regulatory Compliance

13. Beginning for the most part in 2003 and continuing through the time of this investigation, UNICOR at FCI Elkton has implemented engineering controls, work practices, personal protective equipment, respiratory protection, housekeeping, and other measures to mitigate inmate and staff exposures to lead and cadmium during glass breaking. These actions are partially consistent with the OSHA lead and cadmium standards which require that engineering and work practice controls be implemented to maintain exposures at or below the PELs. However, engineering controls (i.e., the LEV mechanical ventilation system) are not designed or tested in compliance with OSHA standards. Additionally, at times since 2003, exposure excursions above the PEL for cadmium have occurred, which indicates that further improvements in engineering and work practice controls are required. During this period, lead was found, at times, to be above the action level, but not above the PEL.

14. The use of respiratory protection between 2004 and present has been adequate to protect workers against the exposure excursions above the action levels and PELs during routine glass breaking. OSHA standards, however, require that routine exposures above the PEL (i.e., over 30 days per year) be controlled by the use of engineering and work practice controls, regardless of whether respiratory protection is used.

15. UNICOR's response to elevated exposures is unclear. UNICOR has made continued improvements in exposure controls since 2003. However, when exposures exceed the PEL, OSHA requires that actions be detailed to reduce exposures to below the PEL. Past monitoring results showing elevated

exposures cannot be clearly linked to subsequent improved control actions. UNICOR lacks a compliant exposure monitoring program that is followed by improved exposure controls should results so warrant. Control actions are not documented in a written compliance program for lead and cadmium.

16. UNICOR has not conducted exposure monitoring consistent with OSHA lead and cadmium standards that require initial monitoring and follow-up monitoring at a frequency that is based on results and exposure potential. Additional monitoring is also required, but not always performed by UNICOR, when new processes or changes in process, controls, or other factors are implemented that could affect levels of exposure.

17. The maintenance activity involving HEPA filter change-out for the glass breaking booth initially resulted in exposures far above the OSHA PELs for lead and cadmium. These exposures were beyond the protection factor capability of the respirators used. However, changes in work practices reduced this exposure to well below the PEL for lead and to only somewhat above for cadmium. Cadmium exposures after work practice improvements were, however, well within the protection factor of the respirators used. Even though initial exposure was unacceptably high and out of compliance, the exposure reduction action is considered to be a successful action consistent with the lead and cadmium standards. If feasible, further exposure reduction for cadmium is desirable using improved engineering or work practice controls.

18. Past UNICOR recycling practices at FCI Elkton were likely to have produced uncontrolled or poorly controlled releases of lead and cadmium dusts. This is evidenced by the bulk dust and wipe sample results collected by FOH, NIOSH/DART, and NIOSH/DSHEFS/HETAB. It is reasonable to presume that these uncontrolled emissions resulted in past exposures and broad non-compliance with the lead and cadmium standards.

7.4 Hazard Analysis and Hazard Controls

19. Prior to the DOJ OIG's investigation, neither UNICOR nor FCI Elkton had implemented effective hazard analysis processes to proactively identify hazards and degrees of exposure and ensure adequate control measures. This is evidenced by the various findings of this report, including failure to recognize, evaluate, or control the extent of the filter maintenance exposure, deficient exposure monitoring, deficient medical surveillance, OSHA non-compliances, and others.

7.5 Environmental Compliance

20. UNICOR and FCI Elkton have not adequately evaluated their wastewater, stormwater, air emissions, and hazard waste streams for compliance with

applicable environmental standards. BOP and UNICOR need to better coordinate their environmental control efforts.

7.6 Exposures to Other Hazards

21. Noise exposure during glass breaking is above the level that requires implementation of a Hearing Conservation Program that includes audiometric testing, hearing protection, training, and monitoring.

22. The observed recycling activities have the potential for excessive heat and ergonomic hazards mainly from lifting and twisting.

8.0 RECOMMENDATIONS

The recommendations presented in this section are compiled from the FOH, NIOSH/DART, NIOSH/DSHEFS/HETAB, and U.S. EPA studies conducted for UNICOR's e-waste recycling operations at FCI Elkton. In many cases, several recommendations from these reports have been consolidated in this section. Additional recommendations and detail are provided based on the results and findings of these studies and on regulatory requirements. The recommendations are subdivided in the same subsections as Section 7.0, Conclusions, as follows:

- Heavy Metals Exposures;
- Medical Surveillance for Lead and Cadmium;
- Health and Safety Regulatory Compliance;
- Hazard Analysis and Controls;
- Environmental Compliance; and
- Other Hazards.

These recommendations are supported by the results, findings, and analyses presented and discussed in Sections 5.0 and 6.0 of this report, as well as the reports referenced in Sections 9.0 and provided in Attachments 1 – 5.

8.1 Heavy Metals Exposures

1. Glass Breaking: For routine glass breaking operations, UNICOR should improve its engineering and work practice controls to reduce and maintain lead and cadmium exposures below the OSHA PELs at all times. These improvements should also have the benefit of reducing exposures during weekly cleaning of the glass breaking room by reducing build-up of surface contamination. Specific recommendations for engineering and work practice controls and verification of effectiveness of the controls follow.

    a. UNICOR should extend the overhead push jet to the right of the existing LEV system so that this jet is continuous across the front face of the hood.

This may correct the backflow condition found by NIOSH/DART smoke tests. After extension, verify the effectiveness of emissions capture by quantitative air flow measurements and qualitative smoke tests or other means, plus exposure monitoring. If not effective, explore other means to correct the backflow problem. See NIOSH/DART report, Attachment 1, Conclusions and Recommendations.

b. UNICOR should implement the mechanical ventilation design features and measurement methods for the LEV system as specified in the OSHA lead and cadmium standards. In addition, UNICOR should conduct periodic inspections of the LEV system to ensure that it remains in a good state of repair.

c. UNICOR should investigate alternative methods to break CRTs, including systems to automate or partially automate the glass breaking process. NIOSH/DART describes various methods presented by Lee et al. [2004] to separate panel glass from funnel glass and for removing the coatings from funnel glass. As described by Lee et al., hot wire and vacuum suction methods, supplemented with LEV, could produce fewer airborne particulates than breaking glass with a hammer. (See NIOSH/DART report, Attachment 1, Recommendation 17).

d. UNICOR should evaluate alternate LEV systems. NIOSH/DART Recommendation 18 in Attachment 1 references best practices from German authorities [BG/BIA 2001] that recommends use of a closed cleaning cabinet that incorporates 300 air changes per hour to control emissions. Many other LEV systems are also commercially available.

e. FCI Elkton safety and health and supervisory personnel should regularly review work practices to ensure that they are properly implemented and that the interaction between the worker, the work piece, and the LEV system is consistently appropriate. Any problems should be corrected with pre-job and on-the-job re-enforcement of practices and with initial and refresher training.

f. UNICOR should evaluate improvement opportunities for daily housekeeping and cleaning practices in the glass breaking area. An example includes daily periodic and end of shift HEPA vacuuming. Improved daily housekeeping would also serve to reduce exposures during the more extensive weekly clean up activity.

g. Any time that a change or improvement is made to the LEV system or work practice that reasonably could be foreseen to change exposure conditions, UNICOR should perform exposure monitoring to verify that the desired effect is achieved.

h. If improvements in engineering and work practice controls are effective in maintaining exposures below lead and cadmium action levels consistently over time (see Recommendation 1 in Section 8.3, below), then UNICOR could reevaluate the level of respiratory protection needed for routine glass breaking operations. If considered, this action should only be taken with the evaluation and recommendation of a Certified Industrial Hygienist, after sufficient exposure monitoring data has been collected and documented over time.

i. UNICOR should prioritize implementation of the recommendations above, as follows: (1) improve the current LEV system and work practices; (2) verify effectiveness of improvements with LEV measurements, smoke tests, and exposure monitoring; and (3) explore alternative LEV systems, work practices, and automation for possible future implementation.

2. Filter Maintenance: For the non-routine filter maintenance activities, UNICOR should adopt the exposure control improvements used in December 2007 as standard operating procedure, continue to improve controls, and verify continued effectiveness of control measures. Specific recommendations follow.

   a. UNICOR should institute a standard operating procedure or revise its current procedure for the filter maintenance activity in a manner that requires: (1) immediate bagging and disposal of used filters rather than attempting to clean and re-use them; (2) the use of water spray to suppress dust during the filter change activity; (3) the use of HEPA filtered vacuuming and wet mopping to remove dust from the floor and work surfaces; and (4) the use of defined PPE and respiratory protection. The procedure should also ensure proper precautions to be taken to guard against electrical hazards when using wet methods. (See NIOSH/DART report, Attachment 1, Recommendation 12).

   b. UNICOR should evaluate and implement additional control measures or refinements to the controls used in December 2007 to further reduce cadmium exposures, if feasible. Examples could include: (1) refinement of wetting techniques, (2) use of a portable LEV system with HEPA filters to draw dusts away from the workers' breathing zones and capture dust emissions, and (3) further refinement and modification of work practices.

   c. UNICOR should continue to require the use of PPE and respiratory protection for this activity (see NIOSH/DART report, Attachment 1, Recommendation 14).

   d. UNICOR should conduct exposure monitoring for this activity every time it is conducted until conclusive data is accumulated over time to demonstrate and document consistent control of lead and cadmium below the PELs (preferable) and/or at levels that are clearly within the protective capacity of respirators used (acceptable). (See Recommendation 1 in Section 8.3 regarding frequency of exposure monitoring.) [Note: Since this activity is conducted less than 30 days per year, respiratory protection is acceptable to supplement engineering and work practice controls.] See Section 8.3 for additional information and details on exposure monitoring.

e. If feasible, rather than changing the filters on a defined monthly basis, UNICOR should use an alternative method, such as static pressure drop measurements for the LEV system, to determine the frequency of filter change-out (see NIOSH/DART report, Attachment 1, Recommendation 13). The current monthly frequency could be too frequent or not frequent enough. Preferably, filter change-out should be based on performance of the LEV system rather than an arbitrary time period. FCI Elkton should consult with an industrial ventilation professional on this topic and on the performance of the overall LEV system, if necessary. Improved measurement processes for the LEV system should also be implemented in a manner that complies with the OSHA requirements for mechanical ventilation under the lead and cadmium standards.

3. Legacy Contamination: Clean-up operations to remediate lead and cadmium legacy contamination appear to be imminent. Prior to the implementation of this work, in order to prevent release to the air or work areas of legacy surface contamination deposited on various structural and general ventilation systems, FCI Elkton should implement operations and maintenance (O&M) practices for any non-routine activities that could disturb this contamination. Such activities could include contractor maintenance of ventilation systems or non-routine internal activities. Should this contamination be disturbed for any reason, FCI Elkton should immediately apply clean-up practices using HEPA filtered vacuums, wet methods, and other remediation techniques to mitigate the release. (See the FOH report on bulk dust and surface contamination for details on an O&M plan, Attachment 2, Recommendation 4). After remediation of all legacy contamination is completed under contract, these O&M actions should no longer be necessary. At that point, current housekeeping and cleaning activities to control any dust migration from the glass breaking room should suffice to keep contamination in check.

4. Exposure from Ingestion: FCI Elkton should re-enforce the importance of hand washing to prevent the potential for hand-to-mouth ingestion exposures. Pre-job briefings, end-of-shift discussions, and general supervision are opportunities to ensure that workers apply proper hand washing and hygiene practices. FCI Elkton should ensure rigorous enforcement of no eating and drinking from open cup restrictions in recycling areas.

8.2 Medical Surveillance for Lead and Cadmium

The medical surveillance recommendations are based on the NIOSH/DSHEFS/HETAB report (see Attachment 3) and OSHA lead and cadmium standards.

1. For inmates engaged in glass breaking, clean-up activities in the glass breaking room, and filter maintenance activities (and any others found to have potential for exposure above the lead and cadmium action levels), FCI Elkton should improve its medical surveillance program as follows:

    a. When conducting biological monitoring, consistently perform all tests for lead and cadmium exposure, as required by the OSHA standards.

    b. Perform pre-placement (i.e., baseline) biological monitoring prior to assigning inmates to glass breaking work. This is particularly important for cadmium.

    c. Perform biological monitoring at the intervals required by the OSHA standards; i.e., every six months (or more frequently should results be elevated).

    d. Provide other medical examinations, as specified in the OSHA standards, such as a detailed work history and medical history, a thorough physical examination, pulmonary status evaluations for respirator users, blood pressure measurements, and laboratory and other tests that the examining physician deems necessary.

2. UNICOR and FCI Elkton should consistently inform personnel of medical surveillance and biological monitoring results and retain and maintain records consistent with OSHA standards.

3. UNICOR and FCI Elkton can discontinue medical surveillance for staff and inmates who are not involved in glass breaking, clean-up in the glass breaking room, and filter change-out. An occupational physician should be retained to confirm this recommendation and determine whether some staff or inmates could require continued surveillance under the cadmium standard based on past exposures (see also Recommendation 4, below).

4. UNICOR or FCI Elkton should retain a board-certified, residency-trained occupational medical physician who is familiar with OSHA standards to oversee the medical surveillance program at FCI Elkton. In addition to lead and cadmium standards, the physician should provide oversight of medical clearance for respirator use.

8.3 Health and Safety Regulatory Compliance

In addition to the recommendations provided in Sections 8.1 and 8.2 regarding engineering and work practice controls and medical surveillance, UNICOR should implement the following actions to achieve compliance with OSHA lead and cadmium standards and to protect staff and inmates from lead and cadmium hazards.

1. Exposure Monitoring: UNICOR should immediately develop and implement an exposure monitoring program at FCI Elkton consistent with OSHA standards to ensure that exposures are reduced and maintained below lead and cadmium action levels and PELs. Specific recommendations are detailed below. Because exposures have exceeded PELs at times since 2003, some of these recommendations go beyond minimum OSHA requirements. If UNICOR should opt to implement only the minimum requirements, these are discussed in Section 6.2.1 and the OSHA lead and cadmium standards.

    a. For routine glass breaking operations and weekly cleaning in the glass breaking room, UNICOR should conduct exposure monitoring on a quarterly basis for a minimum of four consecutive quarters. Inmates monitored should represent those conducting typical glass breaking activities and should also represent those with "worst case" exposure potential. Also, at least one worker with worst case exposure potential should be monitored during the weekly cleaning activity. Following these four monitoring episodes, UNICOR should proceed as follows.

        - If any exposure is above the PEL during any of the initial four monitoring episodes, then take corrective actions and continue quarterly monitoring for an additional four quarters until four consecutive quarters are below the PELs;

        - If during the initial four quarters, any exposure is above any action level, but below the PEL, reduce monitoring frequency to every six months. Resume quarterly monitoring and take corrective actions should PELs be exceeded in subsequent monitoring events.

        - If exposures for any four consecutive quarterly or semi-annual monitoring episodes are all below the actions levels, then conduct annual monitoring and eventually discontinue monitoring if exposure potential above the actions levels is conclusively mitigated through the use of engineering and work practice controls. [Note: Even though monitoring could be eventually discontinued if results are consistently below action levels, annual monitoring is always useful to verify and document continued acceptable performance.]

    b. When any change (i.e., improvement, corrective action, new system, etc.) is made to engineering or work practice controls that could affect exposures, UNICOR should conduct an additional monitoring episode to verify that the change has had the desired effect. This monitoring should be considered as an additional episode and not as a substitute for the quarterly or semi-annual monitoring. This would apply to changes in the current LEV system and work practices, as well as the implementation of new and improved engineering controls or automated systems as discussed in section 8.1, above.

c. For the non-routine HEPA filter change-out activity, UNICOR should perform exposure monitoring for the next four times that the activity is performed. Quarterly, semi-annual, or annual monitoring could then be implemented based on exposure results (quarterly if above any PEL, semi-annual if above the action level but below the PEL, and annual if below the action level). Additional monitoring should be performed during the first time that any changes to the engineering or work practice controls are implemented for this activity. Even if exposures are shown to be consistently below the action levels, it is recommended that annual monitoring of this activity be conducted at a minimum to verify and document sustained exposure control.

d. At UNICOR's and/or FCI Elkton's discretion, a limited amount of monitoring (perhaps annually at the same time as a glass breaking monitoring event) could be performed for select activities outside of the glass breaking room. This would serve to re-enforce and document that these exposures continue to be minimal. [Note: Based on results of this investigation, this monitoring is not required by OSHA standards.]

e. UNICOR should notify all workers with exposures representative of those monitored of the monitoring results within 15 working days after receipt of results. If PELs are exceeded, then FCI Elkton should provide the workers with a statement that describes the corrective actions to be taken to reduce exposures below the PELs.

f. UNICOR should clearly document any changes or corrective actions taken in response to exposure monitoring results or other exposure information or hazard analysis.

2. Compliance Program: UNICOR should develop a written compliance program to define its processes and methods to control exposures at or below the PELs. Engineering controls, work practices, standard operating procedures, PPE and respiratory protection, exposure monitoring, and other elements should be detailed in this program. The program should be immediately updated when modifications to controls or practices are implemented. BOP and UNICOR industrial hygienists should prepare or contribute to this program and ensure its implementation and continued effectiveness into the future.

3. Engineering controls: See Section 8.1.

4. Change Rooms: UNICOR should reconfigure the change room to ensure that glass breaking inmates do not carry cadmium or lead out of the glass breaking room. Separate storage should be provided for non-work uniforms and glass breaking work apparel/PPE. All potentially-contaminated work clothing and PPE should remain in the "dirty" chamber of the change room; non-work clothing should never come in contact with work items. As a minimum requirement, workers should be required to thoroughly wash hands and all potentially exposed skin after doffing PPE, before putting on uniforms when exiting the glass breaking room. Work clothes and PPE should never be worn outside of the glass breaking room to minimize migration of cadmium and lead dusts to other parts of the institution. (See NIOSH/DSHEFS/HETAB report, Attachment 3, Recommendations).

5. Showers: UNICOR should determine the applicability of the OSHA showering requirement. Showering must be conducted at the end of the work shift when the lead or cadmium PEL is exceeded. Through implementation of the exposure monitoring recommendations in Section 8.3, above, UNICOR will determine if any current activities can exceed the PEL. If any such activities are identified, then UNICOR should require showering after the work shift. Based on past exposure data, this requirement could apply to routine glass breaking, weekly clean-up, and/or filter change-out activities; however, UNICOR should determine current exposures based on its latest methods and controls. If showering is required, UNICOR does not necessarily have to provide showers in the work area, but FCI Elkton should ensure that workers do not leave the work area wearing any clothing or equipment worn during the work shift.

6. Respiratory Protection Program: UNICOR should self-assess and ensure that its respiratory protection program meets OSHA requirements for medical clearance, training, fit testing, cleaning and maintenance, and other items.

7. Recordkeeping: UNICOR should improve its recordkeeping for medical surveillance and exposure monitoring data to meet OSHA requirements for types of information maintained, records retention, and employee (staff and inmate) notification of results.

8.4 Hazard Analysis and Hazard Controls

The BOP and UNICOR should develop and implement an ongoing and pro-active hazard analysis process to identify, evaluate, and control occupational hazards. Specific recommendations follow.

1. The BOP and UNICOR should perform management assessments of all UNICOR operations, not just recycling, for compliance with applicable environmental, safety and health requirements. These assessments should be designed at the

management level to ensure that the individual institutions have and implement the required ES&H programs, as well as conduct their own self-assessments to determine effectiveness. (See also NIOSH/DART report, Attachment 1, Recommendation 7).

2. UNICOR should conduct self assessments at the working level to determine the effectiveness of its safety and health and hazard control programs. Examples include the hearing conservation program, respiratory protection program, lead and cadmium compliance program, medical surveillance program, hazard communication program, among others. Self-assessments can, of course, be conducted using safety and health contractors and/or UNICOR safety and health staff in support of internal safety and health staff, as desired. Any deficiencies should be documented and corrective actions should be implemented and documented to close out any deficiencies.

3. FCI Elkton should conduct activity-based job hazard analysis (JHA) for any new, modified, or non-routine work activity prior to the work being conducted. The JHA is intended to identify potential hazards and implement controls for the specific work activity prior to starting the work.

4. BOP and UNICOR should ensure that its staff industrial hygienists and/or consultants proactively perform exposure monitoring, assessment, and hazard analysis and control functions on an on-going basis.

8.5 Environmental Compliance

UNICOR and FCI Elkton should evaluate their wastewater, stormwater, air emissions, and hazardous waste streams to ensure compliance with applicable environmental requirements. The BOP and UNICOR should coordinate their environmental control efforts.

8.6 Exposures to Other Hazards

FCI Elkton should evaluate heat stress and ergonomic hazards (specifically lifting loads and twisting while carrying loads) and ensure that controls are implemented to mitigate any identified hazards and comply with OSHA standards. For workers at risk for ergonomic injury from lifting loads, FCI Elkton should implement training for lifting and carrying techniques. Also see the NIOSH Revised Lifting Equation (http://www.cdc.gov/niosh/dos/94-110/) for information on this topic.

To control hazards from noise exposures, the BOP should evaluate the adequacy of the FCI Elkton hearing conservation program and ensure that it is effectively implemented. UNICOR should ensure the proper use of hearing protection for recycling areas and operations where it is required.

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ATTACHMENTS

ATTACHMENT 1

CONTROL TECHNOLOGY AND EXPOSURE ASSESSMENT FOR ELECTRONIC RECYCLING OPERATIONS ELKTON FEDERAL CORRECTIONAL INSTITUTION ELKTON, OHIO

REPORT DATE:
August 2008

FILE NO.:
EPHB 326-12a

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SITES SURVEYED:	Unicor Recycling Operations Federal Correctional Institution Elkton, Ohio
NAICS:	562920
SURVEY DATE:	February 26 – March 2, 2007 December 11 – 13, 2007
SURVEY CONDUCTED BY:	Dan Almaguer, MS Ed Burroughs, Ph.D., CIH, CSP Keith Crouch, Ph.D. Alan Echt, MPH, CIH Dave Marlow Amir Khan

"The findings and conclusions in this report have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy."

DISCLAIMER

Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention.

The findings and conclusions in this report do not necessarily reflect the views of the National Institute for Occupational Safety and Health.

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<u>Tables, Appendices and Figures</u>

EXECUTIVE SUMMARY

Researchers from the National Institute for Occupational Safety and Health (NIOSH) conducted a study of the recycling of electronic components at the Federal Prison Industries facilities (aka, Unicor) in Elkton, Ohio, to assess workers' exposures to metals and other occupational hazards, including noise, associated with these operations. An in-depth evaluation was conducted from February 26 to March 2, 2007, and a follow-up survey was conducted from December 11 to 13, 2007, to evaluate changes made in selected activities as a result of initial recommendations.

The electronics recycling operations at Elkton can be organized into four production processes: a) receiving and sorting, b) disassembly, c) glass breaking operations, and d) packaging and shipping. A fifth operation, cleaning and maintenance, was also addressed but is not considered a production process per se. It is known that lead (Pb), cadmium (Cd), and other metals are used in the manufacturing of electronic components and pose a risk to workers involved in recycling of electronic components if the processes are not adequately controlled or the workers are not properly trained and provided appropriate personal protective clothing and equipment.

Methods used to assess worker exposures to metals during this evaluation included: personal breathing zone and area sampling for airborne metals; particle size sampling; surface wipe sampling to assess surface contamination; and bulk material samples to determine the composition of settled dust. Samples were analyzed for up to 31 metals with five selected elements (barium, beryllium, cadmium, lead and nickel) given emphasis. Noise exposures were determined using personal dosimeters.

The results of air sampling conducted during the February / March visit indicated that the highest exposures occurred to workers during the filter change-out maintenance operation. Airborne concentrations of Cd and Pb measured during filter change-out showed an 8-hour time weighted average of about 150 times the OSHA Permissible Exposure Limit (PEL) for Cd and 15 times the OSHA PEL for Pb for one of the two workers. Air samples collected on a second worker showed airborne concentrations of 30 times the PEL for Cd and 4 times the PEL for Pb. In both cases the results showed that the Cd concentrations exceeded the assigned protection factor for the powered air-purifying respirator being used by the workers. An over-exposure to Cd was also found during the weekly clean-up operation.

Although beryllium is used in consumer electronics and computer components, such as disk drive arms (beryllium-aluminum), electrical contacts, switches, and connector plugs (copper-beryllium) and printed wiring boards [Willis and Florig 2002, Schmidt 2002], most beryllium "in consumer products is used in ways that are not likely to create beryllium exposures during use and maintenance" [Willis and Florig 2002]. This may account for the fact that beryllium in this study was measured in only two samples at levels above the detection limit of the analytical method. The removal and sorting of components seen here is typical of a maintenance activity (components are removed from the cases and sorted, rather than removed and replaced). Other e-recycling activities that include further processing, such as shredding of the components, may produce higher exposures to beryllium but these processes are not done at this facility.

Samples collected during routine daily glass breaking operations were less than 20% of the OSHA PELs for both Cd and Pb. Samples collected on disassembly workers in the general factory area of all three buildings ranged from non-detectable to 10% of the OSHA PEL for Cd and ranged from non-detectable to 5% of the OSHA PEL for Pb. Unless specified, results of samples presented are for duration of sample and not calculated on an 8 hour time weighted average basis.

Lead, cadmium and other heavy metals were detected in the surface wipe and bulk dust samples. There are few established standards available for wipe samples with which to compare these data. Most of the surfaces tested for lead indicated levels exceeding the most stringent criteria. The wipe sample results can not be used to determine when the contamination occurred. They only represent the surface contamination present at the time the sample was collected.

Measurement of noise levels indicated several samples exceeding the REL and TLV of 85 dBA. One sample exceeded the PEL of 90 dBA and 3 other samples exceeded 50% of the allowable dose requiring that those employees be placed in a hearing conservation program.

As a result of the February/March 2007 survey, it was recommended that the filter change operation be modified and that improved dust suppression methods be used to reduce airborne concentrations. Specific recommendations (implemented prior to the second evaluation) include: 1) the use of water spray to suppress dust during the filter change-out operation; 2) the immediate bagging and disposal of used filters rather than attempting to clean and re-use them; and 3) the use of HEPA vacuums and wet mopping to remove dust from the floor and work surfaces. Measurements made during the follow-up survey in December 2007 indicated significant reductions in the levels of airborne contaminants during this modified operation although respiratory protection during the filter change operation continues to be necessary and other improvements are needed. These improvements are described in detail later in this report.

Recommendations resulting from this study include:

- The respiratory protection program for this facility should be evaluated for this operation in order to ensure that it complies with OSHA regulations.
- Attention should be focused on practices to prevent accidental ingestion of lead.
- Management should evaluate the feasibility of providing and laundering work clothing for all workers in the recycling facility.
- Change rooms should be equipped with separate storage facilities for work clothing and for street clothes to prevent cross-contamination.
- A hearing conservation program must be implemented for workers in the glass breaking operation.
- All Unicor operations should be evaluated from the perspective of health, safety and the environment in the near future.
- A comprehensive program is needed within the Bureau to assure both staff and inmates a safe and healthy workplace.

I. INTRODUCTION

Researchers from the National Institute for Occupational Safety and Health (NIOSH) conducted a study of exposures to metals and other occupational hazards associated with the recycling of electronic components at the Federal Prison Industries (aka, Unicor) in Elkton, Ohio.* The principal objectives of this study were:

1. To measure full-shift, personal breathing zone exposures to metals including barium, beryllium, cadmium, lead and nickel;

2. To evaluate contamination of surfaces in the work areas that could permit skin contact or allow re-suspension of metals into the air;

3. To identify and describe the control technology and work practices in use in operations associated with occupational exposures to metals, as well as to determine additional controls, work practices, substitute materials, or technology that can further reduce occupational exposures;

4. To evaluate the use of personal protective equipment in operations involved in the recycling of electronic components; and,

5. To determine the size distribution of airborne particles for purposes of toxicity and control.

Other objectives such as a preliminary evaluation of noise exposures and visual observations of undocumented hazards, were secondary to those listed above but are discussed as appropriate in this document.

An initial walk-through evaluation was conducted on November 29, 2006, to observe processes and conditions in order to prepare for subsequent testing. An in-depth evaluation was conducted from February 26 to March 2, 2007, during which two full shifts of environmental monitoring were conducted for the duration of normal plant operations. An additional two days of monitoring were conducted during cleaning and maintenance as described later in Section II (Process Description) and Section III (Sampling and Analytical Methods). A follow-up survey was conducted December 11 – 13, 2007, to evaluate changes made in the cleaning and maintenance activities as a result of the recommendations contained in Section VI (Conclusions and Recommendations).

Computers and their components contain a number of hazardous substances. Among these are "platinum in circuit boards, copper in transformers, nickel and cobalt in disk drives, barium and cadmium coatings on computer glass, and lead solder on circuit boards and video screens" [Chepesiuk 1999]. The Environmental Protection Agency (EPA) notes that "In addition to lead, electronics can contain chromium, cadmium, mercury, beryllium, nickel, zinc, and brominated flame retardants" [EPA 2008]. Schmidt [2002] linked these and other substances

* This report documents the study conducted at Elkton, Ohio. Other NIOSH field studies were conducted at Federal correctional facilities in Lewisburg, Pennsylvania and Marianna, Florida

to their use and location in the "typical" computer: lead used to join metals (solder) and for radiation protection, is present in the cathode ray tube (CRT) and printed wiring board (PWB). Aluminum, used in structural components and for its conductivity, is present in the housing, CRT, PWB, and connectors. Gallium is used in semiconductors; it is present in the PWB. Nickel is used in structural components and for its magnetivity; it is found in steel housing, CRT and PWB. Vanadium functions as a red-phosphor emitter; it is used in the CRT. Beryllium, used for its thermal conductivity, is found in the PWB and in connectors. Chromium, which has decorative and hardening properties, may be a component of steel used in the housing. Cadmium, used in Ni-Cad batteries and as a blue-green phosphor emitter, may be found in the housing, PWB and CRT. Cui and Forssberg [2003] note that cadmium is present in components like SMD chip resistors, semiconductors, and infrared detectors. Mercury may be present in batteries and switches, thermostats, sensors and relays [Schmidt 2002, Cui and Forssberg 2003], found in the housing and PWB. Arsenic, which is used in doping agents in transistors, may be found in the PWB [Schmidt 2002].

Lee et al. [2004] divided the personal computer into three components, the main machine, monitor, and keyboard. They further divided the CRT of a color monitor into the "(1) panel glass (faceplate), (2) shadow mask (aperture), (3) electronic gun (mount), (4) funnel glass and (5) deflection yoke. Lee et al. [2004] note that panel glass has a high barium concentration (up to 13%) for radiation protection and a low concentration of lead oxide. The funnel glass has a higher amount of lead oxide (up to 20%) and a lower barium concentration. They analyzed a 14-in Philips color monitor by electron dispersive spectroscopy and reported that the panel contained silicon, oxygen, potassium, barium and aluminum in concentrations greater than 5% by weight, and titanium, sodium, cerium, lead, zinc, yttrium, and sulfur in amounts less than 5% by weight. Analysis of the funnel glass revealed greater than 5% silicon, oxygen, iron and lead by weight, and less than 5% by weight potassium, sodium, barium, cerium, and carbon. Finally, Lee et al. [2004] noted that the four coating layers are applied to the inside of the panel glass, including a layer of three fluorescent colors (red, blue and green phosphors) that contain various metals, and a layer of aluminum film to enhance brightness.

German investigators [BIA 2001, Berges 2008a] broke 72 cathode-ray tubes using three techniques (pinching off the pump port, pitching the anode with a sharp item, and knocking off the cathode) in three experiments performed on a test bench designed to measure emissions from the process. Neither lead nor cadmium was detected in the total dust, with one exception, where lead was detected at a concentration of 0.05 mg/cathode ray tube during one experiment wherein the researchers released the vacuum out of 23 TVs by pinching off the pump port [BIA 2001, Berges 2008b]. They described this result as "sufficiently low that a violation of the German atmospheric limit value of 0.1 mg/m^3 need not generally be anticipated" [BIA 2001]. The researchers noted that "the working conditions must be organized such that skin contact with and oral intake of the dust are excluded" [BIA 2001].

However, there are few articles documenting occupational exposures among electronics recycling workers. Sjödin et al. [2001] and Pettersson-Julander et al. [2004] have reported potential exposures of electronics recycling workers to flame retardants while they dismantled electronic products, although no retardants were used in this facility. Recycling operations in the Elkton facility are limited to disassembly and sorting tasks, with the exception of breaking

CRTs and stripping insulation from copper wiring. Disassembly and sorting probably poses less of a potential hazard to workers than tasks that disrupt the integrity of the components, such as shredding or desoldering PWBs.

The process of greatest concern was the glass breaking operation (described below) that releases visible emissions into the workroom atmosphere. Material safety data sheets and other information on components of CRTs broken in this operation listed several metals, including Pb, Cd, Be and Ni. In addition, FOH investigators expressed a particular interest in Ba.

II. PROCESS DESCRIPTION

The recycling of electronic components at the Elkton Federal Correctional Institution (FCI) is done in three separate buildings: 1) the main factory located within the FCI main compound; 2) the Federal Satellite Low (FSL); and 3) the warehouse. Diagrams of these work areas are shown in Figures I, II and III, respectively, with an enlargement of the glass breaking operation in Figure IV. These figures provide a general visual description of the layout of the work process, although workers often moved throughout the various areas in the performance of their tasks. Photographs from these areas are also included and identified below.

The electronics recycling operations can be organized into four production processes: a) receiving and sorting, b) disassembly, c) glass breaking operations, and d) packaging and shipping. A fifth operation; cleaning and maintenance, will also be addressed but is not considered a production process per se.

Incoming materials to be recycled are received at the warehouse (see Figure III) where they are examined and sorted. During this evaluation it appeared that the bulk of the materials received were computers, either desktop or notebooks, or related devices such as printers. Some items, notably notebook computers, could be upgraded and resold, and these items were sorted out for that task.

After electronic memory devices (e.g., hard drives, discs, etc.) were removed and degaussed or shredded, computer central processing units (CPUs), servers and similar devices were sent for disassembly; monitors and other devices (e.g., televisions) that contain CRTs were separated and sent for disassembly and removal of the CRT. Printers, copy machines and any device that could potentially contain toner, ink, or other expendables were segregated and inks and toners were removed prior to being sent to the disassembly area.

In the disassembly process (see Figures I and II), external cabinets, usually plastic, were removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing were removed and sorted by grade for further treatment if necessary. Components such as circuit boards or chips that may have value or may contain precious metals such as gold or silver were removed and sorted. With few exceptions each of the approximately 85 workers in the main factory will perform all tasks associated with the disassembly of a piece of equipment into the mentioned components with the use of powered and un-powered hand tools (primarily screwdrivers and wrenches), with a few workers collecting the various parts and placing them into the proper collection bin. Work tasks including removing screws and other fasteners from cabinets, unplugging or clipping electrical cables, removing circuit boards, and using whatever other methods necessary to break these devices into their component parts. Essentially all components currently are sold for some type of recycling.

The third production process to be evaluated was the glass breaking operation where CRTs from computer monitors and TVs were sent for processing. This was an area of primary interest in this evaluation due to concern from staff, review of process operations and materials involved, and observations during an initial walk-through. This was the only process where local exhaust ventilation was utilized or where respiratory protection was in universal use. Workers in other locations would wear eye protection and occasionally would voluntarily wear a disposable respirator. The local exhaust ventilation system consisted of a large walk-in hood, approximately 8 ft high and 16 ft wide and 6 ft deep, with 2 or 3 workers positioned toward the front. Air was pulled from behind the workers, past the work area where contaminant was released, and through a filtration system. The filtration system consisted of a blanket filter, a bank of pocket filters, and a high efficiency particulate air (HEPA) filter to remove progressively smaller particles from the air before exhausting into a storage area behind the hood.

Workers in the glass breaking operation wore powered air-purifying respirators (PAPRs), (MB14-72 PAPR w/ Super Top Hood, Woodsboro, MD, Global Secure Safety). Respirators, work boots, gloves and coveralls were donned and doffed in the changing area of the glass breaking room (see Figure IV) where street shoes were stored during the work day and the PPE was stored during off time. CRTs that had been removed from their cases were brought to this process area where they were placed on a metal grid for breaking. First the electron gun was removed by tapping with a hammer to break it free from the tube. Then a series of hammer blows was used to break the funnel glass and allow it to fall through the metal grid into large Gaylord boxes (cardboard boxes approximately 3 feet tall designed to fit on a standard pallet) positioned below the grid. Finally, any internal metal framing or lattice was removed before the panel glass was broken with a hammer and also allowed to fall into a Gaylord box. During the days of sampling the glass breaking operation was in "normal production" with regard to the number of CRTs broken. (Various sources stated that "normal" ranged from 250 to almost 800.) The count was not recorded for the March study, but during the December visit 442 and 265 monitors were broken on the two days of sampling. No count was made by the survey team regarding the number of color vs monochrome monitors broken.

The final production process, packing and shipping, returned the various materials segregated during the disassembly and glass breaking processes to the warehouse to be sent to contracted purchasers of those individual materials. To facilitate shipment some bulky components such as plastic cabinets or metal frames were placed in a hydraulic bailer to be compacted for easier shipping. Other materials were boxed or containerized and removed for subsequent sale to a recycling operation.

In addition to monitoring routine daily activities in the four production processes described above, environmental monitoring was conducted to evaluate exposures during a weekly cleaning operation in the glass breaking operation and during the replacement of filters in the local exhaust ventilation system used for the glass breaking operation. The weekly cleaning involves all six workers in this area to perform routine cleaning operations such as sweeping and vacuuming. This task, done only in the glass breaking operation and taking approximately a half day, requires that all equipment in the area is either vacuumed with a HEPA vacuum or wiped with a wet mop. This same procedure is used for all walls, work surfaces (including the exposed surfaces of the blanket filter), and floors. Any areas where dust might accumulate are cleaned with one of these techniques. During the initial study dry sweeping was used to clean floors, but it was recommended that this practice be replaced with the vacuuming or mopping and during the second study that change was in place. Workers wore their normal work clothing during this procedure and the local exhaust ventilation system was in operation.

The filter change operation is normally performed by two workers (three were involved during the time of the second study because one was in training) who wear disposable Tyvek coveralls, gloves and PAPRs while they remove all three sets of filters, clean the system, and replace the filters. The filter change is a maintenance operation that occurs at approximately monthly intervals during which the ventilation system is shut down and all three sets of filters are removed and replaced (see Figure IV). Initially the blanket filter is vacuumed then removed. Then the pocket filters that are located behind the blanket filter are removed and the containment structure for both is vacuumed. Finally the HEPA filters, which are in a separate structure downstream from the fan, are removed and this area is vacuumed. During the initial sampling visit all filters were cleaned by vacuuming and/or by shaking to remove dust, and re-installed. The practice of replacing all filters as part of this operation was implemented prior to the second sampling visit and the entire process was wetted with a water spray prior to filter removal. This operation was of particular interest because of concern expressed by management and workers and anticipation of elevated exposures.

Subsequent to the initial monitoring of airborne particulate during the filter change operation, modifications were made to the procedure used for this process. The recommended changes included: 1) the immediate bagging and disposal of used filters rather than attempting to clean and re-use them; 2) the use of a water spray to suppress dust during the filter change operation; and 3) the use of HEPA vacuums and wet mopping to remove dust from the floor and work surfaces. The procedure was modified by the addition of a "spray down" step in which all filters were wetted with a water mist prior to removal, and the filters were then immediately bagged in plastic for disposal rather than being cleaned for re-use.

III. SAMPLING AND ANALYTICAL METHODS

Methods used to assess worker exposures in this workplace evaluation included: personal breathing zone and area sampling for airborne metals; particle size sampling; surface wipe sampling to assess surface contamination; and bulk material samples to determine the composition of settled dust. Material safety data sheets and background information on CRTs and other processes in this operation listed several metals, including Pb, Cd, Be and Ni. Additionally, Federal Occupational Health (FOH) personnel expressed specific interest in Ba.

Personal breathing zone and general area airborne particulate samples were collected and analyzed for metals and during the follow-up visit for airborne particulate. Samples were collected for as much of the work shift as possible, at a flow rate of 3 liters/minute (L/min) using a calibrated battery-powered sampling pump (Model 224, SKC Inc., Eighty Four, PA) connected via flexible tubing to a 37-mm diameter filter (0.8 µm pore-size mixed cellulose ester filter) in a 3-piece, clear plastic cassette sealed with a cellulose shrink band. These samples were subsequently analyzed for metals using inductively coupled plasma spectroscopy (ICP) according to NIOSH Method 7300 [NIOSH 1994] with modifications. It is possible to determine both airborne particulate as well as metals on the same sample by using a pre-weighed filter (for both respirable and total particulate samples) and then post-weighing that filter to determine weight gain before digesting for metals analysis. This analytical technique produces a measure for dust and a measure of 31 elements, including the five of particular interest mentioned above, and that information is appended to this report. Because Method 7300 is an elemental analysis, the laboratory report describes the amount of the element present in each sample (µg/sample) as the element, regardless of the compound in which the element was present in the sample.

During the follow-up visit, sampling was conducted for respirable particulates. The respirable portion of a representative subset of samples was separated for collection using 37 mm aluminum cyclones (Cat. 225-01-02, SKC Inc., Eighty Four, PA) at a flow rate of 2.5 L/min, and analysis by weight, as specified in NIOSH method 0600 [NIOSH 1994]. This was done to determine the fraction of airborne contaminant in the respirable size range. Those samples were analyzed using NIOSH Method 7300 [NIOSH 1994] like those above.

Because there is evidence that the presence of an ultrafine component increases the toxicity for chronic beryllium disease and possibly other toxic effects, information on the aerosol size distribution was collected to assist in evaluation of the potential exposure [McCawley et al. 2001]. Personal breathing zone and general area aerosol size distributions were determined using four-stage Sioutas Cascade Impactors (SKC, Inc., Eighty Four, PA), having nominal 50% cut points of 0.25, 0.5, 1, and 2.5 µm aerodynamic diameter. The sampling flow rate for these impactors was 9 L/min, provided by a calibrated Leland Legacy™ sampling pump (SKC, Inc., Eighty Four, PA) [Misra et al. 2002]. A 25-mm diameter, 0.8 µm pore size PVC filter was used on each stage of the impactor to collect particles. A 37-mm diameter, 5 µm pore size PVC filter was used as a backup to collect all particles that were not impacted on the previous four stages. The impactor filters were analyzed by ICP in accordance with NIOSH Method 7300 modified for microwave digestion [NIOSH 1994]. During the follow-up study cyclones were used rather than impactors to provide a measure of respirable fraction for metals and total dust.

Bulk material samples were collected by gathering a few grams of settled dust or material of interest and transferring this to a glass collection bottle for storage and shipment. These samples were analyzed for metals using NIOSH Method 7300 [NIOSH 1994] modified for bulk digestion.

Surface wipe samples were collected using Ghost™ Wipes for metals (Environmental Express, Mt. Pleasant, SC) and Palintest® Dust Wipes for Be (Gateshead, United Kingdom) to evaluate surface contamination. These wipe samples were collected in accordance with ASTM Method D 6966-03 [ASTM 2002], with a disposable paper template with a10-cm by 10-cm square opening. The templates were held in place by hand or taped in place, to prevent movement during sampling. Wipes were placed in sealable test tube containers for storage until analysis. Ghost Wipes™ were sent to the laboratory to be analyzed for metals according to NIOSH Method 7303 [NIOSH 1994]. Palintest wipes were analyzed for beryllium using the Quantech Fluorometer (Model FM109515, Barnstead International, Dubuque, Iowa) for spectrofluorometric analysis by NIOSH Method 9110 [NIOSH 1994].

An initial assessment of noise levels during various tasks in all operations was made during the first in-depth study using a hand held sound level meter. This brief sound-level survey was used to determine where to target noise dosimetry during the follow-up study. During the follow-up study time weighted average noise exposures were determined using personal dosimeters (Quest Technologies model Q300, Oconomowoc, WI) capable of simultaneously logging sound pressure levels under three sets of parameters. For this evaluation data are reported using both the OSHA and NIOSH parameters as follows:

	OSHA	NIOSH
Criteria (dB)	90	85
Exchange rate	5	3
Threshold	80	0
Weight	A	A
Time constant	Slow	Slow

All dosimeters and sound level meters were calibrated on-site prior to use with a 110 dB source and data were downloaded to a laptop computer.

Observations regarding work practices and use of personal protective equipment were recorded. Information was obtained from conversations with the workers and management to determine if the sampling day was a typical workday to help place the sampling results in proper perspective.

A qualitative evaluation of the glass-breaking booth ventilation system was performed during the initial site visit. A smoke machine and smoke tubes were used to study the air flow patterns in the glass break area. The area was separated into four areas (A, B, C and D; see Figure VII) by transparent vinyl curtains hanging from ceiling to floor, and slit vertically at about 6 inch intervals to permit personnel and apparatus to pass through. The ventilation system was intended to capture any emissions of respirable dust, as well as larger airborne debris, generated during the CRT breaking process. No workers were present in the glass breaking operation at the time of this smoke study. Smoke was released in all four areas in order to visually observe air flow patterns.

IV. OCCUPATIONAL EXPOSURE LIMITS AND HEALTH EFFECTS

In evaluating the hazards posed by workplace exposures, NIOSH investigators use mandatory and recommended occupational exposure limits (OELs) for specific chemical, physical, and biological agents. Generally, OELs suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects[†]. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the exposure limit. Combined effects are often not considered in the OEL. Also, some substances can be absorbed by direct contact with the skin and mucous membranes in addition to being inhaled, thus contributing to the overall exposure. Finally, OELs may change over the years as new information on the toxic effects of an agent become available.

Most OELs are expressed as a time-weighted average (TWA) exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday[‡]. Some chemical substances and physical agents have recommended short-term exposure limits (STEL) or ceiling values where there are health effects from higher exposures over the short-term. Unless otherwise noted, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during a workday, and the ceiling limit is an exposure that should not be exceeded at any time, even instantaneously.

In the U.S., OELs have been established by Federal agencies, professional organizations, state and local governments, and other entities. Some OELs are mandatory, legal limits; others are recommendations. The U.S. Department of Labor Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) [29 CFR 1910 (general industry); 29 CFR 1926 (construction industry); and 29 CFR 1915, 1917 and 1918 (maritime industry)] are legal limits that are enforceable in workplaces covered under the Occupational Safety and Health Act and in Federal workplaces under Executive Order 12196 [NARA 2008]. NIOSH Recommended Exposure Limits (RELs) are recommendations that are made based on a critical review of the scientific and technical information available on the prevalence of hazards, health effects data, and the adequacy of methods to identify and control the hazards. Recommendations made through 1992 are available in a single compendium [NIOSH 1992]; more recent recommendations are available on the NIOSH Web site (http://www.cdc.gov/niosh). NIOSH also recommends preventive measures (e.g., engineering controls, safe work practices, personal protective equipment, and environmental and medical monitoring) for reducing or eliminating the adverse health effects of these hazards. The NIOSH Recommendations have been developed using a weight of evidence approach and formal peer review process. Other OELs that are commonly used and cited in the U.S. include the Threshold Limit Values (TLVs)® recommended by the American Conference of

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† On March 20, 1991, the Supreme Court decided the case of International Union, United Automobile, Aerospace & Agricultural Implement Workers of America, UAW v. Johnson Controls, Inc., 111 S. Ct. 1196, 55 EPD 40,605. It held that Title VII forbids sex-specific fetal protection policies. Both men and women must be protected equally by the employer.

‡ OSHA PELs, unless otherwise noted, are TWA concentrations that must not be exceeded during any 8-hour workshift of a 40-hour work-week [NIOSH 1997]. NIOSH RELs, unless otherwise noted, are TWA concentrations for up to a 10-hour workday during a 40-hour workweek [NIOSH 1997]. ACGIH® TLVs®, unless otherwise noted, are TWA concentrations for a conventional 8-hour workday and 40-hour workweek [ACGIH 2008]

Governmental Industrial Hygienists (ACGIH)®, a professional organization [ACGIH 2008]. ACGIH® TLVs® are considered voluntary guidelines for use by industrial hygienists and others trained in this discipline "to assist in the control of health hazards." Workplace Environmental Exposure Levels (WEELs) are recommended OELs developed by AIHA, another professional organization. WEELs have been established for some chemicals "when no other legal or authoritative limits exist" [AIHA 2007].

Employers should understand that not all hazardous chemicals have specific OSHA PELs and for many agents, the legal and recommended limits mentioned above may not reflect the most current health-based information. However, an employer is still required by OSHA to protect their employees from hazards even in the absence of a specific OSHA PEL. In particular, OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, NIOSH investigators encourage employers to make use of other OELs when making risk assessment and risk management decisions to best protect the health of their employees. NIOSH investigators also encourage the use of the traditional hierarchy of controls approach to eliminating or minimizing identified workplace hazards. This includes, in preferential order, the use of: (1) substitution or elimination of the hazardous agent, (2) engineering controls (e.g., local exhaust ventilation, process enclosure, dilution ventilation) (3) administrative controls (e.g., limiting time of exposure, employee training, work practice changes, medical surveillance), and (4) personal protective equipment (e.g., respiratory protection, gloves, eye protection, hearing protection).

Both the OSHA PELs and ACGIH® TLVs® address the issue of combined effects of airborne exposures to multiple substances [29 CFR 1910.1000(d)(1)(i), ACGIH 2008]. ACGIH® [2008] states:

> When two or more hazardous substances have a similar toxicological effect on the same target organ or system, their combined effect, rather than that of either individually, should be given primary consideration. In the absence of information to the contrary, different substances should be considered as additive where the health effect and target organ or system is the same. That is, if the sum of
>
> $$\frac{C_1}{T_1}+\frac{C_2}{T_2}+\ldots\ \frac{C_n}{T_n} \qquad \text{Eqn. 1}$$
>
> exceeds unity, the threshold limit of the mixture should be considered as being exceeded (where C_1 indicates the observed atmospheric concentration and T_1 is the corresponding threshold limit…).

A. Exposure Criteria for Occupational Exposure to Airborne Chemical Substances

The OELs for the five primary contaminants of interest, in micrograms per cubic meter ($\mu g/m^3$), are summarized and additional information related to those exposure limits is presented below.

Occupational Exposure Limits for Five Metals of Primary Interest ($\mu g/m^3$)

	Barium (Ba)	Beryllium (Be)	Cadmium (Cd)	Lead (Pb)	Nickel (Ni)
REL	500 TWA	0.5 TWA	Lowest Feasible Concentration	50 TWA	15 TWA
PEL	500 TWA	2 TWA 5 (30 minute ceiling) 25 (peak exposure never to be exceeded)	5 TWA	50 TWA	1000 TWA
TLV	500 TWA	2 TWA 10 (STEL)	10 (total) TWA 2 (respirable) TWA	50 TWA	1500 TWA (elemental) 100 TWA (soluble inorganic compounds) 200 TWA (insoluble inorganic compounds

While this subset of five metals has been selected for consideration through the body of this report because their presence was noted on MSDSs or other information pertaining to CRTs and other processes at this facility (beryllium, cadmium, lead and nickel) or due to the interest expressed in barium exposures by FOH personnel, the occupational exposure limits of all 31 metals quantified in this work are listed in Appendix A. Note that these limits refer to the contaminant as the element (e.g., the TLVs®, beryllium and compounds, as Be; cadmium and compounds, as Cd [ACGIH 2008]). Additionally, the OELs for dust and yttrium are presented here since these substances were found at high levels.

Occupational Exposure Criteria for Barium (Ba)

The current OSHA PEL, NIOSH REL, and ACGIH® TLV® is 0.5 mg/m^3 as a TWA for airborne barium exposures (barium and soluble compounds, except barium sulfate, as barium) [29 CFR 1910.1000, NIOSH 2005, ACGIH 2008]. There is no AIHA WEEL for barium [AIHA 2007]. Skin contact with barium, and many of its compounds, may cause local irritation to the eyes, nose, throat and skin, and may cause dryness and cracking of the skin and skin burns after prolonged contact [Nordberg 1998].

Occupational Exposure Criteria for Beryllium (Be)

The OSHA general industry standard sets a beryllium PEL of 2 $\mu g/m^3$ for an 8-hour TWA, a ceiling concentration of 5 $\mu g/m^3$, not to exceed 30 minutes and a maximum peak concentration of 25 $\mu g/m^3$, not to be exceeded for any period of time [29 CFR 1910.1000]. The NIOSH REL for beryllium is 0.5 $\mu g/m^3$ for up to a 10-hour work day, during a 40-hour workweek [NIOSH 2005]. The current TLV® is an 8-hr TWA of 2 $\mu g/m^3$, and a STEL of 10 $\mu g/m^3$ [ACGIH 2008]. The ACGIH® published a notice of intended changes for the beryllium TLV® to 0.05 $\mu g/m^3$ TWA and 0.2 $\mu g/m^3$ STEL based upon studies investigating both chronic beryllium disease and beryllium sensitization [ACGIH 2008]. There is no AIHA WEEL for beryllium [AIHA 2007]. Beryllium has been designated a known human carcinogen by the International Agency for Research on Cancer [IARC 1993].

Occupational Exposure Criteria for Cadmium (Cd)

The OSHA PEL for cadmium is 5 $\mu g/m^3$ as a TWA [29 CFR 1910.1027]. Exposure at or above half that value, the Action Level of 2.5 $\mu g/m^3$ TWA, requires several actions of the employer. These include providing respiratory protection if requested [29 CFR 1910.1027(g)(1)(v)], medical surveillance if currently exposed more than 30 days per year [1910.1027(l)(1)(i)(A)], and medical surveillance if previously exposed unless potential aggregated cadmium exposure did not exceed 60 months [1910.1027(l)(1)(i)(b)]. Initial examinations include a medical questionnaire and biological monitoring of cadmium in blood (CdB), cadmium in urine (CdU), and Beta-2-microglobulin in urine (β2-M) [29 CFR 1910.1027 Appendix A]. An employee whose biological testing results during both the initial and follow-up medical examination are elevated above the following trigger levels must be medically removed from exposure to cadmium at or above the action level: (1) CdU level: above 7 µg/g creatinine, or (2) CdB level: above 10 µg/liter of whole blood, or (3) β2-M level: above 750 µg/g creatinine and (a) CdU exceeds 3 µg/g creatinine or (b) CdB exceeds 5 µg/liter of whole blood [OSHA 2004].

The ACGIH® TLV® for cadmium and compounds as cadmium is 10 $\mu g/m^3$ as a TWA, and 2 $\mu g/m^3$ TWA for the respirable fraction of airborne cadmium and compounds, as cadmium [ACGIH 2008]. The ACGIH® also published a Biological Exposure Index® that recommends that cadmium blood level be controlled at or below 5 µg/L and urine level to be below 5 µg/g creatinine [ACGIH 2008]. There is no AIHA WEEL for cadmium [AIHA 2007].

In 1976, NIOSH recommended that exposures to cadmium in any form should not exceed a concentration greater than 40 $\mu g/m^3$ as a 10-hour TWA or a concentration greater than 200 $\mu g/m^3$ for any 15-minute period, in order to protect workers against kidney damage and lung disease. In 1984, NIOSH issued a Current Intelligence Bulletin, which recommended that cadmium and its compounds be regarded as potential occupational carcinogens based upon evidence of lung cancer among a cohort of workers exposed in a smelter [NIOSH 1984]. NIOSH recommends that exposures be reduced to the lowest feasible concentration [NIOSH 2005]. This NIOSH REL was developed using a previous NIOSH policy for carcinogens (29 CFR 1990.103). The current NIOSH policy for carcinogens was adopted in September 1995. Under the previous policy, NIOSH usually recommended that exposures to carcinogens be limited to the "lowest feasible concentration," which was a nonquantitative value. Under the previous policy, most quantitative RELs for carcinogens were set at the limit of detection (LOD) achievable when the REL was originally established. From a practical standpoint, NIOSH testimony provided in 1990 on OSHA's proposed rule on occupational exposure to cadmium noted that, "NIOSH research suggests that the use of innovative engineering and work practice controls in new facilities or operations can effectively contain cadmium to a level of 1 $\mu g/m^3$. Also, most existing facilities or operations can be retrofitted to contain cadmium to a level of 5 $\mu g/m^3$ through engineering and work practice controls" [NIOSH 1990].

Early symptoms of cadmium exposure may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or cough. Short-term exposure effects of cadmium inhalation include cough, chest pain, sweating, chills, shortness of breath, and weakness. Short-term exposure effects of ingestion may include nausea, vomiting, diarrhea, and abdominal cramps [NIOSH 1989]. Long-term exposure effects of cadmium may include loss of the sense of smell, ulceration of the nose, emphysema, kidney damage, mild anemia, an increased risk of cancer of the lung, and possibly of the prostate [NIOSH 1989, Thun et al. 1991, Goyer 1991].

Occupational Exposure Criteria for Lead (Pb)

The OSHA PEL for lead is 50 μg/m^3 (8-hour TWA), which is intended to maintain worker blood lead level (BLL) below 40 μg/deciliter (dL). Medical removal is required when an employee's BLL reaches 50 μg/dL [29 CFR 1910.1025]. The NIOSH REL for lead (8-hour TWA) is 0.050 mg/m^3; air concentrations should be maintained so that worker blood lead remains less than 0.060 mg Pb/100 g of whole blood [NIOSH 2005]. At BLLs below 40 μg/dL, many of the health effects would not necessarily be evident by routine physical examinations but represent early stages in the development of disease. In recognition of this, voluntary standards and public health goals have established lower exposure limits to protect workers and their children. The ACGIH® TLV® for lead in air is 50 μg/m^3 as an 8-hour TWA, with worker BLLs to be controlled to ≤ 30 μg/dL. A national health goal is to eliminate all occupational exposures that result in BLLs >25 μg/dL [DHHS 2000]. There is no AIHA WEEL for lead [AIHA 2007].

Occupational exposure to lead occurs via inhalation of lead-containing dust and fume and ingestion from contact with lead-contaminated surfaces. Symptoms of lead poisoning include weakness, excessive tiredness, irritability, constipation, anorexia, abdominal discomfort (colic), fine tremors, and "wrist drop" [Saryan and Zenz 1994, Landrigan et al. 1985, Proctor et al. 1991a]. Overexposure to lead may also result in damage to the kidneys, anemia, high blood pressure, impotence, and infertility and reduced sex drive in both genders. In most cases, an individual's BLL is a good indication of recent exposure to and current absorption of lead [NIOSH 1978].

Occupational Exposure Criteria for Nickel (Ni)

The NIOSH REL for nickel metal and other compounds (as nickel) is 15 μg/m^3 based on its designation as a potential occupational carcinogen [NIOSH 2005]. The ACGIH® TLV® for insoluble inorganic compounds of nickel is 200 μg/m^3 (inhalable fraction). For soluble inorganic nickel compounds the TLV® is 100 μg/m^3 (inhalable fraction). The TLV® for elemental nickel is 1,500 μg/m^3 (inhalable fraction) [ACGIH 2008]. The OSHA PEL for nickel is 1,000 μg/m^3 TWA [29 CFR 1910.1000]. Metallic nickel compounds cause allergic contact dermatitis [Proctor et al. 1991b]. NIOSH considers nickel a potential occupational carcinogen [NIOSH 2005]. There is no AIHA WEEL for nickel [AIHA 2007].

Occupational Exposure Criteria for Dust

The maximum allowable exposure to airborne particulate not otherwise regulated is established by OSHA at 15 mg/m^3 for total and 5 mg/m^3 for the respirable portion [29 CFR 1910.1000]. A more stringent recommendation of 10 mg/m^3 inhalable and 3 mg/m^3 respirable is presented by the ACGIH® which feels that "even biologically inert insoluble or poorly soluble particulate may have adverse health effects" [ACGIH 2008]. There is no AIHA WEEL for these substances [AIHA 2007].

Occupational Exposure Criteria for Yttrium (Y)

The NIOSH REL, OSHA PEL, and ACGIH® TLV® for yttrium and its compounds, as Y, are all 1,000 µg/m^3 [NIOSH 2005, 29 CFR 1910.1000, ACGIH 2008]. Yttrium is used in color television phosphors when combined with rare earth elements [Proctor et al. 1991c]. Exposure occurs through inhalation [Proctor et al. 1991c]. While yttrium compounds irritate the lungs of animals, no effects have been noted among humans [Proctor et al. 1991c]. The ACGIH® TLV® is based upon value is intended to minimize the potential for respiratory fibrosis, reported in rats following intratracheal administration of a single, very large dose" [ACGIH 2001]. A study of occupational exposures to yttrium europium vanadate phosphor found no effects from exposure to the yttrium at a mean yttrium concentration of 1.4 mg/m^3 [Tebrock and Machle 1968].

B. Surface Contamination Criteria

Occupational exposure criteria have been discussed above for airborne concentrations of several metals. Surface wipe samples can provide useful information in two circumstances; first, when settled dust on a surface can contaminate the hands and then be ingested when transferred from hand to mouth; and second, if the surface contaminant can be absorbed through the skin and the skin is in frequent contact with the surface [Caplan 1993]. Although some OSHA standards contain housekeeping provisions which address the issue of surface contamination by mandating that surfaces be maintained as free as practicable of accumulations of the regulated substances, there are currently no surface contamination criteria included in OSHA standards [OSHA 2008]. The health hazard from these regulated substances results principally from their inhalation and to a smaller extent from their ingestion; those substances are by and large "negligibly" absorbed through the skin [Caplan 1993]. NIOSH RELs do not address surface contamination either, nor do ACGIH TLVs or AIHA WEELs. Caplan [1993] stated that "There is no general quantitative relationship between surface contamination and air concentrations..." He also noted that, "Wipe samples can serve a purpose in determining if surfaces are as 'clean as practicable'. Ordinary cleanliness would represent totally insignificant inhalation dose; criteria should be based on surface contamination remaining after ordinarily thorough cleaning appropriate for the contaminant and the surface." With those caveats in mind, the following paragraphs present guidelines that help to place the results of the surface sampling conducted at this facility in perspective.

Surface Contamination Criteria for Five Metals of Primary Interest

Surface Contamination Criteria for Lead

Federal standards have not been adopted that identify an exposure limit for lead contamination of surfaces in the industrial workplace. However, in a letter dated January 13. 2003 [Fairfax 2003], OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace [29 CFR 1926.62(h)(1), 1926.62(i)(2)(i) and 1926(i)(4)(ii)] interpreted the level of lead- contaminated dust allowable on workplace surfaces as follows: a) All surfaces shall be maintained as 'free as practicable' of accumulations of lead, b) The employer shall provide clean change areas for employees whose airborne exposure to lead is above the permissible exposure limit, c) The employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination, d) The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of HUD's acceptable decontamination level of 200 $\mu g/ft^2$ for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas, e) In situations where employees are in direct contact with lead-contaminated surfaces, such as, working surfaces or floors in change rooms, storage facilities, lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level, and f) For other surfaces, OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of lead contamination meets the definition of "practicable." OSHA notes that "the term 'practicable' was used in the standard, as each workplace will have to address different challenges to ensure that lead-surface contamination is kept to a minimum. It is OSHA's view that a housekeeping program which is as rigorous as 'practicable' is necessary in many jobs to keep airborne lead levels below permissible exposure conditions at a particular site" [Fairfax 2003]. Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of lead dust does not become a source of employee lead exposures. OSHA has stated that any method that achieves this end is acceptable.

In the United States, standards for final clearance following lead abatement were established for public housing and facilities related to children. However, no criteria have been recommended for other types of buildings, such as commercial facilities. One author has suggested criteria based upon lead-loading values. Lange [2001] proposed a clearance level of 1000 $\mu g/ft^2$ for floors of non-lead free buildings and 1100 $\mu g/ft^2$ for lead-free buildings, and states that "no increase in BLL should occur for adults associated or exposed within a commercial structure" at the latter level. These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions such as: a) Lead uptake following ingestion is 35% absorption of lead in the gastrointestinal system, b) Fingers have a total "touch" area of 10 cm^2 and 100% of the entire presumed lead content on all 10 fingers is taken up, c) The average 'normal' environmental lead dose (from 'uncontaminated food/water/air) is 20 μg per day, d) The weight of the exposed person is 70 kg, and e) Daily lead excretion is limited to an average of 48 µg. Lange [2001] notes that "use of the proposed values would provide a standard for non-child-related premises (e.g. commercial, industrial, office)…" but cautions that, " Further investigation is warranted to evaluate exposure and subsequent dose to adults from surface lead."

Surface Contamination Criteria for Beryllium
A useful guideline is provided by the U.S. Department of Energy, where DOE and its contractors are required to conduct routine surface sampling to determine housekeeping conditions wherever beryllium is present in operational areas of DOE/NNSA facilities. Those facilities must maintain removable surface contamination levels that do not exceed 3 µg/100 cm^2 during non-operational periods. The DOE also has release criteria that must be met before beryllium-contaminated equipment or other items can be released to the general public or released for use in a non-beryllium area of a DOE facility. These criteria state that the removable contamination level of equipment or item surfaces does not exceed the higher of 0.2 µg/100 cm^2 or the level of beryllium in the soil in the area of release. Removable contamination is defined as "beryllium contamination that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing."

Surface Contamination Criteria for Cadmium
Like lead and beryllium, cadmium poses serious health risks from exposure. Cadmium is a known carcinogen, is very toxic to the kidneys, and can also cause depression. However, OSHA, NIOSH, AIHA and ACGIH® have not recommended criteria for use in evaluating wipe samples. The OSHA Cadmium standard [29 CFR 1910.1027] mandates that "All surfaces shall be maintained as free as practicable of accumulations of cadmium," that, "all spills and sudden releases of material containing cadmium shall be cleaned up as soon as possible," and that, "surfaces contaminated with cadmium shall, wherever possible, be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne."

Surface Contamination Criteria for Nickel
NIOSH, OSHA, AIHA and ACGIH® have not established occupational exposure limits for nickel on surfaces.

Surface Contamination Criteria for Barium
NIOSH, OSHA, AIHA and ACGIH® have not established occupational exposure limits for barium on surfaces.

C. Noise Exposure Criteria

The OSHA standard for occupational exposure to noise [29 CFR 1910.95] specifies a maximum PEL of 90 dB(A) for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship, or exchange rate. This means that a person may be exposed to noise levels of 95 dB(A) for no more than 4 hours, to 100 dB(A) for 2 hours, etc. Conversely, up to 16 hours exposure to 85 dB(A) is allowed by this exchange rate. NIOSH, in its Criteria for a Recommended Standard, proposed an REL of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard [NIOSH 1972]. The NIOSH 1972 criteria document also used a 5 dB time/intensity trading relationship in calculating exposure limits. However, the 1998 revised criteria recommends a 3 dB exchange rate, noting that it is more firmly supported by scientific evidence [NIOSH 1998]. The ACGIH® also changed its TLV® in 1994 to a more protective 85 dB(A) for an 8-hour exposure, with the stipulation that a 3 dB exchange rate be used to calculate time-varying noise exposures. Thus, a worker can be exposed to 85 dB(A) for 8 hours, but to no more than 88 dB(A) for 4 hours or 91 dB(A) for 2 hours.

In 1983, a hearing conservation amendment to the OSHA noise standard took effect [29 CFR 1910.95(c)] that requires employers to "administer a continuing, effective hearing conservation program" whenever employee noise exposures equal or exceed an 8-hour TWA of 85 dBA or, equivalently, a dose of fifty percent. The requirements include noise monitoring, audiometric testing, providing hearing protectors, training workers, and recordkeeping.

V. RESULTS AND DISCUSSION

The initial work described here was conducted in early 2007 at the Elkton FCI, Unicor Recycling Factory, Federal Satellite Low (FSL) and Warehouse electronic components recycling operations. Follow-up testing was done at the FCI Unicor Recycling Factory only in December 2007, to evaluate the effectiveness of improvements made in response to that initial work. During this testing, air, surface wipe, bulk dust and noise samples were collected in locations where the various electronics recycling operations were taking place or had taken place in the past. The primary purposes of this evaluation were to estimate the potential exposures of inmates and/or staff to toxic substances generated during the recycling of electronic components; and to recommend remedial measures to reduce exposures if necessary.

A statistical summary of air sampling results is presented in Table 1 and results of personal breathing zone and area air sampling are shown in Tables 2 and 3, with the former being total and the latter being size-selective (impactor) data; surface wipe sample results are contained in Table 4; bulk material sample results are presented in Table 5; and noise measurements in Table 6. As mentioned in Section III above, all samples were analyzed for 31 metals due to the parameters of the analytical method. While the data in these tables present the results of just the five metals of primary interest in this evaluation; results of all analyses are contained in the appendices. These data indicate levels well below the occupational exposure limits of those other metals, even when results for combined exposures as calculated by Equation 1 are considered.

A. Bulk Material Sample Results

Three bulk material samples of dust from the floor of the glass breaking operation were collected in February 2007 during the filter change operation. These samples were analyzed for metals, and the composition of all three samples was similar. The results are presented in the Table 5 for the metals of primary interest. Beyond those 5 metals, the only metal present in these samples in significant concentration was zinc, which was approximately 1% of all three. The entire data set (all 31 metals) is presented in Appendix B.

B. Surface Wipe Sample Results

The surface wipe sample results collected during both sampling visits in the electronic recycling operations at the Elkton FCI are summarized below and in Table 4, and the entire surface wipe sample data set is contained in Appendix C. Results of spectrofluorometric analysis for Be confirmed ICP measurements. Wipe samples were also collected by FOH industrial hygienists, but from different locations and for different purposes, and those data are not included in this report.

Recycling Factory
Wipe samples collected during the February / March study indicated no beryllium (Be) detectable in the recycling factory; the limit of detection was 0.03 µg/sq ft. Most (10 of 14) of the surfaces tested for lead (Pb) indicated levels exceeding the OSHA recommended 200 µg/sq ft, with five above 1,000, and one above 10,000 µg/sq ft. The highest concentration of barium detected in a wipe sample was 150 µg/sq ft. Several of the Cd measurements were between 40 and 250 µg/sq ft. Nickel surface contamination was less than 250 µg/sq ft in 10 of 11 samples. Housekeeping practices that reduce surface dust levels and engineering controls that reduce particulate release into the air should reduce these levels in the future.

Wipe sample data collected during the second visit did not appear to be different than that discussed above. The analytical limit of detection for Be was 0.1 µg/sq ft which did produce detectable Be on most of the wipe samples during this study. (Analytical instrumentation had been adjusted to improve sensitivity for 24 elements at the cost of eliminating measurements for Al, Sb, Ca, Li, Mg, K and Ti.) Modifications in the procedures for changing filters in the GBO were not expected to produce lower surface contamination, and no reduction was seen.

FSL Building
Wipe samples collected in the FSL also did not indicate metals on work surfaces at levels of concern. No Be was detected here. All Pb samples were below the OSHA recommended level. Surface measurements of Cd and Ni were below levels of immediate concern. No samples were collected in the FSL during the December study.
Warehouse
Surface wipe samples were not collected in the warehouse as part of this work.

C. Air Sample Results

Air measurements were collected during both normal and non-routine operations in the areas identified, including the glass breaking operation. Data presented here and in Table 2 are for the duration of the samples rather than for an 8-hour time weighted average since the concentrations of contaminants are so low. Measurements made during non-routine operations showed significant exposures and are discussed below and presented at the bottom of Table 2. The full data set of all 31 metals is presented in Appendix D.

Recycling Factory
Twenty-five samples were collected in the Unicor recycling factory for airborne metals during the February study and an additional twenty in December, including measurements made in the

glass breaking operation during normal production operations. These data can be identified by date in Table 2, but the magnitudes of the exposures were not generally different by date. Measurements in the GBO during other operations are discussed below. Measurements during routine operations revealed that barium concentrations ranged between 0.1 and 4.3 $\mu g/m^3$ and were unremarkable. Beryllium levels also were very low, with one of 25 samples being above the LOD of 0.07 $\mu g/m^3$, and that sample was 0.08 $\mu g/m^3$. Cd and Ni, likewise, were found at low levels ranging up to 1 and 0.6 $\mu g/m^3$, respectively. Lead was the metal found in highest quantity, with concentrations ranging up to 18 $\mu g/m^3$, but only 5 samples were >5 $\mu g/m^3$ (10% of the occupational exposure limits).

FSL Building

Airborne metal concentrations in the FSL were generally lower than those in the factory. In the 12 samples collected in this location, Ba ranged up to 1 $\mu g/m^3$, all Be concentrations were below 0.07 $\mu g/m^3$, Cd ranged from 0.1 to 0.5 $\mu g/m^3$, and all Ni measurements were <1 $\mu g/m^3$. Even the lead samples were all below 1 $\mu g/m^3$ except one which the NIOSH investigator suspected was compromised based on visual observations and analytical results. No samples were collected in the FSL during the December study.

Warehouse

Six air samples were collected in the warehouse to measure airborne metal levels, and again, results were unremarkable. Ba ranged from 0.1 to 0.3 $\mu g/m^3$, all Be samples were below the LOD, Cd ranged from <0.1 to 0.4 $\mu g/m^3$, and all Pb and Ni measurements were at or below the LOD. No samples were collected in the warehouse during the December study.

Glass Breaking Operation- Filter Cleaning and Maintenance Operation

One non-routine operation evaluated was the weekly cleaning of the glass breaking operation. During the first in-depth study one of four samples collected during this procedure indicated an exposure to 23 $\mu g/m^3$ for Cd for a 79-minute sample. Assuming no additional exposure to Cd during the shift (based on visual observations of work tasks during that time) results in an 8-hour TWA exposure of 3.8 $\mu g/m^3$ which is above the Action Level of 2.5 $\mu g/m^3$, but below the PEL of 5 $\mu g/m^3$.

The filter change operation in the glass breaking operation, discussed in the Process Description (Section II), was the task of most concern regarding exposures of workers to toxic metals. Visual observations indicated, and measurements confirmed, very high levels of airborne dust and metals during this operation (see Figure IV). Airborne concentrations of Cd and Pb in excess of their respective occupational criteria were documented; the amount of Cd detected exceeded the assigned protection factor of the powered air purifying respirators (PAPRs) being used by the workers (see further discussion below). Task-based airborne Ba concentrations ranged from 1 to 460 $\mu g/m^3$. No Be was measured (LOD = 0.02 $\mu g/m^3$) in any samples. One 128-minute sample for Ni measured 25 $\mu g/m^3$, resulting in an 8-hr TWA exposure of 6.7 $\mu g/m^3$ (assuming no further exposure), less than the applicable OELs. Other Ni measurements ranged from a 113 minute area sample to a 114 minute personal sample of 0.3 to 7 $\mu g/m^3$ Ni, respectively, resulting in 8-hr TWAs of 0.07 $\mu g/m^3$ to 1.7 $\mu g/m^3$, below relevant OELs.

Lead measurements ranged up to 2,700 $\mu g/m^3$ and Cd measurements ranged up to 2,400 $\mu g/m^3$, but when TWA exposures were calculated for these workers those exposures became 860 and 760 $\mu g/m^3$ Pb and Cd (samples ECMFF 03A&B) and 220 and 170 $\mu g/m^3$ Pb and Cd (samples ECMFF 04A&B). These 8-hr TWA measurements indicate exposures above the REL, TLV and PEL of 50 $\mu g/m^3$ for lead and the PEL of 5 $\mu g/m^3$ for cadmium. Both workers' 8-hr TWA exposures to cadmium exceeded the maximum use concentration assumed for the PAPRs used by these workers (the assigned protection factor of 25 multiplied by the OSHA PEL of 5 $\mu g/m^3$). The respirators provided adequate protection against the measured exposures to lead.

Subsequent to the initial monitoring of airborne particulate during the filter change operation, modifications (describes in Section II) were made to the procedure used for this process. The results of these changes would appear to be a dramatic reduction in airborne particulate. The last six measurements in Table 2 indicate levels of Ba, Be, Pb and Ni well below those respective exposure limits. Eight-hour TWAs based on two task-based Cd measurements of 7.8 and 12.9 $\mu g/m^3$ were 3.5 and 6.1 $\mu g/m^3$, respectively. The former exceeds the OSHA Action level for cadmium of 2.5 $\mu g/m^3$, while the latter exceeds the PEL of 5 $\mu g/m^3$. Measurements of respirable Cd were below the TLV of 2 $\mu g/m^3$ for that entity. Comparing the geometric means of the 8-hour TWA personal breathing zone cadmium exposures shows the reduction achieved by the change in work practices. The geometric mean of the two 8-hour cadmium TWAs from the March sampling date was 357 $\mu g/m^3$. The geometric mean of the four 8-hour cadmium TWAs from the December sampling was 0.375 $\mu g/m^3$. This indicates a reduction of 99.9%.

D. Particulate Size Sampling Results (Impactor Data)

Figures V and VI show the relative concentrations of metals in eleven sets of impactor data, excluding the filter change operation, as a function of particle size. The first figure displays all five particle-size cuts measured using these samples, showing the sum of the metals measured for each size range for each sample. The significant information here is that the mass of metals on the backup filters was, in most instances, greater than the sum of the metals on all stages. The second figure is an enlargement showing just the mid-three cut points and confirming that the mass of metals is similar regardless of particle size. Given that the mass of a particle is proportional to the square of that particle's radius, these data would indicate a very large portion of particles are in the small size ranges.

Impactor sampling data tend to confirm that seen with other air samples. The first two sets of impactor data in Table 3 (ECMFF 5 & 6) were taken during the filter change operation in the glass breaking exhaust system and correspond to the samples for total metals taken during that procedure. These indicate airborne levels of Cd and Pb above the occupational exposure limits with little Ba, Be, and Ni. Samples ECMFF 5(a – e) combined also indicated a total of 4,500 $\mu g/m^3$ of Y (occupational exposure limit is 1,000 $\mu g/m^3$ per Appendix I) during a five-hour period and 19,000 $\mu g/m^3$ for metals in the air (data not shown in attached tables). Time weighted average exposures for both Y and dust would be exceeded for this sample.

The third and fourth impactors (ECMHF 5 and 6), taken during the weekly cleaning of the glass breaking operation, indicate generally higher levels of metals than during normal operations but are in general an order of magnitude lower than the samples collected during the filter change operation.

Impactor samples collected during the two days of normal production in February, in the glass breaking operation and elsewhere, again tend to confirm the samples for total metals in that there were generally measurable levels of Ba, Cd, Pb and Ni (Be was below the limit of detection in most samples) but at levels much below the occupational exposure limits.

During the follow-up study cyclones were used rather than impactors to provide a measure of respirable fraction for metals and total dust. These data indicate levels below all occupational exposure limits, including respirable Cd.

E. Sound level measurements

Spot measurements of noise made with a hand-held sound pressure meter in February 2007, suggested the need for a more comprehensive noise study. That was done during the December visit and is described here.

The data collected with noise dosimeters is presented in Table 6 for the 9 sets of data collected. Five personal and 2 area samples were collected in the GBO and 2 area samples were collected in the disassembly area where the February measurements had indicated a lower potential for overexposure. On each day of sampling, each sample is described, and the start and stop times are presented along with the sample duration (run time). Following that, the mean sound pressure level for the duration of the run (TEST AVERAGE DB) and the time weighted average sound pressure level for an eight hour day (TWA DB) is shown. Sound pressure levels are in dB, A weighted, slow response and presented for both the OSHA and NIOSH criteria. Time weighted calculations assume no exposure during the un-sampled time. For the first day of sampling, two sets of samples are shown because the dosimeters were stopped during lunch and restarted after lunch. This resulted in two separate samples. During the second and third days the dosimeters were not stopped during the lunch break. The technique was modified for the second day for the workers' convenience. Several of the noise samples exceeded the REL and TLV of 85 dBA.

The OSHA noise standard [29 CFR 1910.95] instructs the employer to calculate the allowable noise dose from more than one sample as follows:

> When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: C(1)/T(1) + C(2)/T(2) C(n)/T(n) exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level.

This means that, using the OSHA exchange values, one of the three samples collected on December 11, 2007 exceeded the allowable dose to document an overexposure to the PEL of 90 dBA. Using the allowable doses in Appendix B to the OSHA noise standard, and rounding, sample E2CST-2 resulted in a dose of 1.37 (137% of the allowable dose).[§] The other two samples collected that day exceeded 50% of their allowable dose, requiring the employees represented by that sample to be placed in a hearing conservation program.[**]

Noise doses on the second and third days were less than 50% of the allowable dose, except for sample E2CSW-2. That sample was collected on a worker breaking glass. That individual was exposed at a level of 90.6 dBA for 345 minutes of an allowable dose at 91 dB of 420 minutes, or 82% of the allowable dose.

F. Air Flow Observations

Smoke was released from the smoke machine in all four areas of the glass breaking operation (see Figure VII). In area A, the staging area, all smoke released traveled through the curtain *s* and was captured by the ventilation hood. Some of the smoke released close to area B moved first through curtain *t* and room B before passing through curtain *s* and being captured. There were two major recirculation zones in area A, as indicated by the circular patterns in the diagram adjacent to the entrance jet (4 straight arrows).

In area B (changing room), all smoke released traveled through curtain *s* and was captured by the ventilation system. The air flow was subjectively described as weak by visual observation in the back of area B (nearest the door), but strong and direct near curtain *s*. A slight tendency of the air near curtain *t* to flow in to area A first was noted in the back half of area B.

No smoke released in area C flowed back behind curtain *s*, even when the jet of smoke was directed at the curtain from C back towards area A. The hood in this area was a walk-in type, with three glass breaking stations. Visible airborne emissions from glass breaking were removed quickly from the point of release by the air flow, and were apparently captured by the booth ventilation.

Area D was normally occupied by workers only during ventilation system maintenance. No smoke released in area D migrated to any other area, but was captured efficiently by the ventilation system.

Smoke released in the booth confirmed the apparent capture effectiveness of the exhaust hood in two of the three glass breaking stations. The station on the right side of the booth, however, exhibited some back flow within the booth when smoke was released at the level of the grille. Smoke released at this point traveled first toward the ventilation inlet at the back of the booth, but subsequently, a small portion of the smoke was seen to travel back along the ceiling and the right side wall toward and beyond the front of the booth. Workers would be present along this path, both beside the breaking station (the normal work position for the glass breakers), and in front of the booth, where coordinators handled full and empty Gaylord boxes.

[§] 71 minutes at 92.5 dBA/318 minutes allowed at 93 dBA + 179 minutes at 97.7 dBA/156 minutes allowed at 98 dBA = 1.37, or 137% of the allowable dose.

[**] 67 min at 90.5dbA/420 minutes allowed at 91 dBA + 181 minutes at 93.4 dBA/318 minutes allowed at 93 dBA = 0.73, or 73% of allowable dose; and 102 minutes at 91.6 dBA/306 minutes allowed at 92 dBA + 177 minutes at 91 dBA/420 minutes allowed at 91 dBA = 0.75, or 75% of the allowable dose.

Only this qualitative assessment of air flow was conducted, no quantitative air flow measurements were made.

VI. CONCLUSIONS AND RECOMMENDATIONS

The primary purpose of sampling is to determine the extent of employee exposures and the adequacy of protection. Sampling also permits the employer to evaluate the effectiveness of engineering and work practice controls and informs the employer whether additional controls need to be installed. Values that exceed OELs indicate that additional controls are necessary. This evaluation focused on the evaluation of airborne exposures, with additional data collected on surface contamination and noise exposures. The results of air sampling during the February/March 2007 Elkton survey found that lead, cadmium, and other metals, such as barium and zinc are generated and released during the recycling operations at this facility. Exposures were found that exceeded the OSHA Action Level for cadmium during the weekly clean-up in the glass-breaking area. In addition, 8-hr TWA measurements indicate exposures above the REL, TLV and PEL of 50 $\mu g/m^3$ for lead and the PEL of 5 $\mu g/m^3$for cadmium for two workers during the filter change operation. Both workers' 8-hr TWA exposures to cadmium exceeded the maximum use concentration assumed for the PAPRs used by these workers (the assigned protection factor of 25 multiplied by the OSHA PEL of 5 $\mu g/m^3$). The respirators provided adequate protection against the measured exposures to lead. Additional testing in December 2007 indicated marked improvements in control and reductions in excess of 99% in airborne exposures to metals during the filter change operations in the GBO. However, air sampling revealed exposures that exceeded the OSHA Action Level and PEL for cadmium during the filter change operation, even after that process was modified to improve control.

The results of air sampling clearly indicate that the highest exposures occurred among workers involved in the glass breaking operations. These operations involve three distinct processes: the filter change-out maintenance operation which occurs about once a month; a weekly cleaning process, and routine glass breaking which occurs on a daily basis. The highest potential exposures were measured among the workers involved in the filter change-out maintenance operation. The second highest exposed group is those same workers during the routine daily glass breaking operations. Samples collected for the routine operation showed detectable concentrations were less than 20% of the OSHA PELs for both Cd and Pb.

Smoke tests indicated the ventilation system appears to capture dust before worker exposure can occur, except possibly at the right hand breaking station. Air sampling tends to confirm these observations. No corrective measures were attempted during this study, but it appears that extending the overhead push jet to the right so that this jet is continuous across the front face of the hood may correct the backflow condition. It appeared that dust could migrate from the glass breaking booth to adjacent work areas and in particular to the area where workers changed to and from protective clothing and respirators. Workers in the glass breaking operation were also overexposed to noise.

Disassembly workers as a group, including those in the FSL, had lower potential exposures during routine day-to-day operations as do workers in the warehouse. Samples collected on disassembly workers in the general factory area of all three buildings ranged from non-detectable to 10% of the OSHA PEL for Cd and ranged from non-detectable to 5% of the OSHA PEL for Pb.

The data collected during the filter change maintenance operation showed that airborne concentrations during this once per month maintenance operation exceeded the OSHA PELs for cadmium and lead. Although the two workers performing the filter change-out operation wore respiratory protection, the Cd concentrations detected exceeded the assigned protection factor of the powered air purifying respirator (PAPR) being used. Modifications to the process resulted in a reduction in exposures that exceeded 99%. There were not enough samples to test for statistical significance.

While overexposures were documented in the filter change operation only, modifications can be made to improve operations in general. Based on the data presented above, the following recommendations are made. These recommendations are divided into 3 categories, described as programmatic issues, procedural issues, and housekeeping issues.

Programmatic issues:

1. The respiratory protection program for this facility should be evaluated for this operation in order to ensure that it complies with OSHA regulation 1910.134.
2. Based upon the air sampling results during filter changing and weekly clean-up, a regulatory assessment should be performed with respect to OSHA regulations found at 29 CFR 1910.1025 (Lead) and 29 CFR 1910.1027 (Cadmium).
3. Because of the noise levels found in the glass breaking operation, engineering controls should be designed or selected using noise reduction as a criterion.
4. Until noise in the glass breaking operation can be reduced through engineering controls, a hearing conservation program including noise monitoring, audiometric testing, providing hearing protectors, training workers, and recordkeeping must be implemented for workers in the glass breaking operation.
5. Training of workers should be scheduled and documented in the use of techniques for dust suppression, the proper use of local ventilation, personal protection equipment (e.g., coveralls, respirators, gloves) and hazard communication.
6. Frequently while conducting the on-site work, NIOSH researchers observed tasks being conducted in a manner which appeared to be biomechanically taxing. Tasks should be evaluated to determine there are excesses in repetitive stress trauma and if modifications in procedures or equipment would provide benefit to this workplace.
7. Heat stress should be evaluated during hot weather (e.g., the summer months). Heat exposures above recommended limits were measured at a similar BOP facility during the summer, and it is recommended that appropriate measurements be taken at Elkton to prevent this problem.
8. All Unicor operations, including but not limited to recycling should be evaluated from the perspective of health, safety and the environment in the near future.
9. A program should be established within the Bureau of Prisons to assure that these issues are adequately addressed by competent trained and certified individuals. While a written program to address these issues is necessary at each facility, adequate staffing with safety and health professionals is required to ensure its implementation. One

indication of adequate staffing is provided by the United States Navy, which states "Regions/Activities with more than 400 employees shall assign, at a minimum, a full time safety manager and adequate clerical support" [USN 2005]. That document also provides recommended hazard-based staffing levels for calculating the "number of professional personnel needed to perform minimum functions in the safety organization."

10. A comprehensive program is needed within the Bureau which provides sufficient resources, including professional assistance, to assure each facility the assets needed to assure both staff and inmates a safe and healthy workplace.
11. This facility is a Federal prison, and the workers are Federal prisoners. The Belmont Report [HEW 1979] notes that, "…under prison conditions they [prisoners] may be subtly coerced or unduly influenced to engage in research activities for which they would not otherwise volunteer." Although we did not observe this, Elkton managers should ensure that prisoners are not unduly influenced to perform work which is considered unsafe or unhealthy.

Procedural issues:

12. The modifications to the filter change-out practice should be adopted as standard operating procedure for this process, including: 1) the immediate bagging and disposal of used filters rather than attempting to clean and re-use them; 2) the use of a water spray to suppress dust during the filter change operation; and 3) the use of HEPA filtered vacuums and wet mopping to remove dust from the floor and work surfaces. When using wet methods to help control dust, care needs to be taken to assure that the wet methods do not introduce any potential electrical or other safety hazard.
13. The use of an alternative method (e.g., static pressure drop) should be investigated to determine frequency of filter change. The manufacturer of this system may have guidelines in this regard.
14. Workers performing the filter change operation must continue to utilize respiratory protection as part of a comprehensive respiratory protection program. The PAPRs used provide adequate protection for the modified filter change operation.
15. Because the facility already provides uniforms to its workers, management should evaluate the feasibility of providing and laundering work clothing for all workers in the recycling facility, instead of the current practice of providing disposable clothing for glass breaking workers only. Contaminated work clothing must be segregated from other clothes and laundered in accordance with applicable regulations.
16. Change rooms should be modified to provide separate storage facilities for protective work clothing and equipment and for street clothes that prevent cross-contamination.
17. The use of alternative methods to break cathode-ray tubes should be investigated by Elkton management. Lee et al. [2004] present different methods to separate panel glass from funnel glass in CRT recycling (sec 2.1) and for removing the coatings from the glass (sec 2.2). The hot wire and vacuum suction methods (supplemented with local exhaust ventilation) described by Lee et al. may produce fewer airborne particulates than breaking the glass with a hammer. The authors [Lee et al. 2004] describe a commercially-available method in which an electrically-heated wire is either manually or automatically wound around the junction of the panel and funnel glass, heating the glass. After heating the glass for the necessary time, cool (e.g., room temperature) air is directed at the surface, fracturing the glass-to-glass junction using thermal shock.

The separated panel and funnel glass can then be sorted by hand. They also describe a method wherein a vacuum-suction device is moved over the inner surface of the panel glass to remove the loose fluorescent coating [Lee et al. 2004]. The vacuum used must be equipped with HEPA filtration. Industrial central vacuum systems are available; they may cost less in the long run than portable HEPA vacuum cleaners. These modifications may also reduce the noise exposure to glass breakers.

18. German authorities [BG/BIA 2001] have issued a set of best-practices for dismantling CRTs. Their recommendations include the use of a closed cleaning cabinet that incorporates 300 air changes per hour to control emissions.

Housekeeping:

19. Due to the levels of surface contamination of lead measured in the recycling facility, special attention should be focused on hygiene practices to prevent accidental ingestion of lead. Workers should wash their hands before eating, drinking, or smoking.
20. Given the concentrations of lead and cadmium detected in the bulk dust samples surface wipe samples and air measurements, periodic industrial hygiene evaluations and facility inspections are recommended to confirm that exposures are maintained below applicable occupational exposure limits.
21. Daily and weekly cleaning of work areas by HEPA-vacuuming and wet mopping should be continued. The BG/BIA guidelines [2001] recommend daily cleaning of tables and floors with a type-H vacuum cleaner. Type H is the European equivalent of a HEPA vacuum, where the H class requires that the filter achieve 99.995% efficiency, where 90% of the test particles are smaller than 1.0 um and pass the assembled appliance test, 99.995% efficiency where 10% of the particles are smaller than 1.0 um, 22% below 2.0 um, and 75% below 5.0 um. While some surface contamination was measured in work areas, this would be much greater if it were not for the good housekeeping practices in effect in all locations observed. Other practices not observed during the time of this evaluation, but which have been observed at other facilities should be discouraged; these include the use of compressed air to clean parts or working surfaces, and the consumption of food, beverage or tobacco in the workplace.

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Table 1
Summary Statistics for Airborne Metal Measurements*

	Ba	Be	Cd	Pb	Ni
	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
25 samples taken in the FCI Unicor factory					
Ar. Mean	0.54	0.02	0.18	2.73	0.18
Ar. St Dev	0.90	0.02	0.19	4.13	0.15
Geo Mean	0.29	0.02	0.12	1.24	0.12
GSD	2.70	2.11	2.42	3.65	2.78
12 samples taken in the Federal Satellite Low					
Ar. Mean	0.41	0.02	0.20	1.53	0.54
Ar. St Dev	0.23	0.02	0.13	3.50	0.15
Geo Mean	0.36	0.01	0.16	0.59	0.52
GSD	1.62	1.76	1.90	3.14	1.37
3 samples taken in the Warehouse					
Ar. Mean	0.23	0.19	0.41	1.17	0.45
Ar. St Dev	0.06	0.55	0.54	1.20	0.39
Geo Mean	0.23	0.02	0.27	0.71	0.32
GSD	1.26	1.00	2.08	2.00	1.49
4 samples taken in the GBO during the weekly cleaning procedure; LEV was operating;					
Ar. Mean	1.00	0.05	8.05	3.11	0.50
Ar. St Dev	0.58	0.00	10.37	2.06	0.00
Geo Mean	0.88	0.05	2.59	2.55	0.50
GSD	1.75	1.00	10.06	2.13	1.00
7 samples taken in the GBO during filter change operation; LEV not operating;					
Ar. Mean	120.57	0.01	941.75	1177.50	10.50
Ar. St Dev	162.82	0.00	1018.46	1039.76	9.85
Geo Mean	33.65	0.01	412.89	900.47	7.79
GSD	8.79	1.00	11.42	8.93	4.72

The following samples were taken during the second site visit

Ba		Be	Cd	Pb	Ni	Particulate
	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
10 samples taken during normal operations						
Ar. Mean	0.61	0.01	0.29	1.33	0.12	415.37
Ar. St Dev	0.57	0.00	0.36	2.59	0.05	216.01
Geo Mean	0.30	0.01	0.10	0.40	0.11	344.83
GSD	4.30	1.22	5.33	4.11	1.70	2.10
10 samples taken during normal operation, respirable fractions						
Ar. Mean	0.08	0.01	0.02	0.15	0.04	66.49
Ar. St Dev	0.08	0.00	0.00	0.10	0.02	31.76
Geo Mean	0.04	0.01	0.02	0.13	0.03	58.59
GSD	4.54	1.30	1.30	1.89	1.92	1.79
3 samples taken during filter change operations						
Ar. Mean	1.97	0.01	7.04	0.31	0.17	188.27
Ar. St Dev	1.57	0.00	6.32	0.00	0.12	44.82
Geo Mean	1.32	0.01	3.35	0.31	0.14	184.81
GSD	3.59	1.26	6.84	1.00	2.00	1.26
3 samples taken during filter change operations, respirable fractions						
Ar. Mean	0.38	0.01	0.07	0.31	0.05	173.50
Ar. St Dev	0.14	0.00	0.05	0.00	0.03	77.35
Geo Mean	0.37	0.01	0.06	0.31	0.04	161.49
GSD	1.46	1.49	2.48	1.00	1.92	1.61

*Ar. Mean = arithmetic mean
Ar. St Dev = arithmetic standard deviation
Geo Mean = geometric mean
GSD = geometric standard deviation
All “non-detected” samples were set at half the limit of detection for statistical calculations.

Table 2 –Airborne Metal Measurements

Sample ID	Building	Date	Area / Personal	Sample Description	Sample Duration	Ba Be		Cd	Pb	Ni
					Minutes	µg/M³	µg/M³	µg/M³	µg/M³	µg/M³
The following 25 samples were taken in the FCI Unicor factory										
ECMTFT1	FCI	2/27/2007	A	Worker stripping copper	393	0.1	<0.03	<0.6	<0.4	<0.08
ECMTFT2	FCI	2/27/2007	P	Worker stripping copper	291	0.2	<0.05	<0.1	0.6	0.1
ECMTFT3	FCI	2/27/2007	A	Monitor tear-down between 4th & 5th work station from back	379	0.2	<0.04	<0.1	0.8	0.3
ECMTFT4	FCI	2/27/2007	A	Material disassembly, front 1/2	20	<0.5	<0.07	<1	<8	<1
ECMTFT5	FCI	2/27/2007	P	Orderly	281	0.3	<0.05	<0.1	1.3	0.2
ECMTFT6	FCI	2/27/2007	P	Material disassembly, 3rd table from back	255	0.2	<0.05	<0.1	0.8	0.2
ECMTFT7	FCI	2/27/2007	P	Material disassembly, Table 7 from back	256	0.3	<0.05	0.1	1.8	0.3
ECMTFT8	FCI	2/27/2007	P	Material disassembly, Table 6 from front	164	0.2	0.08	<0.1	1.5	0.3
ECMTFT11	FCI	2/27/2007	P	Coordinator	423	0.4	<0.01	0.2	2.7	0.1
ECMTFT12	FCI	2/27/2007	A	Glass breaking	420	0.2	<0.01	<0.1	1	<0.02
ECMTFT13	FCI	2/27/2007	P	Intake	238	<0.1	<0.01	<0.1	<0.1	<0.03
ECMWFT1	FCI	2/28/2007	A	Glass breaker	208	1.4	<0.06	0.2	9.5	<0.1
ECMWFT2	FCI	2/28/2007	P	Glass breaker	305	1.7	<0.01	0.6	8.9	0.1
ECMWFT3	FCI	2/28/2007	P	Glass breaking, feeder	258	1.4	<0.01	0.3	7.5	0.2
ECMWFT4	FCI	2/28/2007	P	Glass breaking, coordinator	412	4.3	<0.01	0.8	18	0.4
ECMWFT5	FCI	2/28/2007	A	Monitor disassembly, 4th	395	0.3	<0.03	0.2	1.1	0.2

				bench from back						
ECMWFT6	FCI	2/28/2007	A	Monitor disassembly, 8th bench from back	400	0.2	<0.03	0.1	0.8	<0.1
ECMWFT7	FCI	2/28/2007	P	Intake area, forklift driver	332	0.2	<0.03	0.1	0.5	0.1
ECMWFT8	FCI	2/28/2007	A	Intake area, near weigh station	408	0.2	<0.03	0.1	0.7	0.1
ECMWFT9	FCI	2/28/2007	A	Copper stripping area	390	0.1	<0.03	<0.1	0.4	<0.1
ECMWFT10	FCI	2/28/2007	P	Worker stripping copper	300	0.1	<0.04	<0.1	<0.6	<0.1
ECMWFT11	FCI	2/28/2007	P	Monitor disassembly, 8th bench from back	289	0.2	<0.05	0.1	1.2	0.2
ECMWFT12	FCI	2/28/2007	P	Monitor disassembly, 2nd bench from back	283	0.2	<0.05	0.1	1.1	0.1
ECMWFT13	FCI	2/28/2007	P	Monitor disassembly, 4th bench from back	280	0.5	<0.05	0.3	2.3	0.6
ECMWFT14	FCI	2/28/2007	P	Monitor disassembly, material handler	251	0.3	<0.05	0.1	1.2	0.2
The following 12 samples were taken in the Federal Satellite Low										
ELMTF-P1	FSL	2/27/2007	P	Disassembly worker	207	<0.5	<0.02	0.1	0.7	0.7
ELMTF-P2	FSL	2/27/2007	P	Disassembly worker	203	<0.5	<0.02	0.1	<0.4	0.5
ELMTF-P3	FSL	2/27/2007	P	Disassembly worker	198	<0.5	<0.03	<0.1	0.9	0.6
ELMTF-T1	FSL	2/27/2007	A	Area sample north	369	<0.5	<0.02	0.1	<0.3	0.3
ELMWF-A11	FSL	2/28/2007	A	North FSL area	392	0.3	<0.04	0.2	<0.5	0.5
ELMWF-A12	FSL	2/28/2007	A	Area - Central FSL	395	0.6	<0.03	0.2	0.7	0.7
ELMWF-A13	FSL	2/28/2007	A	Area south FSL (suspect tampering)	398	1	<0.03	0.3	12.6	0.6

Table 2 –Airborne Metal Measurements (continued)

Sample ID	Building	Date	Area / Personal	Sample Description	Ba		Be	Cd	Pb	Ni	
							μg/M³	μg/M³	μg/M³	μg/M³	μg/M³
ELMWF-P11	FSL	2/28/2007	P	Bailer (metal)	187	0.5	0.07	0.3	<0.5	0.7	
ELMWF-P12	FSL	2/28/2007	P	Bailer (plastic cardboard)	286	0.5	<0.02	0.1	0.5	0.4	
ELMWF-P13	FSL	2/28/2007	P	Worker on line 1 (north)	284	0.2	<0.02	0.2	0.7	0.5	
ELMWF-P14	FSL	2/28/2007	P	Worker on central line	287	0.5	<0.02	0.5	0.9	0.7	
ELMWF-P15	FSL	2/28/2007	P	Orderly	280	0.3	<0.02	0.2	0.5	0.3	
The following 6 samples were taken in the warehouse											
EWMTF1	WHSE	2/27/2007	P	Orderly	253	0.2	<0.1	<0.1	<2	<1	
EWMTF2	WHSE	2/27/2007	P	General worker	247	0.13	<0.1	<0.1	<2	<1	
EWMWF03	WHSE	2/28/2007	P	Clean-up, sweeping	307	0.2	<0.02	0.4	0.3	0.1	
EWMWF04	WHSE	2/28/2007	P	De-gaussing, grinding	202	0.2	<0.02	0.4	<0.3	0.2	
EWMWF05	WHSE	2/28/2007	P	Work on floor	338	0.3	<0.02	0.3	0.5	0.1	
EWMWF06	WHSE	2/28/2007	A	Area sample, middle of warehouse	381	0.2	<0.02	0.1	<0.3	0.1	
The following 4 samples were taken in the GBO during the weekly cleaning procedure; LEV was operating;											
ECMHF1	FCI / GBO	3/1/2007	P	GBO worker doing weekly cleaning	79	1.8	<0.1	23.3	5.7	<1	
ECMHF2	FCI / GBO	3/1/2007	P	GBO worker doing weekly cleaning	72	0.66	<0.1	4.7	2.02	<1	
ECMHF3	FCI / GBO	3/1/2007	A	In change area during weekly cleaning	67	<1	<0.1	0.1	<2	<1	
ECMHF4	FCI / GBO	3/1/2007	A	In breaking area during weekly cleaning	64	1.02	<0.1	4.1	3.7	<1	
The following 7 samples were taken in the GBO during the filter change maintenance operation; LEV not operating;											

ECMFF04B	FCI / GBO	3/2/2007	P	Worker doing filter change	91	5	<0.02	18	25	3
ECMFF07	FCI / GBO	3/2/2007	A	On computer monitor at desk of clerk,	113	1	<0.02	3	6	0.3
ECMFF01	FCI / GBO	3/2/2007	A	BZ level, near HEPA filter	318	15	<0.02	31	71	0.5
ECMFF02	FCI / GBO	3/2/2007	A	BZ level in right GBO station	322	63	<0.02	27	360	3
ECMFF03A	FCI / GBO	3/2/2007	P	Worker doing filter change	128	460	<0.02	2,400	2700	25
ECMFF03B	FCI / GBO	3/2/2007	P	Worker doing filter change	90	150	<0.02	650	760	7
ECMFF04A	FCI / GBO	3/2/2007	P	Worker doing filter change about 20 ft from GBO	114	150	<0.02	690	890	7

The following samples were taken during the second site visit and include measurements for airborne particulate;

Sample ID	Building	Date	Area / Personal	Sample Description		Ba	Be	Cd	Pb	Ni	Particulate *
E2CMTR-01	FCI	12/11/2007	P	Feeding monitors	281	0.15	<0.02	<0.03	0.31	0.02	85.6 R
E2CMTR-02	FCI	12/11/2007	P	Glass breaking	286	0.22	<0.02	<0.03	0.29	<0.08	59.0 R
E2CMTT-01	FCI	12/11/2007	P	Glass breaking	267	1.02	<0.03	0.65	3.26	0.13	490
E2CHTT-02	FCI	12/11/2007	P	Feeding monitors	283	1.66	<0.02	0.98	8.17	0.17	722
E2CMTM-01	FCI	12/11/2007	P	Moving product	285		<0.07				
E2CMTT-03	FCI	12/11/2007	P	Moving product	284	0.08	<0.02	<0.05	<0.23	0.15	223
E2CMWT-01	FCI	12/12/2007	P	Moving product	237	0.08	<0.03	<0.06	<0.28	0.11	199
E2CMWT-02	FCI	12/12/2007	P	Moving product	224	0.99	<0.03	<0.06	0.31	0.15	467
E2CMWT-03	FCI	12/12/2007	P	Feeding monitors	240	1.03	<0.03	0.64	0.31	0.21	654
E2CMWT-04	FCI	12/12/2007	P	Copper stripping	239	0.04	<0.03	<0.06	<0.28	<0.14	70.3
E2CMWT-05	FCI	12/12/2007	P	Glass breaking	233	0.82	<0.03	0.45	0.31	<0.14	519
E2CMWR-01	FCI	12/12/2007	P	Feeding monitors	233	0.05	<0.02	<0.04	<0.21	<0.10	73.0 R
E2CHWR-02	FCI	12/12/2007	P	Feeding monitors	239	0.11	<0.02	<0.04	<0.20	<0.10	81.5 R
E2CMWR-03	FCI	12/12/2007	P	Moving product	231	0.04	<0.02	<0.04	<0.21	<0.10	113 R
E2CMWR-04	FCI	12/12/2007	P	Disassembly	240	<0.02	<0.02	<0.04	<0.20	<0.10	30.1 R

E2CMWR-05	FCI	12/12/2007	P	Disassembly	229	<0.02	<0.02	<0.04	<0.21	0.06	52.2 R
E2CMWM-01	FCI	12/12/2007	P	Feeding monitors	235		<0.09				
E2CMWM-03	FCI	12/12/2007	A	Disassembly area	162		<0.12				
E2CMWT-06	FCI	12/12/2007	P	Disassembly	244	0.35	<0.03	<0.05	0.31	0.15	394
E2CMWR-06	FCI	12/12/2007	P	Disassembly	105	<0.01	<0.01	<0.02	<0.12	0.01	23.2 R
The following 6 samples were taken during filter change operations											
E2CMHT-01	FCI	12/13/2007	A	On top of HEPA filters	304	0.31	<0.02	0.37	0.31	0.12	179
E2CMHT-02	FCI	12/13/2007	P	Filter change	215	2.19	<0.02	7.83	0.31	0.08	148.8
E2CMHT-03	FCI	12/13/2007	P	Filter change	225	3.42	<0.03	12.93	0.31	0.31	237 8
E2CMHR-02	FCI	12/13/2007	A	Center exhaust hood face, 6.5 Ft. high	307	0.25	<0.01	0.08	0.31	0.02	169 R
E2CMHR-03	FCI	12/13/2007	P	Filter change	220	0.37	<0.02	<0.04	0.31	<0.11	98.5 R
E2CMHR-04	FCI	12/13/2007	P	Filter change	229	0.53	<0.02	0.11	0.31	0.07	253 R

*R indicates respirable fraction

Table 3 –Impactor Samples

Sample ID Cut	Description	Location	Date	Particle Size point (µm)	Ba $\mu g/m^3$	Be $\mu g/m^3$	Cd $\mu g/m^3$	Pb $\mu g/m^3$	Ni $\mu g/m^3$	TOTAL METALS $\mu g/m^3$
ECMFF 5A	Five hour personal sample on	FCI	3/2/07	2.5	83	<0.03	388	560	3.7	7,100
ECMFF 5B	worker doing filter change			1.0	75	<0.03	330	359	2.9	6,500
ECMFF 5C	in GBO			0.50	6	<0.03	13	19	<0.1	410
ECMFF 5D				0.25	42	<0.03	131	96	0.8	2,900
ECMFF 5E				Filter	4	<0.03	4	2	0.1	2,200
	Total metal per sample				210	<0.03	866	1037	7.6	19,000
ECMFF 6A	Two hour personal sample on	FCI	3/2/07	2.5	22	<0.01	50	114	0.7	1,900
ECMFF 6B	worker doing filter change			1.0	2	<0.01	1	7	<0.04	82
ECMFF 6C	in GBO			0.50	0.3	<0.01	0.03	2	<0.04	13
ECMFF 6D				0.25	0.1	<0.01	0.02	0	<0.04	8
ECMFF 6E				Filter	0.1	<0.01	0.01	<0.1	0.01	540
	Total metal per sample				24	<0.01	51	123	0.8	2,500
ECMHF 5A	Two hour personal sample on	FCI	3/1/07	2.5	0.5	<0.02	3	5	0.1	62
ECMHF 5B	worker doing clean-up			1.0	<0.04	<0.02	0.1	4	<0.1	16
ECMHF 5C	in glass breaking area/room				0.50	<0.02	<0.02	<0.02	5	<0.1
ECMHF 5D				0.25	<0.02	<0.02	<0.02	3	<0.1	13
ECMHF 5E				Filter	<0.4	<0.02	<0.02	<0.3	<0.1	1,600
	Total metal per sample				0	<0.02	3	16	0.1	1,700
ECMHF 6A	Two hour personal sample on	FCI	3/1/07	2.5	0.1	<0.06	<0.1	<0.8	<0.1	31
ECMHF 6B	worker doing clean-up			1.0	0.1	<0.06	0.3	24	<0.1	59
ECMHF 6C	in glass breaking area/room				0.50	<0.05	<0.06	<0.1	7	<0.1
ECMHF 6D				0.25	<0.05	<0.06	<0.1	12	<0.1	35
ECMHF 6E				Filter	1	<0.06	<0.1	<0.5	0.1	2,500
	Total metal per sample				1	<0.06	0.3	43	0.1	2,700
ECMTFS 2A	On table 1, front half	FCI	2/27/07	2.5	0.3	<0.03	0.05	6	0.4	70
ECMTFS 2B				1.0	0.0	<0.03	<0.05	11	<0.06	27
ECMTFS 2C				0.50	<0.02	<0.03	<0.05	4	<0.06	17
ECMTFS 2D				0.25	<0.02	<0.03	<0.05	3	<0.06	13
ECMTFS 2E				Filter	0.3	<0.03	<0.05	<0.2	0.1	1,000
	Total metal per sample				1	<0.03	0.05	23	0.4	1,200

Table 3 –Impactor Samples (continued)

SampleID Cut	Description	Location	Date	Particle Size Cut point (µm)	Ba µg/m^3	Be µg/m^3	Cd µg/m^3	Pb µg/m^3	Ni µg/m^3	TOTAL METALS µg/m^3
ECMTFS 3A	3rd funnel breaker	FCI	2/27/07	2.5	2	<0.02	1	25	0.2	260
ECMTFS 3B				1.0	1	<0.02	0.2	6	<0.06	50
ECMTFS 3C				0.50	1	<0.02	0.1	5	<0.06	31
ECMTFS 3D				0.25	0.1	<0.02	<0.04	1	<0.06	11
ECMTFS 3E				Filter	1	<0.02	0.1	0.3	<0.06	840
	Total metal per sample				5	<0.02	2	37	0.2	1,200
ECMTFS 4A	Panel breaker	FCI	2/27/07	2.5	8	<0.01	10	44	0.7	750
ECMTFS 4B				1.0	1	<0.01	0.1	3	<0.03	25
ECMTFS 4C				0.50	0.1	<0.01	<0.01	5	<0.03	11
ECMTFS 4D				0.25	0.1	<0.01	<0.01	4	<0.03	9
ECMTFS 4E				Filter	<0.02	<0.01	0.01	<0.1	<0.03	500
	Total metal per sample				9	<0.01	10	56	0.7	1,300
ECMTFS 6A	Intake area	FCI	2/27/07	2.5	0.1	0.01	<0.03	1	0.1	19
ECMTFS 6B				1.0	0.01	0.01	<0.03	1	0.03	8
ECMTFS 6C				0.50	0.01	0.01	<0.03	1	0.03	6
ECMTFS 6D				0.25	0.01	0.01	<0.03	3	0.03	9
ECMTFS 6E				Filter	0.1	0.01	0.01	0	0.01	630
	Total metal per sample				0.2	0.07	0.01	6	0.2	670
ECMWFS 7A	Area sample,	FCI	2/28/07	2.5	2.1	0.005	0.4	19	0.2	180
ECMWFS 7B	glass breaking booth			1.0	0.2	0.005	<0.001	1	0.02	12
ECMWFS 7C				0.50	0.1	0.005	0.01	0	0.02	8
ECMWFS 7D				0.25	0.03	0.005	<0.001	0	0.02	4
ECMWFS 7E				Filter	0.1	0.005	0.01	<0.1	0.01	350
	Total metal per sample				2.5	0.02	0.4	21	0.3	550
ECMWFS 8A	Glass breaker	FCI	2/28/07	2.5	2.3	0.01	0.5	13	0.1	200
ECMWFS 8B				1.0	1.5	0.01	0.2	8	0.1	110
ECMWFS 8C				0.50	0.4	0.01	0.03	1	0.03	20
ECMWFS 8D				0.25	0.2	0.01	<0.01	1	0.03	8
ECMWFS 8E				Filter	0.5	0.01	0.05	0.4	0.01	460
	Total metal per sample				4.9	0.03	1	24	0.2	800

Table 3 –Impactor Samples (continued)

Sample ID	Description	Location	Date	Particle Size Cut point (μm)	Ba μg/m^3	Be μg/m^3	Cd μg/m^3	Pb μg/m^3	Ni μg/m^3	TOTAL METALS μg/m^3
ECMWFS 9A	Glass breaking feeder	FCI	2/28/07	2.5	1.2	0.01	0.2	10	0.1	97
ECMWFS 9B				1.0	0.3	0.01	0.04	3	<0.03	24
ECMWFS 9C				0.50	0.1	0.01	<0.01	1	<0.03	8
ECMWFS 9D				0.25	0.1	0.01	<0.01	1	<0.03	6
ECMWFS 9E				Filter	0.2	0.01	0.01	<0.1	0.01	560
	Total metal per sample				1.7	0.03	0.3	15	0.2	700
EWMTF 3A	Area sample, warehouse,	W	2/27/07	2.5	0.2	0.01	<0.01	5	<0.03	60
EWMTF 3B	location 2 (see diagram)			1.0	0.02	0.01	<0.01	5	<0.03	16
EWMTF 3C				0.50	0.01	0.01	<0.01	3	<0.03	9
EWMTF 3D				0.25	0.01	0.01	<0.01	0.3	<0.03	6
EWMTF 3E				Filter	0.1	0.01	<0.01	<0.1	<0.03	490
	Total metal per sample				0.4	0.06	<0.01	14	<0.03	590
EWMTF 4A	Area sample, warehouse,	W	2/27/07	2.5	0.1	0.01	<0.01	1	<0.03	28
EWMTF 4B	location 1 (see diagram)			1.0	0.1	0.01	<0.01	1	<0.03	10
EWMTF 4C				0.50	0.01	0.01	<0.01	1	<0.03	7
EWMTF 4D				0.25	0.01	0.01	<0.01	1	<0.03	7
EWMTF 4E				Filter	0.1	0.01	<0.01	<0.1	<0.03	560
	Total metal per sample				0.3	0.06	<0.01	4	<0.03	610

*Total metals per sample, and total metals per stage are sums of all 31 metals quantified rather than the five metals listed in this table

Table 4 –Wipe Sample Results

Sample ID	Location	Date	Sample description	Ba	Be	Cd	Pb	Ni
				Results in ug/sq ft				
The following samples were taken in the FCI Unicor Factory								
ECMTW1	FCI	2/28/2007	On steel work bench, copper stripping	44	<0.3	25	360	43
ECMTW2	FCI	2/28/2007	On work bench, smooth rubber, far end	56	<0.3	13	3,000	110
ECMTW3	FCI	2/28/2007	On work bench, cardboard cover, far end	17	<0.3	2	150	21
ECMTW4	FCI	2/28/2007	On work bench, rough rubber, near end	120	<0.3	56	660	260
ECMTW5	FCI	2/28/2007	On work bench, smooth rubber near end	150	<0.3	33	670	240
ECMTW6	FCI	2/28/2007	On gray desk top in weigh station	3	<0.3	2	24	<4
ECMTW7	FCI	3/1/2007	Charger bench in change room	72	<0.3	70	1,200	6
ECMTW8	FCI	3/1/2007	Outside of locker door in change room	<0.7	<0.3	<0.7	4	<4
ECMTW9	FCI	3/1/2007	Back of aluminum bench in change room	<0.7	<0.3	1	11	<4
ECMTW10	FCI	3/1/2007	Front of aluminum bench in change room	90	<0.3	9	1,400	7
ECMTW11	FCI	3/1/2007	Right side of I-beam in breaking room	100	<0.3	350	580	7
ECMTW12	FCI	3/1/2007	Back of inlet jet at top front of hood, right side, breaking room	35	<0.3	44	330	<4
ECMTW13	FCI	3/1/2007	Floor in breaking room adjacent to change room	590	<0.3	30	10,200	66
ECMTW14	FCI	3/1/2007	Floor, middle of entry room to glass breaking	190	<0.3	11	2,100	15
The following samples were taken in the Federal Satellite Low								
ELMTF-W1	FSL	2/28/2007	End of shift, on Table 1 north	12	<0.3	4	21	4
ELMTF-W2	FSL	2/28/2007	End of shift, on Table 1 central	28	<0.3	8	77	93
ELMTF-W3	FSL	2/28/2007	End of shift, table 3 south	27	<0.3	13	36	45
ELMTF-W4	FSL	2/28/2007	Bailer 1	130	<0.3	17	120	160
ELMTF-W5	FSL	2/28/2007	Bailer 2	55	<0.3	5	100	290
ELMWF-W11	FSL	3/1/2007	Bailer (metal)	66	<0.3	10	57	110
ELMWF-W12	FSL	3/1/2007	Bailer (plastic)	37	<0.3	4	72	40
ELMWF-W13	FSL	3/1/2007	Table 1, north	25	<0.3	8	190	200
ELMWF-W14	FSL	3/1/2007	Table 1 south	20	<0.3	4	180	240
ELMWF-W15	FSL	3/1/2007	Table 3, central	26	<0.3	167	86	120

Table 4 –Wipe Sample Results (Continued)

The following samples were taken in the FCI Unicor Factory during the second site visit

Sample ID	Date	Description	Ba	Be	Cd	Pb	Ni
E2CMTW-01	12/11/2007	ADP north end on computer desk top near doors to recycle operations	<0.2	<0.1	<0.9	<4	<3
E2CMTW-02	12/11/2007	ADP south end on computer desk top near doors to recycle operations	0.2	0.1	<0.9	3.6	<3
E2CMTW-03	2/11/2007	Recycle room south end work bench top near doors to ADP	202.5	0.1	24.2	170.9	55.7
E2CMTW-04	12/11/2007	Recycle room north end work bench top near doors to ADP	63.2	0.2	22.3	310.3	102.2
E2CMTW-05	12/11/2007	Recycle room north end work bench top middle of disassembly area	249.0	0.1	63.2	505.4	260.1
E2CMTW-06	12/11/2007	Recycle room south end work bench top middle of disassembly area	4.6	0.1	3.2	22.3	15.8
E2CMTW-07	12/11/2007	Recycle room outside double door to glass breaking room on top of order desk	8.0	0.1	4.6	36.2	4.5
E2CMTW-08	12/11/2007	Recycle CLERK station near glass breaking room	3.3	0.1	1.8	8.4	7.7
E2CMTW-09	12/12/2007	Filter room on top of HEPA filter	193.2	<0.1	371.6	1202.1	10.2
E2CMTW-10	12/12/2007	Glass breaking table	249.0	<0.1	399.5	1202.1	13.0
E2CMTW-11	12/12/2007	Change room on top of lockers	26.0	0.2	32.5	133.8	12.1

Table 5
Composition of Bulk Dust Samples from the Glass Breaking Operation
February 2007

Sample	Ba	Be	Cd	Pb	Ni
ECMFB01	670	<0.1	240	14000	60
ECMFB02	650	<0.1	240	14000	40
ECMFB03	860	<0.1	350	9100	79

The data are presented in milligram of metal per kg of dust (mg/kg).

Table 6
Noise Exposure Measurements

Date:	12/11/07					
Sample I D:	E2CST - 2		E2CST - 3		E2CST - 1	
Description:	Glass breaking		Glass breaking		Sweeper in GBO	
Dosimeter serial no.	QC9040064		QC9050002		QC9040070	
Test Started	9:53:19AM		8:59:02AM		9:27:35AM	
Test Stopped	11:04:47AM		10:06:51AM		11:10:15AM	
Test Run Time	1:11		1:07		1:42	
	OSHA	NIOSH	OSHA	NIOSH	OSHA	NIOSH
TEST AVG (DB)	92.5	95.6	90.5	93.1	91.6	93.2
TWA (DB)	78.8	87.3	76.4	84.6	80.4	86.5
Date:	12/11/07					
Sample I D:	E2CST - 2		E2CST - 3		E2CST - 1	
Description:	Glass breaking		Glass breaking		Sweeper in GBO	
Dosimeter serial no.	QC9040064		QC9050002		QC9040070	
Test Started	12:53:38PM		11:57:06AM		1:01:48PM	
Test Stopped	3:52:59PM		2:58:05PM		3:59:16PM	
Test Run Time	2:59		3:01		2:57	
	OSHA	NIOSH	OSHA	NIOSH	OSHA	NIOSH
TEST AVG (DB)	97.7	99.4	93.4	96.0	91.0	92.1
TWA (DB)	90.6	95.1	86.3	91.8	83.9	87.8
Date:	12/12/07					

Sample I D:	E2CSW - 2		E2CSW - 3		E2CSW - 1		E2CSW- 4	
Description:	Glass breaking		Area sample - CRT disassembly		Cleaner - GBO		Area sample - CRT disassembly	
Dosimeter serial no.	QC9040064		QC9050002		QC9040070		QC9040061	
Test Started	8:44:41AM		8:09:14AM		8:47:10AM		9:17:50AM	
Test Stopped	2:30:29PM		1:47:18PM		2:35:28PM		2:42:33PM	
Test Run Time	5:45		5:38		5:48		5:24	
	OSHA	NIOSH	OSHA	NIOSH	OSHA	NIOSH	OSHA	NIOSH
TEST AVG (DB)	90.6	94.1	75.8	86.9	85.9	88.8	61.5	76.8
TWA (DB)	88.3	92.6	73.3	85.4	83.6	87.4	58.7	75.1

Date:	12/13/07			
Sample I D:	E2CSW - 9		E2CSW - 10	
Description:	Area - in GBO near feed window		Area - in GBO, left side of hood	
Dosimeter serial no.	QC9040064		QC9040070	
Test Started	8:43:23AM		8:49:38AM	
Test Stopped	1:56:41PM		2:03:22PM	
Test Run Time	5:13		5:14	
_	OSHA	NIOSH	OSHA	NIOSH
TEST AVG (DB)	67.4	79.2	68.2	77.5
TWA (DB)	64.4	77.3	65.1	75.7

Appendix A
Occupational Exposure Criteria for Metal/Elements

TABLE 2. EXPOSURE LIMITS, CAS #, RTECS

Element (Symbol)	CAS #	RTECS	Exposure Limits, mg/m³ (Ca = carcinogen) OSHA	NIOSH	ACGIH
Silver (Ag)	7440-22-4	VW3500000	0.01 (dust, fume, metal)	0.01 (metal, soluble)	0.1 (metal) 0.01 (soluble)
Aluminum (Al)	7429-90-5	BD0330000	15 (total dust) 5 (respirable)	10 (total dust) 5 (respirable fume) 2 (salts, alkyls)	10 (dust) 5 (powders, fume) 2 (salts, alkyls)
Arsenic (As)	7440-38-2	CG0525000	varies	C 0.002, Ca	0.01, Ca
Barium (Ba)	7440-39-3	CQ8370000	0.5	0.5	0.5
Beryllium (Be)	7440-41-7	DS1750000	0.002, C 0.005	0.0005, Ca	0.002, Ca
Calcium (Ca)	7440-70-2	–	varies	varies	varies
Cadmium (Cd)	7440-43-9	EU9800000	0.005	lowest feasible, Ca	0.01 (total), Ca 0.002 (respir.), Ca
Cobalt (Co)	7440-48-4	GF8750000	0.1	0.05 (dust, fume)	0.02 (dust, fume)
Chromium (Cr)	7440-47-3	GB4200000	0.5	0.5	0.5
Copper (Cu)	7440-50-8	GL5325000	1 (dust, mists) 0.1 (fume)	1 (dust) 0.1 (fume)	1 (dust, mists) 0.2 (fume)
Iron (Fe)	7439-89-6	NO4565500	10 (dust, fume)	5 (dust, fume)	5 (fume)
Potassium (K)	7440-09-7	TS6460000	–	--	–
Lanthanum	7439-91-0	–	–	–	–
Lithium (Li)	7439-93-2	–	–	--	–
Magnesium (Mg)	7439-95-4	OM2100000	15 (dust) as oxide 5 (respirable)	10 (fume) as oxide	10 (fume) as oxide
Manganese (Mn)	7439-96-5	OO9275000	C 5	1; STEL 3	5 (dust) 1; STEL 3 (fume)
Molybdenum (Mo)	7439-98-7	QA4680000	5 (soluble) 15 (total insoluble)	5 (soluble) 10 (insoluble)	5 (soluble) 10 (insoluble)
Nickel (Ni)	7440-02-0	QR5950000	1	0.015, Ca	0.1 (soluble) 1 (insoluble, metal)
Phosphorus (P)	7723-14-0	TH3500000	0.1	0.1	0.1
Lead (Pb)	7439-92-1	OF7525000	0.05	0.05	0.05
Antimony (Sb)	7440-36-0	CC4025000	0.5	0.5	0.5
Selenium (Se)	7782-49-2	VS7700000	0.2	0.2	0.2
Tin (Sn)	7440-31-5	XP7320000	2	2	2
Strontium (Sr)	7440-24-6	–	–	–	–
Tellurium (Te)	13494-80-9	WY2625000	0.1	0.1	0.1
Titanium (Ti)	7440-32-6	XR1700000	–	–	–
Thallium (Tl)	7440-28-0	XG3425000	0.1 (skin) (soluble)	0.1 (skin) (soluble)	0.1 (skin)
Vanadium (V)	7440-62-2	YW240000	–	C 0.05	–
Tungsten	7440-33-7	–	5	5 10 (STEL)	5 10 (STEL)
Yttrium (Y)	7440-65-5	ZG2980000	1	N/A	1
Zinc (Zn)	7440-66-6	ZG8600000	–	–	–
Zirconium (Zr)	7440-67-7	ZH7070000	5	5, STEL 10	5, STEL 10

Appendix B

Metallic Composition of Bulk Dust Samples from the Glass Breaking Operation
Concentrations are in mg/kg (ppm by weight)

Sample #:	ECMFB01	ECMFB02	ECMFB03
Al	480	480	1100
Sb	8.8	5.4	21
As	<6	<6	<6
Ba	670	650	860
Be	<0.1	<0.1	<0.1
Cd	240	240	350
Ca	1100	910	1700
Cr	13	14	24
Co	<0.5	<0.5	0.9
Cu	15	15	29
Fe	2000	2000	2500
La	12	16	13
Pb	14000	14000	9100
Li	0.5	0.5	1.4
Mg	150	150	300
Mn	43	43	41
Mo	<2	<2	<2
Ni	60	40	79
P	57	68	82
K	460	450	690
Se	<10	16	<10
Ag	<0.2	<0.2	<0.2
Sr	190	180	240
Te	4	<4	15
Tl	<4	8.6	<4
Sn	26	15	18
Ti	10	10	13
V	<0.3	<0.3	<0.3
Y	6500	5700	3500
Zn	15000	14000	9000
Zr	<7	7.4	0

Appendix C
Metallic Composition of Wipe Samples

Concentrations are in ug/sq foot

Sample ID	ECMTW1	ECMTW10	ECMTW11	ECMTW12	ECMTW13	ECMTW14	ECMTW2	ECMTW3	ECMTW4	ECMTW5	ECMTW6	ECMTW7	ECMTW8	ECMTW9	EWMWW05	EWMWW06	EWMWW07	EWMWW08	EWMWW09	EWMWW10
Al	320	350	33	11	440	430	250	270	340	270	240	190	240	4.8	1300	260	180	290	200	270
Sb	8.4	2	2	2	4.2	2.1	19	12	12	35	2	2	2	2	21	3.9	2	8.4	2	2
As	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Ba	4.7	9.7	11	3.8	63	20	6	1.8	13	48	0.33	7.7	0.08	0.08	89	3.2	1.5	51	1.7	0.41
Be	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Cd	2.7	0.94	38	4.7	3.2	1.2	1.4	0.24	6	3.5	0.17	7.5	0.07	0.11	6	0.18	0.09	0.33	0.07	0.07
Ca	520	280	230	220	1100	810	520	270	600	620	290	100	100	300	14000	100	100	1700	100	100
Cr	2.5	0.78	0.61	0.02	2.5	0.6	2.7	0.74	3.3	10	0.02	1.9	0.02	0.02	18	0.53	0.18	3.6	0.67	0.2
Co	0.27	0.06	0.06	0.06	0.1	0.06	0.35	0.06	0.22	0.58	0.06	0.06	0.06	0.06	2	0.06	0.06	0.19	0.06	0.06
Cu	69	2.2	1.1	0.49	11	4.3	33	8.9	45	170	1.2	1.7	0.3	0.03	110	2.7	1.1	170	1.7	1.9
Fe	490	110	53	24	720	300	1100	83	590	440	47	140	3.6	0.9	5800	90	50	560	60	36
La	0.3	0.3	0.38	0.3	0.73	0.3	0.86	0.3	0.54	0.46	0.3	0.3	0.3	0.3	3.2	0.3	0.3	0.3	0.3	0.3
Pb	39	150	62	35	1100	230	320	16	71	72	2.6	130	0.47	1.2	110	3.8	1	8.7	1.6	0.96
Li	0.29	0.12	0.11	0.05	0.35	0.31	0.83	0.17	1.3	1.4	0.16	0.08	0.04	0.04	2.6	0.12	0.06	1.7	0.12	0.08
Mg	60	29	13	8.4	81	56	120	43	100	87	46	14	44	7	2200	38	13	500	29	32
Mn	8	2.3	1.3	0.52	12	5.6	290	8.1	92	35	2	2.1	0.68	0.04	160	2.6	1.1	11	1.1	1.2
Mo	0.39	0.3	0.3	0.3	0.3	0.3	0.32	0.3	0.54	0.57	0.3	0.3	0.3	0.3	3.8	0.3	0.3	0.62	0.3	0.3
Ni	4.6	0.76	0.78	0.4	7.1	1.6	12	2.3	28	26	0.4	0.65	0.4	0.4	31	1.1	0.4	7.6	0.4	0.4
P	30	4.9	6.5	5.3	17	17	12	3.4	16	1	4.7	3.3	1	1	190	7.6	12	7.3	9.3	3.1
K	76	59	13	11	160	100	120	34	110	140	58	18	15	18	1900	120	140	240	160	61
Se	2	2	2.4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Ag	0.17	0.04	0.02	0.02	0.1	0.11	1.7	0.47	1.1	0.83	0.03	0.02	0.02	0.02	2.6	0.15	0.03	2.3	0.07	0.05
Sr	2	5.1	4.3	1.6	30	13	2.6	0.69	11	3.1	0.26	2.2	0.1	0.61	35	0.19	0.1	3.4	0.41	0.1

Te	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.4	0.5	0.5	0.5	0.5	0.5
Tl	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Sn	7.6	2	2	2	3	2	470	27	92	100	2	2	2	2	21	6	2	8.5	2	2
Ti	2	1.3	0.81	0.35	6.2	3.9	2.5	1.4	9.2	17	0.74	0.98	0.38	0.07	40	1.3	0.53	9.5	0.94	0.72
V	0.03	0.03	0.02	0.02	0.15	0.1	0.29	0.05	0.15	0.17	0.02	0.02	0.02	0.02	2.2	0.04	0.02	0.26	0.03	0.03
Y	3.5	5.3	260	35	32	7.8	5.1	0.29	4.6	2.8	0.41	46	0.2	0.81	14	0.56	0.09	0.23	0.11	0.06
Zn	94	22	620	98	200	47	950	72	630	1200	32	140	9	9	910	26	9	320	9	9
Zr	0.6	0.6	0.6	0.6	1.1	1.2	0.61	0.6	1	1.2	0.6	0.6	0.6	0.6	3.1	0.6	0.6	1.1	0.6	0.6

Underline = <LOD (Limit of detection)

Appendix C (Continued)
Metallic Composition of Wipe Samples

Concentrations are in ug/sq foot

These samples were collected during the second site visit

Sample ID	E2CMTW-01	E2CMTW-02	E2CMTW-03	E2CMTW-04	E2CMTW-05	E2CMTW-06	E2CMTW-07	E2CMTW-08	E2CMTW-09	E2CMTW-10	E2CMTW-11
As	<9	13.0	<9	<9	<9	<9	<9	11.1	15.7	13.9	<9
Ba	<0.2	0.2	201.9	63.0	248.2	4.5	8.3	3.3	192.6	248.2	25.9
Be	<0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	<0.1	<0.1	0.2
Cd	<0.9	<0.9	24.1	22.2	63.0	3.1	4.6	1.8	370.4	398.2	32.4
Cr	0.3	0.6	14.3	43.9	69.8	8.1	3.1	2.2	23.5	21.7	6.0
Co	<0.6	<0.6	9.1	4.6	11.1	1.8	<0.6	<0.6	2.0	1.1	2.7
Cu	<0.5	<0.5	82.4	1203.8	879.7	16.7	16.7	6.0	<0.5	21.3	10.2
Fe	<60	9.3	2778.0	4352.2	10093.4	537.1	398.2	92.6	453.7	2963.2	518.6
La	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	6.2	<0.5	0.9
Pb	<4	3.6	170.4	309.3	503.7	22.2	36.1	8.3	1198.2	1198.2	133.3
Mn	<2	7.1	73.2	148.2	583.4	18.5	12.0	4.7	13.0	28.7	16.7
Mo	<2	<2	<2	11.1	10.2	<2	<2	<2	<2	<2	<2
Ni	<3	<3	55.6	101.9	259.3	15.7	4.4	7.7	10.2	13.0	12.0
P	<200	<200	<200	259.3	1944.6	<200	213.0	185.2	250.0	416.7	379.7

Se	<10	<10	14.8	<10	<10	<10	<10	<10	<10	<10	<10
Ag	<0.2	0.2	3.0	6.5	10.2	0.8	0.4	<0.2	<0.2	0.3	0.5
Sr	<0.3	<0.3	19.4	19.4	51.9	1.9	4.5	0.3	128.7	212.1	14.8
Te	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Tl	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Sn	<20	<20	157.4	379.7	407.4	<20	<20	<20	<20	18.5	<20
V	<0.2	<0.2	0.4	1.4	1.2	0.6	0.3	<0.2	<0.2	<0.2	0.2
Y	0.3	0.5	5.7	12.0	41.7	2.3	4.1	1.2	1203.8	1111.2	86.1
Zn	<100	287.1	2092.8	2926.2	10982.4	175.9	120.4	<100	5333.8	10982.4	83.3
Zr	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20

Appendix D

Metallic Composition of Filter Samples

<LOD Underline

Concentrations are in $\mu g/m^3$

Sample ID	ECMTFT1	ECMTFT11	ECMTFT12	ECMTFT13	ECMTFT2	ECMTFT3	ECMTFT4	ECMTFT5	ECMTFT6	ECMTFT7	ECMTFT8
Al	*0.93*	1.50	0.35	0.26	*1.52 1.*	*71*	14.59	*3.67*	*1.23 4.*	*58 3.*	*51*
Sb	0.42	0.12	0.12	0.14	0.58	0.45	8.10	0.59	0.67	0.65	1.03
As	0.59	0.17	0.16	0.20	0.82	0.63	11.35	0.83	0.94	0.92	1.44
Ba	*0.08*	0.40	0.15	*0.02*	0.20	0.18	0.49	0.27	0.16	0.31	0.25
Be	0.03	0.01	0.01	0.01	0.05	0.04	0.65	0.05	0.05	0.05	0.08
Cd	0.59	0.18	*0.05*	0.02	0.08	0.06	1.13	0.08	0.09	*0.09*	0.14
Ca	11.85	10.73	4.20	2.37	16.36	20.64	53.48	35.47	18.77	44.49	30.95
Cr	0.08	0.02	0.02	0.03	0.11	0.08	1.46	0.11	0.12	0.12	0.19
Co	0.05	0.01	0.01	0.02	0.07	0.05	0.97	0.07	0.08	0.08	0.12
Cu	0.08	0.02	0.02	0.03	0.12	0.09	1.62	0.12	0.13	*0.42*	0.21
Fe	4.49	4.74	1.59	1.36	6.78	7.90	*11.35*	15.37	8.18	15.70	16.71
La	0.03	0.01	0.01	0.01	0.04	0.03	0.49	0.04	0.04	0.04	0.06
Pb	0.42	2.75	1.00	0.14	*0.61 0.*	*76*	8.10	*1.30*	*0.75 1.*	*83 1.*	*47*
Li	0.85	0.25	0.23	0.29	1.17	0.90	16.21	1.18	1.34	1.31	2.06
Mg	*0.69*	0.72	*0.21 0.*	*13*	*0.91*	*1.35*	6.48	2.60	*1.23*	3.01	*1.96*
Mn	0.20	0.12	*0.04 0.*	*03*	*0.20*	0.25	1.13	0.46	*0.28*	0.51	0.68
Mo	0.25	0.07	0.07	0.09	0.35	0.27	4.86	0.35	0.40	0.39	0.62
Ni	0.08	0.08	0.02	0.03	0.11	0.27	1.46	*0.25*	*0.16 0.*	*27 0.*	*29*
P	2.54	0.75	0.70	0.87	3.51	2.69	48.62	3.55	4.02	3.93	6.19
K	0.85	*0.85 0.*	*30*	0.29	1.17	*0.99*	16.21	*1.77*	1.34	*2.62*	2.06
Se	1.69	0.50	0.47	0.58	2.34	*2.15*	32.41	2.36	2.68	2.62	4.13

Ag	0.03	0.01	0.01	0.01	0.05	0.04	0.65	0.05	0.05	0.05	0.08	
Sr	*0.03*	0.14	0.06	*0.01 0.*	*06*	*0.07*	0.32	0.15	*0.07*	0.16	*0.10*	
Te	0.42	0.12	0.12	0.14	0.58	0.45	8.10	0.59	0.67	0.65	1.03	
Tl	0.68	0.20	0.19	0.23	0.94	0.72	12.97	0.95	1.07	1.05	1.65	
Sn	0.76	0.22	0.21	0.26	1.05	0.81	14.59	1.06	1.21	1.18	1.86	
Ti	0.08	0.08	0.03	0.01	0.14	0.13	*0.16*	0.24	0.11	0.25	0.25	
V	0.03	0.01	0.01	0.01	0.04	0.03	0.49	0.04	0.04	0.04	0.06	
Y	0.06	5.74	1.61	*0.01*	0.14	0.11	0.32	0.52	0.12	0.18	0.78	
Zn	1.35	10.73	3.50	0.40	2.10	2.60	*7.94*	5.79	5.50	7.72	8.25	
Zr	0.34	0.10	0.09	0.12	0.47	0.36	6.48	0.47	0.54	0.52	0.83	
Sample ID	**ECMWFT12**	**ECMWFT13**	**ECMWFT14**	**ECMWFT2**	**ECMWFT3**	**ECMWFT4**	**ECMWFT5**	**ECMWFT6**	**ECMWFT7**	**ECMWFT8**	**ECMWFT9**	**EC**
Al	*3.29*	8.78	*2.92*	4.78	5.92	10.91	3.46	*2.24*	*2.27 1.*	*41 0.*	*86*	
Sb	0.61	0.59	0.66	0.49	0.57	0.65	0.42	0.41	0.42	0.41	0.43	
As	0.85	0.83	0.93	0.68	0.80	0.91	0.59	0.58	0.59	0.58	0.60	
Ba	0.24	0.50	0.25	1.66	1.37	4.29	0.31	0.21	0.19	0.16	*0.09*	
Be	0.05	0.05	0.05	0.04	0.05	0.05	0.03	0.03	0.03	0.03	0.03	
Cd	*0.15*	0.30	*0.09*	0.58	0.32	0.82	*0.15 0.*	*09*	*0.06 0.*	*07*	0.06	
Ca	26.81	54.58	31.87	22.46	46.66	54.57	32.91	17.38	18.48	18.26	10.36	1
Cr	0.11	0.11	0.12	0.09	0.10	0.12	0.08	0.07	0.08	0.07	0.08	
Co	0.07	0.07	0.08	*0.07*	0.07	*0.08*	0.05	0.05	0.05	0.05	0.05	
Cu	*0.28*	0.94	0.13	0.10	0.11	*0.16 0.*	*17*	0.08	0.08	0.08	0.09	
Fe	13.40	55.77	13.28	9.76	18.21	31.18	15.19	11.59	13.44	7.80	6.22	
La	0.04	*0.06*	0.04	0.03	0.03	0.04	0.03	0.02	0.03	0.02	0.03	
Pb	*1.12 2.*	*25*	*1.22*	8.88	7.51	18.19	*1.10 0.*	*79*	*0.50 0.*	*67*	0.43	
Li	1.22	1.19	1.33	0.98	1.14	1.30	0.84	0.83	0.84	0.83	0.86	
Mg	*1.46*	4.51	*1.73 1.*	*37*	2.85	3.51	2.03	*1.16*	1.76	*1.16 0.*	*48*	
Mn	0.44	1.54	0.42	*0.21*	0.44	0.84	0.50	0.41	0.40	0.23	0.24	
Mo	0.37	0.36	0.40	0.29	0.34	0.39	0.25	0.25	0.25	0.25	0.26	

Ni	*0.11*	0.63	*0.19*	*0.11 0.*	*16*	*0.36 0.*	*22*	0.07	*0.08 0.*	*13*	0.08
P	3.66	3.56	3.98	2.93	3.41	3.90	2.53	2.48	2.52	2.49	2.59
K	*1.58 3.*	*80*	*1.59*	*2.54*	*2.73*	4.81	*1.94 1.*	*32*	*1.34 1.*	*24 0.*	*95*
Se	2.44	2.37	2.66	1.95	2.28	2.60	1.69	1.66	1.68	1.66	1.73
Ag	0.05	0.05	0.05	0.04	0.05	0.05	0.03	0.03	0.03	0.03	0.03
Sr	*0.11*	0.26	*0.12*	0.59	0.50	1.05	0.16	0.11	*0.08 0.*	*07 0.*	*04*
Te	0.61	0.59	0.66	0.49	0.57	0.65	0.42	0.41	0.42	0.41	0.43
Tl	0.97	0.95	1.06	0.78	0.91	1.04	0.68	0.66	0.67	0.66	0.69
Sn	1.10	*1.90*	1.20	0.88	1.02	1.17	0.76	0.75	0.76	0.75	0.78
Ti	0.19	0.38	0.23	0.18	0.31	0.42	0.24	0.15	0.15	0.14	0.09
V	0.04	0.04	0.04	0.03	0.03	0.04	0.03	0.02	0.03	0.02	0.03
Y	0.19	0.28	0.17	47.84	13.66	66.26	0.17	0.12	0.13	0.12	0.08
Zn	10.97	18.98	4.91	86.90	29.59	119.53	5.15	3.56	2.69	2.57	1.55
Zr	0.49	0.47	0.53	0.39	0.46	0.52	0.34	0.33	0.34	0.33	0.35

Sample ID	**ECMTFS 4E**	**ELMTF-P1**	**ELMTF-P2**	**ELMTF-P3**	**ELMTF-T1**	**ELMTF-T2**	**ELMTF-T3**	**ELMWF-A11**	**ELMWF-A12**	**ELMWF-A13**	**ELMWF-P11**	**ELMWF-P12**	**ELMWF-P13**	**ELMWF-P14**	**ELMWF-P15**
Al	1.68	3.97	4.10	4.25	2.53	3.79	3.07	4.60	7.06	10.71	4.76	3.82	5.04	5.26	3.60
Sb	0.10	0.36	0.37	0.39	0.27	0.27	0.27	0.53	0.52	0.50	0.53	0.35	0.35	0.36	0.36
As	0.34	1.20	1.24	6.44	0.90	0.90	0.90	1.77	1.72	1.67	1.76	1.16	1.17	1.20	1.20
Ba	0.15	0.29	0.32	0.89	0.26	0.36	0.21	0.34	0.59	0.95	0.51	0.45	0.25	0.45	0.35
Be	0.01	0.02	0.02	0.03	0.02	0.02	0.02	0.04	0.03	0.03	*0.07 0.*	*02*	0.02	0.02	0.02
Cd	*0.01*	0.11	*0.06 0.*	*04*	0.06	0.08	0.08	0.19	0.24	0.27	0.26	0.09	0.18	0.50	0.16
Ca	318.17	32.49	29.85	29.60	18.07	30.71	21.68	24.75	46.48	85.37	26.43	27.76	26.94	38.27	22.80

Cr	0.10	0.94	0.62 0.	71 0.	39 0.	54 0.	45 0.	72 0.	90 0.	84 0.	95 0.	64 0.	66 0.	61 0.	47
Co	0.01	0.04	0.04	0.04	0.03	0.04	0.03	0.05 0.	05	0.05	0.14	0.03	0.04	0.04	0.04
Cu	0.17	0.52 0.	72 0.	68 0.	33 0.	67 0.	23 0.	58 1.	48	1.84	0.65 0.	60 0.	59	1.20	0.59
Fe	0.68	19.25	38.56	28.31	21.68	36.13	14.45	33.59	68.86	61.94	31.71	30.07	42.17	49.04	49.20
La	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.05	0.01	0.01	0.01	0.01
Pb	0.10	0.66	0.37	0.93	0.27	0.49 0.	41	0.53	0.71	12.55	0.53	0.50 0.	67 0.	87 0.	48
Li	0.34	1.20	1.24	1.29	0.90	0.90	0.90	1.77	1.72	1.67	1.76	1.16	1.17	1.20	1.20
Mg	1.68	2.29 2.	24 2.	45 1.	36 2.	62 1.	54	1.77	3.79	7.03	2.11 2.	66 2.	34 3.	35 2.	04
Mn	0.01	0.43 0.	51 0.	53 0.	34	0.61	0.32 0.	57	1.22	1.09	0.72	0.61	0.52	0.84	0.86
Mo	0.07	0.24	0.25	0.26	0.18	0.18	0.18	0.35	0.34	0.33	0.35	0.23	0.23	0.24	0.24
Ni	0.01	0.66	0.49	0.58	0.30	0.48	0.14	0.46	0.65	0.62	0.65	0.38	0.47	0.73	0.28
P	171.06	3.25	2.49	2.57	1.81	3.07	1.81	3.54	3.44	4.18	3.52	2.43 2.	34 2.	75	2.40
K	0.19	3.13	2.86	2.70	1.81	4.52	2.08	3.18	4.99	12.22	3.70	3.24	2.69	4.66	2.76
Se	0.24	0.84	3.23	2.83	0.63	2.26	0.63	1.24	1.29 2.	68 1.	66	0.81	0.82	0.84	1.15
Ag	0.01	0.02	0.04	0.09	0.05	0.05	0.03 0.	07 0.	07	0.13	0.07	0.06	0.04	0.10	0.07
Sr	0.19	0.26	0.35	0.40	0.31	0.56	0.26	0.51	1.31	0.80	0.39	0.38	0.36	0.73	1.32
Te	0.17	0.60	0.62	0.64	0.45	0.45	0.45	0.88	0.86	0.84	0.88	0.58	0.59	0.60	0.60
Tl	0.24	0.84	0.87	0.90	0.63	0.63	0.63	1.24	1.21	1.17	1.23	0.81	0.82	0.84	0.84
Sn	0.34	1.20	1.24	1.29	0.90	0.90	0.90	1.77	1.72	21.76	1.76	1.16	1.17	1.20	1.20
Ti	0.03	0.24	0.30	0.49	0.25	0.42	0.22	0.41	0.93	0.75	0.41	0.37	0.41	0.55	0.83
V	0.01	0.04	0.04	0.04	0.03	0.03	0.03	0.05	0.05	0.05	0.07	0.03	0.04	0.04	0.04
Y	0.00 0.	01	0.01	0.03	0.03	0.03	0.02	0.07	0.07	0.40	0.11	0.05	0.02	0.04	0.05
Zn	0.07	4.81	7.09	11.33	3.70	5.33	2.35	6.54	8.61	10.88	11.10	8.67	8.67	10.05	4.08
Zr	0.14	0.48	0.50	0.51	0.36	0.36	0.36	0.71	0.69	0.74 1.	76	0.46	0.47	0.48	0.48

Appendix D

Metallic Composition of Filter Samples

Concentrations are in $\mu g/m^3$

Sample ID	E2CMTR-01	E2CMTR-02	E2CMTT-01	E2CHTT-02	E2CMTT-03	E2CMWT-01	E2CMWT-02	E2CMWT-03	E2CMWT-04	E2CMWT-05	E2CMWR-01	E2CHWR-02
Date	12/11/07	12/11/07	12/11/07	12/11/07	12/11/07	12/12/07	12/12/07	12/12/07	12/12/07	12/12/07	12/12/07	12/12/07
Al	<0.86	<0.84	<1.26	<1.18	<1.17	<1.42	<1.51	<1.39	<1.41	<1.44	<1.04	<1.02
Sb	<0.34	<0.34	<0.50	<0.47	<0.47	<0.57	<0.60	<0.56	<0.56	<0.58	<0.42	<0.41
As	<0.60	<0.59	<0.88	<0.83	<0.82	<0.99	<1.05	<0.97	<0.98	<1.01	<0.73	<0.71
Ba	0.15	0.22	1.02	1.66	0.08	0.08	0.99	1.03	0.04	0.82	0.05	0.11
Be	<0.02	<0.02	<0.03	<0.02	<0.02	<0.03	<0.03	<0.03	<0.03	<0.03	<0.02	<0.02
Cd	<0.03	<0.03	0.65	0.98	<0.05	<0.06	<0.06	0.64	<0.06	0.45	<0.04	<0.04
Ca	5.13	3.29	10.67	14.21	15.27	14.06	16.57	23.67	5.34	18.74	3.23	4.58
Cr	<0.17	<0.17	0.34	<0.24	<0.23	<0.28	<0.30	<0.28	<0.28	<0.29	<0.21	<0.20
Co	<0.04	<0.04	<0.06	<0.06	<0.06	<0.07	<0.08	<0.07	<0.07	<0.07	<0.05	<0.05
Cu	0.04	0.08	0.19	0.20	0.11	0.18	0.18	0.35	0.11	0.19	<0.03	0.05
Fe	<1.71	<1.68	6.53	11.84	4.93	10.79	18.07	16.71	2.95	6.92	<2.09	<2.04
La	<0.009	<0.008	<0.013	<0.012	<0.012	<0.014	<0.015	<0.014	<0.014	<0.014	<0.010	<0.010
Pb	0.31	0.29	3.26	8.17	<0.23	<0.28	0.31	0.31	<0.28	0.31	<0.21	<0.20
Li	<0.009	<0.008	<0.013	<0.012	<0.012	<0.014	<0.015	<0.014	<0.014	<0.014	<0.010	<0.010
Mg	0.28	0.16	0.67	1.11	0.80	0.50	0.66	1.39	0.31	0.88	<0.10	<0.10
Mn	<0.04	0.05	0.09	0.40	0.11	0.12	0.18	0.24	<0.07	0.14	<0.05	<0.05
Mo	<0.26	<0.25	<0.38	<0.36	<0.35	<0.43	<0.45	<0.42	<0.42	<0.43	<0.31	<0.31
Ni	0.02	<0.08	0.13	0.17	0.15	0.11	0.15	0.21	<0.14	<0.14	<0.10	<0.10
P	<0.86	<0.84	<1.26	<1.18	<1.17	<1.42	<1.51	<1.39	<1.41	<1.44	<1.04	<1.02
K	0.27	0.26	1.23	2.01	0.56	<0.43	1.01	2.09	<0.42	1.44	<0.31	<0.31
Se	<2.57	<2.53	<3.77	<3.55	<3.52	<4.26	<4.52	<4.18	<4.22	<4.32	<3.13	<3.06
Ag	<0.009	<0.008	<0.013	<0.012	<0.012	<0.014	<0.015	<0.014	<0.014	<0.014	<0.010	<0.010
Sr	0.06	0.07	0.41	0.50	0.04	0.31	0.30	0.56	0.34	0.58	0.01	0.05
Te	<0.34	<0.34	<0.50	<0.47	0.05	<0.57	<0.60	<0.56	0.47	0.83	<0.42	<0.41
Tl	<0.43	<0.42	<0.63	<0.59	<0.59	<0.71	<0.75	<0.70	<0.70	<0.72	<0.52	<0.51

Sn	<0.60	<0.59	<0.88	<0.83	<0.82	<0.99	1.08	<0.97	<0.98	<1.01	<0.73	<0.71
Ti	0.02	<0.01	0.05	0.08	0.07	0.18	0.11	0.18	0.18	0.12	<0.01	<0.01
V	<0.02	<0.02	<0.03	<0.02	<0.02	<0.03	<0.03	<0.03	<0.03	<0.03	<0.02	<0.02
Y	0.33	0.75	40.18	59.22	0.27	0.33	28.62	20.89	<0.03	25.94	0.16	0.35
Zn	1.0	1.8	63.9	65.0	1.4	2.0	39.0	38.8	0.8	43.1	0.4	1.1
Zr	<0.09	<0.08	<0.13	<0.12	<0.12	<0.14	<0.15	<0.14	<0.14	<0.14	<0.10	<0.10

Appendix D (Continued)

Sample ID	E2CMWR-03	E2CMWR-04	E2CMWR-05	E2CMWT-06	E2CMWR-06	E2CMHT-01	E2CMHT-02	E2CMHT-03	E2CMHR-02	E2CMHR-03	E2CMHR-04
Date	12/12/07	12/12/07	12/12/07	12/12/07	12/12/07	12/13/07	12/13/07	12/13/07	12/13/07	12/13/07	12/13/07
Al	<1.03	<1.01	<1.04	<1.36	<0.58	<0.78	2.98	5.80	<0.54	<1.09	<1.06
Sb	<0.41	<0.40	<0.42	<0.54	<0.23	<0.31	<0.63	<0.59	<0.22	<0.44	<0.42
As	<0.72	<0.70	<0.73	<0.95	<0.41	<0.54	<1.10	<1.04	<0.38	<0.77	<0.74
Ba	0.04	<0.02	<0.02	0.35	<0.01	0.31	2.19	3.42	0.25	0.37	0.53
Be	<0.02	<0.02	<0.02	<0.03	<0.01	<0.02	<0.02	<0.03	<0.01	<0.02	<0.02
Cd	<0.04	<0.04	<0.04	<0.05	<0.02	0.37	7.83	12.93	0.08	<0.04	0.11
Ca	3.40	2.71	3.13	62.45	0.64	4.51	25.07	38.63	3.81	4.81	6.22
Cr	<0.21	<0.20	<0.21	<0.27	<0.12	<0.16	0.38	0.43	<0.11	<0.22	<0.21
Co	<0.05	<0.05	<0.05	<0.07	<0.03	<0.04	<0.08	<0.07	<0.03	<0.05	<0.05
Cu	0.10	0.43	0.20	1.29	0.06	0.06	0.33	0.48	0.13	0.11	0.19
Fe	<2.06	<2.01	<2.09	10.05	<1.16	2.18	12.85	26.75	1.63	<2.19	<2.11
La	<0.010	<0.010	<0.010	<0.014	<0.006	<0.008	<0.016	0.030	<0.005	<0.011	<0.011
Pb	<0.21	<0.20	<0.21	0.31	<0.12	0.31	0.31	0.31	0.31	0.31	0.31
Li	<0.010	<0.010	<0.010	<0.014	<0.006	<0.008	<0.016	<0.015	<0.005	<0.011	<0.011
Mg	<0.10	<0.10	<0.10	1.63	<0.06	0.18	1.44	2.38	0.27	0.13	0.27
Mn	<0.05	0.71	0.20	0.26	<0.03	<0.04	0.33	0.56	0.14	<0.05	<0.05
Mo	<0.31	<0.30	<0.31	<0.41	<0.17	<0.23	<0.47	<0.45	<0.16	<0.33	<0.32
Ni	<0.10	<0.10	0.06	0.15	0.01	0.12	0.08	0.31	0.02	<0.11	0.07
P	<1.03	<1.00	<1.04	<1.36	<0.58	<0.78	<1.57	49.04	<0.54	<1.09	4.64

K	<0.31	<0.30	<0.31	1.00	<0.17	0.64	4.70	5.50	0.87	0.51	1.16
Se	<3.09	<3.01	<3.13	<4.07	<1.74	<2.33	<4.70	<4.46	<1.63	<3.28	<3.17
Ag	<0.010	<0.010	<0.010	<0.014	<0.006	<0.008	<0.016	<0.015	<0.005	<0.011	<0.011
Sr	0.08	<0.01	1.25	0.90	0.70	0.16	1.02	1.63	1.03	0.12	0.24
Te	<0.41	<0.40	1.31	<0.54	<0.23	<0.31	<0.63	<0.59	<0.22	<0.44	<0.42
Tl	<0.52	<0.50	<0.52	<0.68	<0.29	<0.39	<0.78	<0.74	<0.27	<0.55	<0.53
Sn	<0.72	<0.70	<0.73	<0.95	<0.41	<0.54	<1.10	<1.04	<0.38	<0.77	<0.74
Ti	0.05	<0.01	0.56	0.50	<0.01	0.03	0.15	0.28	0.50	<0.01	0.02
V	<0.02	<0.02	<0.02	<0.03	<0.01	<0.02	<0.03	<0.03	<0.01	<0.02	<0.02
Y	0.39	<0.02	<0.02	0.09	<0.01	7.70	104.96	178.31	2.34	1.86	3.27
Zn	1.0	0.1	0.4	4.1	0.0	17.8	234.8	386.2	6.5	5.4	9.0
Zr	<0.10	<0.10	<0.10	<0.14	<0.06	<0.08	<0.16	<0.15	<0.05	<0.11	<0.11

Figure I Diagram of the Unicor factory located within the FCI main compound (See Figure IV for more detail of Glass Breaking Operation)

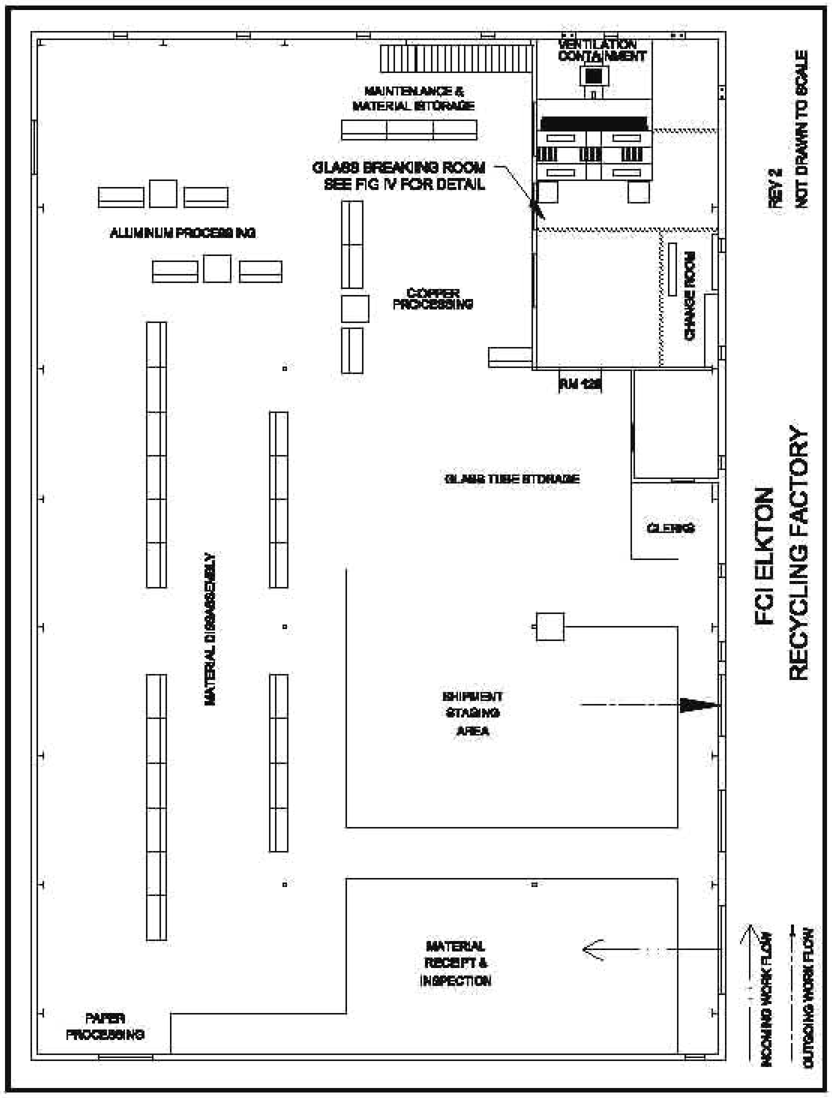


Figure II Diagram of the Unicor facility in the Federal Satellite Low (FSL)

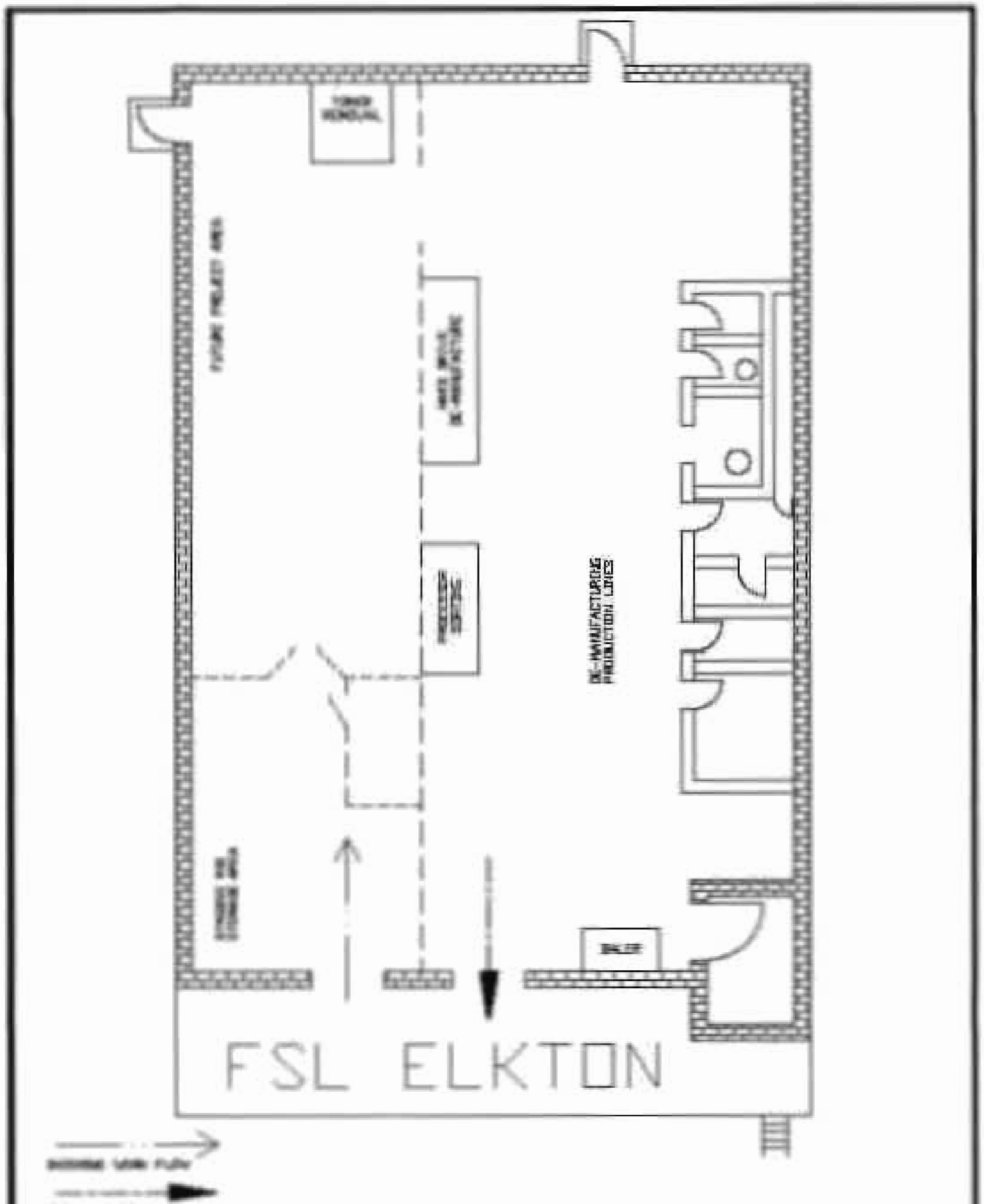


Figure III Diagram of the warehouse handling electronics recycling operations

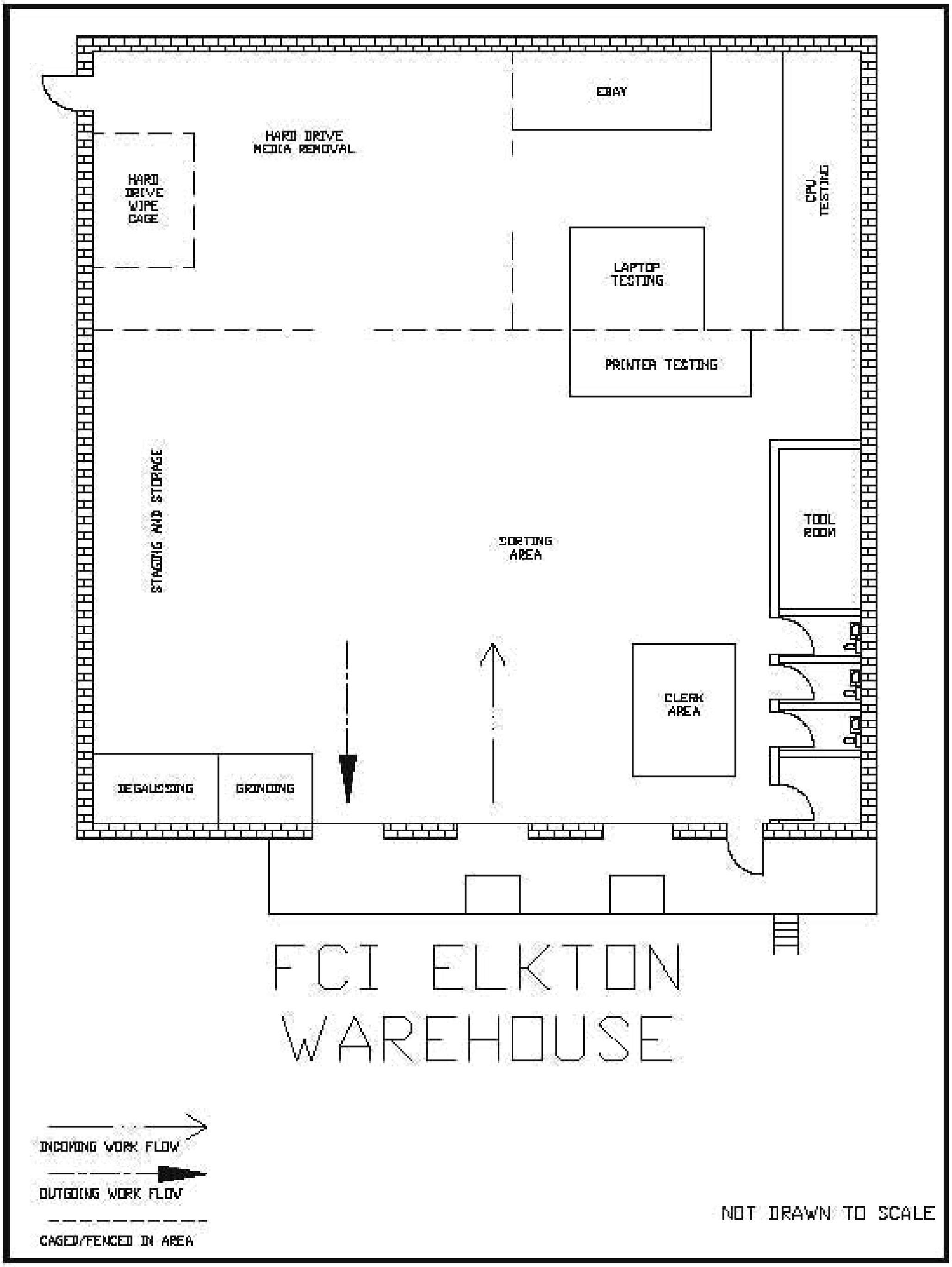


Figure IV Diagram of the glass breaking area within the FCI

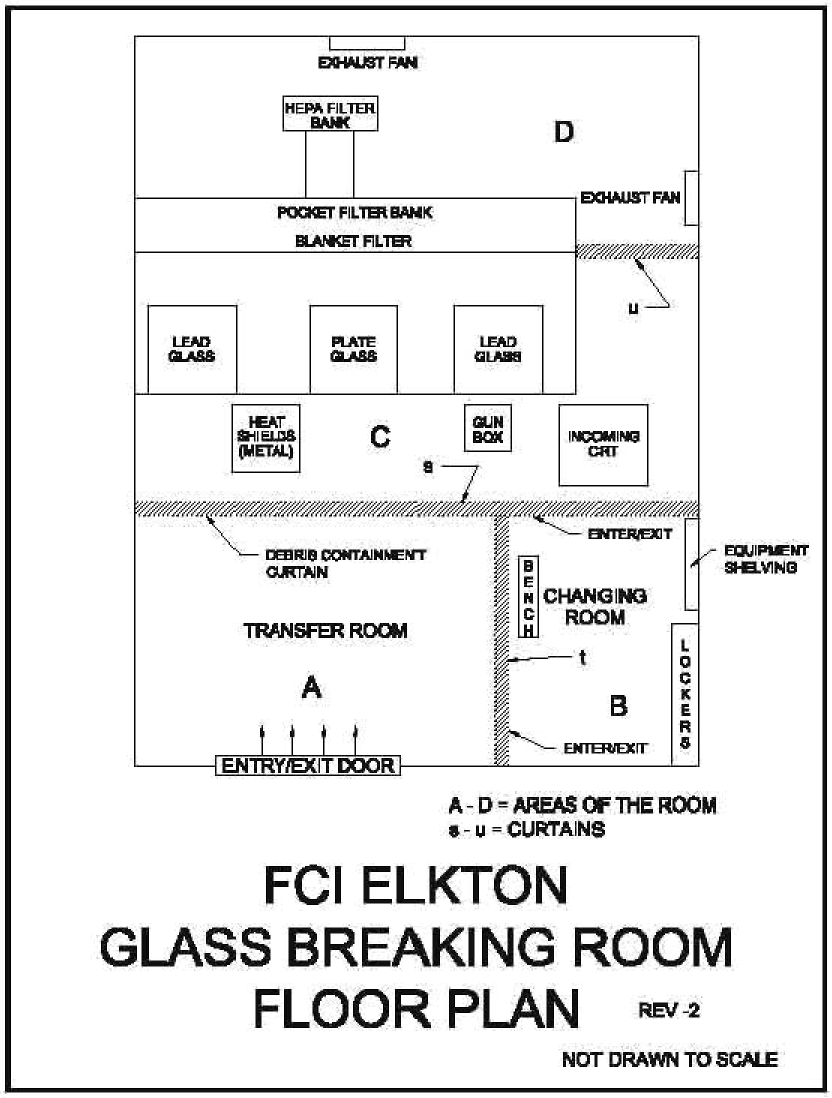


Figure V Elkton Warehouse Showing Storage Areas with Boxes of Items to be Recycled

Figure VI Overview of Elkton Recycling Factory Disassembly Area

Figure VII Electron Gun Removal in Glass Breaking Operation

Figure VIII Filter Change Operation in Glass Breaking Area
Showing Large Amount of Visible Dust

Figure IX – Five cut particle size distribution from impactor data

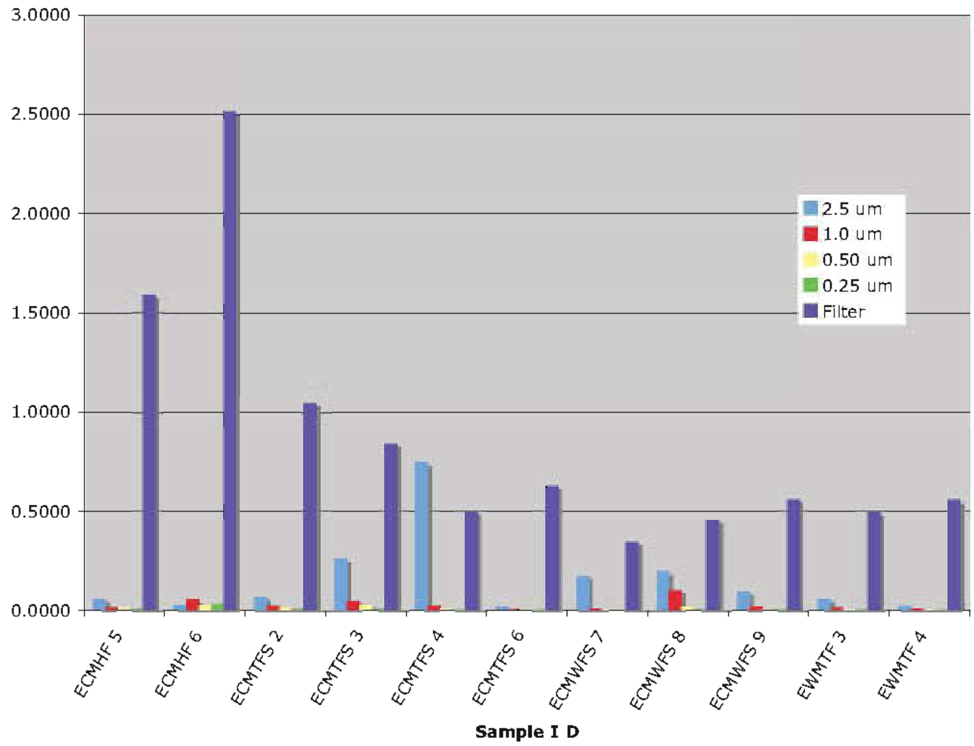
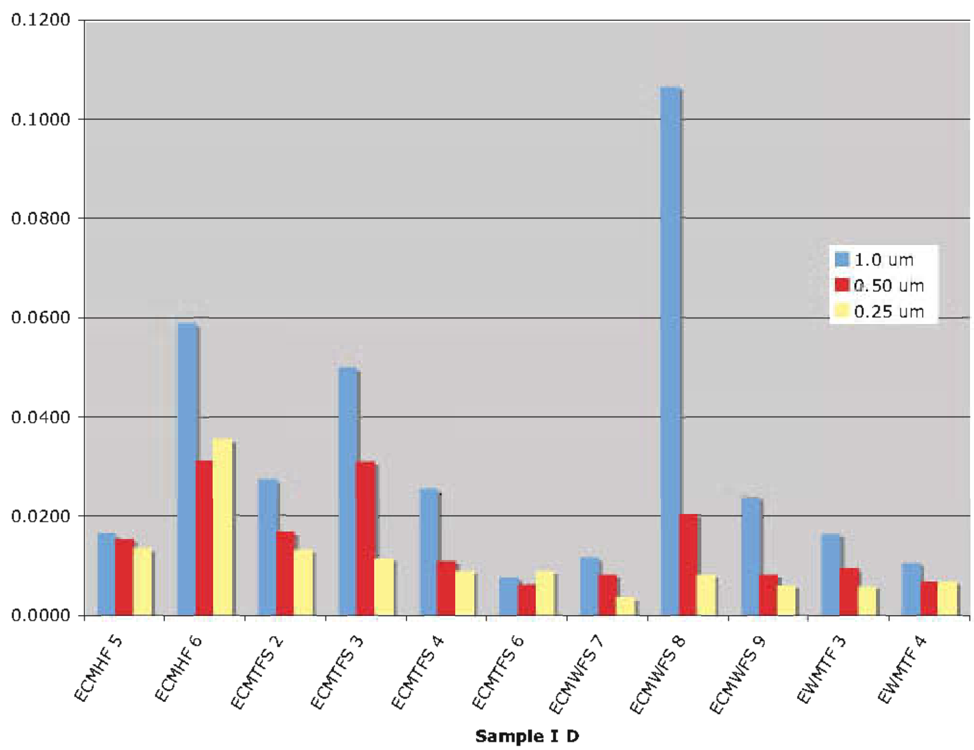


Figure X – Three cut particle size distribution from impactor data



ATTACHMENT 2

--Summary--
Findings and Recommendations Pertaining to Air/Wipe/Bulk/TCLP Sampling Data from Electronics Recycling Facilities, FCI Elkton (Lead and Cadmium Data Only)

November 15, 2007
(Rev. April 2010)

Submitted to: Mr. S. Randall Humm
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
U.S. Department of Justice

Submitted by: Captain Paul Pryor, CIH
Team Leader
FOH & NIOSH Safety and Health Investigation Team

I. BACKGROUND

An investigative team comprised of safety and health professionals from the Federal Occupational Health Service (FOH) and the National Institute for Occupational Safety and Health (NIOSH) has completed initial characterizations of airborne exposures and facilities contamination stemming from various electronics recycling operations conducted at Federal Correctional Institution (FCI) Elkton. Characterizations were performed in early 2007 and involved the collection and analysis of air, wipe, bulk dusts and waste samples from the FCI Elkton's Recycling Factory, Warehouse, and Federal Satellite Low (FSL). Samples were collected from locations where various electronics recycling operations were currently taking place or had taken place in the past. The overall purpose of the characterizations was to evaluate whether inmates or staff had been or currently are at risk from elevated exposures to toxic substances.

Information provided in this Summary is based on the analytical data compiled in the spreadsheets entitled: "Elkton Wipe/Bulk/TCLP Data Table-Lead and Cadmium Only (Samples Collected 2/27-28/07)" and "Elkton Filter Data" (Appendices 1 & 2).[1] Also, the guidelines referenced by the FOH and NIOSH Investigative Team to evaluate the risk posed by the various levels of contamination found on building surfaces are found at the end of Appendix 1.

II. FINDINGS

A. <u>UNICOR Recycling Factory</u>

1. The results of bulk and wipe samples taken from various surfaces in the Recycling Factory reflect that significant particulate lead and cadmium contamination currently exists inside the Factory's ventilation system near 20' high ceilings as well as on various elevated and non-elevated building surfaces (steel structural supports, on top of light fixtures, on upper surfaces of ceiling-mounted ducts, etc.).
2. It is likely that this contamination originally emanated from the cathode ray tube (CRT) glass breaking operations which were reported to have occurred for some period of time in one or more unenclosed locations on the factory floor.
3. The lead and cadmium contamination appears to be present on various elevated building surfaces located throughout the factory floor, even at distances well away from the current and former glass breaking areas. Contamination was found to be present at levels significantly exceeding quantitative surface contamination guidelines established for lead.
4. The ability of the dust to accumulate on surfaces near the ceiling is consistent with the hypotheses that significant airborne dust containing lead and cadmium was released into the general factory environment.
    a. This supports the conclusion that dust particles were not effectively captured by local filters or effectively addressed via other engineering controls. Hence, especially in the absence of a stringently applied respiratory protection program

[1] Personal and area air samples, as well as wipe, bulk dusts, and waste samples were analyzed for additional metals besides lead and cadmium. Since the data review for these other metals has not yet been completed, it is beyond the scope of this report to address these findings.

and other exposure reduction controls, personal exposures of workers to lead and cadmium were likely to have occurred especially at elevations lower than where many of the surface samples were collected. That is, it is reasonable to assume that greater concentrations of contaminated dusts would have been present in the air and on surfaces nearer the floor (closer to the glass breaking operations) than 20' overhead. Also, it is likely that particles would tend to settle on the floor and lower surfaces and then become re-entrained in the air during dry sweeping, walking, etc.

b. Particle sizes would be expected to be small to allow them to accumulate at ~20' elevations and it is likely that a significant fraction of the lead and cadmium-laden dusts would have the increased toxicity associated with particles in the 'respirable size' range.

5. As would be expected, surface contamination inside the current area where CRT glass breaking occurs was found to be high. Engineering controls (air filtration, enclosures, etc.) and personal protective equipment (respirators, coveralls, etc.) are currently used to mitigate contamination release and exposure concerns. Wipe sample results indicate that lead and cadmium-laden dusts are distributed throughout the glass breaking area, although some surfaces appear to be effectively decontaminated during periodic (daily and weekly) housekeeping operations.
6. Outside the enclosed glass breaking room, wipe samples taken from work benches, in the change room, and other 'non-control' areas associated with the current glass breaking operation generally reflect that these working surfaces become contaminated to some extent over the course of normal work activities. These data suggest that some contamination migration outside the enclosed 'control' area (i.e., where respirators and other personal protection equipment are used) does occur, although the routine cleaning of these surfaces appears to keep these contamination levels in check.
7. Bulk samples of settled dust collected from various locations outside the current glass breaking room (e.g., from ductwork by the ceiling, from ballast on the roof beneath a rooftop air handler, etc.) were found to contain significant lead and cadmium concentrations. Testing performed on a limited number of samples showed that this accumulated dust contained extractible lead at levels which suggest that any clean-up of accumulated dusts from the factory may require these sediments to be treated as hazardous waste.
8. It is unknown to what extent the recent (i.e., February 2007) inadvertent release of dusts from the ventilation ducts (reportedly due to a wiring error made during maintenance of an air handler) has contributed to the surface contamination found, but it is likely from the filter/bulk/wipe samples that at least some lead and cadmium-containing dusts remain in/on the ducts and that these dusts may require any ducts that are discarded to be treated as hazardous waste.
9. Testing via the EPA RCRA Toxic Characteristic Leaching Procedure (TCLP) showed that mop wash water from floor cleaning operations performed inside the current CRT glass breaking operations does not need to be handled as hazardous waste with respect to lead and cadmium. Further testing of this waste water may be necessary to determine if it can be discharged to the drain(s) inside the recycling factory.
10. TCLP testing of samples collected from gaylord boxes labeled "Broken Funnel Glass" and "Mixed Waste" showed that these waste streams would be considered "hazardous

waste" per the EPA RCRA TCLP criteria for lead if the waste was not recycled or otherwise did not meet new (effective Jan 29, 2007) requirements pertinent to "used and broken CRTs." Samples identified as "Broken Glass from Panel Box" and "Dust from Gaylord box labeled monochrome waste" reflect that these wastes would not be considered hazardous waste.

11. Results of air sampling in all but the glass breaking area of the Recycling Factory indicated that during the two days of operations when tests were conducted, exposures to lead and cadmium were well within recommended levels (generally 10 to 100 times below the permissible limits).
12. Measurements of airborne lead and cadmium during two days of glass breaking operations showed that exposures were less than half of the permissible levels. This reflects that the local exhaust ventilation in the back of the glass breaking booth is successfully keeping exposures low. For additional protection, it should be noted that workers in this area also wear respirators, gloves and coveralls.
13. Air monitoring performed in the glass breaking area during the filter change-out operations, however, showed concentrations that exceeded the OSHA Permissible Exposure Limit (PEL) by a factor of over 450 times for cadmium and over 50 times the PEL for lead. This operation was characterized by excessive visible dust caused by activities such as removing dust-laden filters and banging them together to knock the particulates off.

B. Warehouse

1. The results of the bulk and wipe sampling performed in the Warehouse show that particulate lead and cadmium contamination currently exists on the various surfaces tested (on elevated horizontal surfaces of light fixtures, pipes, etc.). Significant deposits of visible black dust were observed on all these surfaces. Based on the limited sampling regimen, it appears that the contamination is focused primarily on surfaces in proximity to an area currently designated as the "Warehouse Sorting Area." This open area reportedly had been where some CRT glass breaking originally occurred in 1998.
2. Surface contamination appears to be much less in Warehouse areas that are located away from the 'Sorting Area' (i.e., the former glass breaking area) and, overall, much less concentrated as compared to that found on surfaces in the Recycling Factory. These results are consistent with the premise that the contamination originally emanated from the reported CRT glass breaking operations but that the operation was smaller in scope and/or duration (or had better engineering controls) than that which took place in the Recycling Factory.
3. The presence of the surface contamination in the Warehouse suggests that some degree of personal lead/cadmium exposure occurred in the past through inhalation and/or ingestion and may still be occurring today to a much lesser degree (i.e., through workers breathing/ingestion of re-entrained dust, touching dust-contaminated surfaces, etc.).
4. Three personal air samples and one area air sample were collected in the Elkton Warehouse during one day of electronics recycling operations in this facility. Only one lead sample was above the limit of detection for the analytical method, that one being approximately 1% of the permissible limit for lead. Cadmium was measured in all four samples, but never in concentrations above 10% of the limit.

C. FSL

1. The results of the bulk and wipe sampling performed at the FSL show that particulate lead contamination currently exists on the various surfaces tested. Some cadmium contamination was also present on the surfaces tested, but to a much lesser extent.
2. Surfaces located in or near where the former chip recovery/de-soldering area was previously located showed the presence of extremely high concentrations of lead while other surfaces such as those within walled offices and on the opposite end of the building were low.
3. Inner surfaces of local exhaust ventilation ducts and dampers (either currently in-place or removed and discarded) showed extremely high concentrations. This reflects that this ventilation system once removed FSL air containing significant quantities of lead produced by the de-soldering operations. The data also suggests that, should these de-soldering operations have been conducted without the benefit (i.e., prior to) the installation of the local exhaust system, significant airborne concentrations, and personal exposures, would have resulted.
4. Surfaces on in-place exhaust dampers of the FSL's exterior wall by where the former chip recovery/de-soldering operations were located had high concentrations of lead. This indicates that airborne lead contamination was exhausted into the outdoor environment.
5. Surfaces on floors, work tables, and routinely used machines showed the presence of some contamination. Therefore, these surfaces (with which current workers routinely come into contact) have potential to contribute to lead exposure (e.g., via hand-to-mouth, ingestion). However, concentrations on these surfaces were found to be generally low suggesting that existing cleaning and end-of-shift housekeeping are currently successful in keeping levels in check.
6. Two days of air sampling during electronics recycling operations at the FSL showed no airborne lead or cadmium concentrations exceeding permissible limits. More specifically, no airborne lead levels were measured above 2% of the most stringent criteria (excluding one sample with which tampering was suspected). No cadmium measurements were found above 10% of the adopted criteria for that metal.

III. RECOMMENDATIONS

1. Air monitoring in the general factory work areas of each of the three buildings indicates that the presence of surface contamination containing lead and cadmium is not posing an imminent inhalation threat that requires immediate evacuation and remediation but rather one that can be responded to in a prompt but well-coordinated manner. Assuming that the industrial hygiene assessment and the ongoing monitoring of conditions (see Recommendation #8, below) are favorable and do not show that degradation or other factors are resulting in increased exposure potential, some flexibility in scheduling the clean-up activities is deemed acceptable. However, it is recommended that cleanup activities should be completed in accordance with approved project specifications within three years. As such, abatement activities may be coordinated with and integrated into other building upgrade plans (e.g., ventilation retrofits, rooftop filter cleaning and/or replacement, expansion operations, etc.).

2. While air samples taken on the general factory floor in the Recycling Factory, Warehouse, and FSL did not show airborne exposures of concern during typical, day-to-day operations, the data from the 'filter change-out' operation showed that airborne exposures can exceed by a factor of over 450 times the concentration adopted by OSHA as the Permissible Exposure Limit (PEL) for cadmium and over 50 times the PEL for lead. Even though the workers performing this operation wore respiratory protection (i.e., powered air purifying respirators-PAPRs), these excessive exposures well exceed the Protection Factor afforded by this type of respirator. Hence, this operation should be immediately discontinued until improved dust suppression and engineering controls can be identified, instituted, and confirmed as effective. Note: It should be noted that OSHA regulations mandate a number of specific requirements for whenever exposures to lead and/or cadmium exceed their respective action levels or PELs. Requirements may include provisions for instituting medical surveillance, enhanced engineering controls, air monitoring, special worker notifications, showers, laundering of contaminated work clothes, etc. Since it is apparent that action levels and PELs can be exceeded during the filter change-out operation, it is recommended that a comprehensive regulatory assessment be performed with respect to OSHA regulations found at 29 CFR 1910.1025 (Lead) and 29 CFR 1910.1027 (Cadmium).
3. Based on the elevated air monitoring results obtained during the filter change-out operations, it is strongly recommended that Elkton's Respiratory Protection Program be re-evaluated for this operation in order to comply with OSHA regulation 1910.134. Specifically, the use of PAPRs must comply with 1910.134 (d) (3) (i) (A) concerning Assigned Protection Factors as they relate to the exposure conditions found during this operation.
4. An operations and maintenance (O&M) plan should be immediately developed and implemented in order to protect staff, inmates, contractors, and the environment from lead and cadmium residues found on various surfaces throughout the Recycling Factory, Warehouse and FSL. The O&M plan should identify policies and procedures for minimizing personal exposures and the spread of contamination during any activities which might result in the disturbance of or contact with contaminated building surfaces and components. Given the very high concentrations of lead and cadmium found in many dust deposits, special emphasis should be on preventing re-entrainment and release to the workplace air or exposure via ingestion. Elements of the O&M plan should include:
   - Specific identification of activities and operations which may disturb the contamination (e.g., duct maintenance, work involving contact with structural supports, etc.);
   - Pre-job identification, delineation and assessment of areas/surfaces of concern;
   - When and how to use exposure mitigating techniques (e.g., techniques for dust suppression, local capture ventilation, etc.) and personal protection equipment (e.g., coveralls, respirators, gloves) during any activities/operations of concern;
   - Training and hazard communication;
   - Emergency scenario contingencies (e.g., should inadvertent release/exposures occur);
   - Disposal of dust-contaminated materials/wastes (possibly classified as hazardous waste); and

- Ongoing monitoring and evaluation of conditions (via air, skin, surface sampling);

5. It is recommended that the FOH and NIOSH Investigative Team participate in the review of the O&M plans and abatement specifications, the ongoing monitoring and evaluation of conditions, and the oversight of any abatement actions.
6. It is recommended that comprehensive plans be developed and implemented to remediate the contamination (inside ducts, on surfaces, etc.) in accordance with sound hazardous material abatement specifications (such as, for example, adaptations of specifications currently used to remove lead paint from residences). These plans should address considerations such as the containment of the remediation areas, method of remediation (removal, isolation/enclosure, encapsulation, etc.), worker protection, clearance levels to be achieved, disposal of hazardous wastes, etc.
7. Especially in the Warehouse and FSL where some areas/surfaces were found to exist with little/no contamination, it may be prudent to more precisely delineate which building locations and components warrant clean-up and which do not.
8. Given the very high concentrations of lead and cadmium in some dust samples (one sample from the FSL was as high as16% lead), periodic industrial hygiene evaluations and facility inspections are recommended to confirm that conditions remain acceptable until corrective actions are completed. Such evaluations (air sampling, hand wipe sampling, assessments of dust disturbance potential, etc.) should be performed to better characterize current exposures during various routine and non-routine operations and activities.
9. Regarding the ongoing CRT glass breaking operations, although air monitoring did not show that workers were exposed at levels exceeding OSHA action levels or PELs, it was apparent that dust migrated from the control area to adjacent general work areas. Therefore, improvements in contamination containment (e.g., install a state-of-the-art three stage decontamination room(s) adjacent to the GBO) should be implemented in order to reduce the presence of lead and cadmium on surfaces outside the control area (i.e., work benches, changing room, etc.). Also, OSHA regulations (29 CFR 1910.1025 and 29 CFR 1910.1027) may call for additional, periodic full shift exposure monitoring to document negative exposures (i.e., below action levels) during this operation.
10. Based on the testing performed, bulk quantities of settled dusts originating from the glass breaking and de-soldering operations should be treated as hazardous waste, unless additional testing permits otherwise.
11. It is recommended that additional characterization be performed of possible environmental impacts from the release to the FSL building exterior of lead exhaust air from the de-soldering operation.

APPENDIX 1

Appendix 1
Reference Criteria for Lead and Cadmium Utilized by FOH/NIOSH to Evaluate Wipe and Bulk Samples at FCI Elkton

In general, exposure standards for lead and cadmium have been established by various agencies and organizations (e.g., OSHA, NIOSH, ACGIH, EPA, etc.) to assess particular risks in the workplace, home, or environment. However, criteria specifically dealing with lead and cadmium surface contamination of interior building surfaces and work areas are less evident. To address this issue, FOH and NIOSH performed a literature search and reviewed a number of pertinent regulations and published articles in order to identify reference criteria and guidelines for use in determining whether the lead and cadmium contamination found on surfaces at FCI Elkton presents an occupational hazard warranting remedial action. The results of this research are presented below.

Lead

Federal standards have not been adopted that identify a specific limit for lead contamination of surfaces in the industrial workplace. In residences and federally owned or assisted housing, the U.S. Department of Housing and Urban Development (HUD) has established clearance levels for lead on surfaces after lead abatement or interim control activities and they include: floors, 40 µg/ft2; interior window sills, 250 µg/ft2, and window wells, 800µg/ft2 **(Ref: http://www. cdc.gov/ niosh/2001-113.html)**. Although these criteria are not strictly applicable to industrial settings where children are not living, a review of these standards and related interpretations and guidance provided by the federal government, as well as articles published in peer-reviewed technical safety and health journals, provide a basis for the FOH/NIOSH investigative team to assess the risks associated with lead contamination on various building material surfaces at FCI Elkton and to recommend decontamination activities as warranted. A summary of information pertinent to lead on surfaces at FCI Elkton (i.e., in the non-residential environment) is provided below:

OSHA - In a letter dated January 13. 2003, OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace (i.e., 29 CFR 1926.62) can be summarized and/or interpreted as follows: a) All surfaces shall be maintained as 'free as practicable' of accumulations of lead, b) The employer shall provide clean change areas for employees whose airborne exposure to lead is above the permissible exposure limit, c) The employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination, d) The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of HUD's initially proposed decontamination criteria of 200 ug/ft^2 for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas, e) In situations where employees are in direct contact with lead-contaminated surfaces, such as, working surfaces or floors in change rooms, storage facilities, lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 ug/ft^2 level, and f) For other surfaces, OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of lead contamination meets the definition of "practicable." Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulations of lead dust do not become sources of employee lead exposures. OSHA has stated that any method that achieves this end is acceptable (Ref: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p id=25617).

Proposed Lead Surface Concentration Clearance Standard (Peer-reviewed technical article) - John H. Lange proposed a clearance level of 1000 ug/ft2 for floors of non-lead free buildings and 1100 ug/ft2 for lead-free buildings. Lange's proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions such as: a) Lead uptake following ingestion is 35% absorption of lead in the gastrointestinal system, b) Fingers have a total "touch" area of 10 cm2 and 100% of the entire presumed lead content on all 10 fingers is taken up, c) The average 'normal' environmental lead dose (from 'uncontaminated food/water/air) is 20ug per day, d) The weight of the exposed person is 70 kg, and e) Daily lead excretion is limited to an average of 48 ug. **(Ref: Lange, John H., A Suggested Lead Surface Concentration Standard for Final Clearance of Floors in Commercial and Industrial Buildings by Indoor Built Environment 2001;10:48-51).**

Note: While buildings at FCI Elkton are reported to be free of lead paint, the buildings can not be said to be lead free due to the electronics recycling operations that are currently taking place (or have taken place in the past). In addition, FOH testing results have confirmed the presence of varying quantities of lead dust in many areas.

EPA - There are no Federal standards limiting soil lead contamination in the workplace. However, the EPA has proposed standards for residential soil-lead levels, expressed as the average total lead by weight in drip-line and mid-yard composite soil samples: 400 ppm as a level of concern that should trigger appropriate risk reduction activities and $\geq$ 2000 ppm as a trigger for permanent abatement of soil lead hazards. Also, EPA regulations require wastes with extractible lead concentrations at 0.05 mg/l or greater (as determined via TCLP analysis) be disposed of as hazardous waste under RCRA standards. As noted above, FOH's testing shows that these limits are exceeded by bulk dust samples collected from various locations at FCI Elkton. **(Ref: http://www.cdc.gov/niosh/2001-113.html)**

FOH – In addition, for relatively inaccessible or seldom accessed surfaces (e.g., surfaces of ceiling rafters, top surfaces of elevated ducts, etc.) at FCI Elkton, and in the absence of other established criteria, FOH proposes on an interim basis 4000 ug/ft2 as a clearance guideline. This value was derived from HUD's 40 ug/ft2 criterion as discussed above multiplied by a factor of 100 to account for factors such as inaccessibility, no children, etc.

Note: This proposed value is based on the assumption that an effective Operations and Maintenance Plan would be instituted such that any personnel coming into contact with these inaccessible/limited access surfaces are trained in exposure mitigation techniques (e.g., dust suppression techniques, controlled work area, decontamination procedures, etc.) and equipped with appropriate personal protection.

NIOSH - NIOSH has completed over 30 Health Hazard Evaluations (HHEs) from 1996 to 2006 which document hazard assessments of non-residential buildings with lead-contamination in air, dust and/or soil. For each, NIOSH provided a Toxicity Determination of "Positive" or "Negative" based on the conditions characterized. In general, where possible, data from multiple sources (air samples, dust wipes, blood lead levels, soil contamination, etc.) and salient conditions (nature of at-risk population, duration of exposures, etc.) were all factored into the Toxicity Determination. As such, it is the FOH/NIOSH Investigative Team's position that characterization of multiple media (air, surface, soil, blood) is desirable and necessary to arrive at the most defensible conclusions and recommendations dealing with whether lead contamination presents a risk and needs to be abated. **(Ref: http://www.cdc.gov /niosh/updates/leadhaz.html then http://www.cdc.gov/niosh/2001-113.html#manufacturing; http://www.cdc.gov/niosh/hhe/reports/pdfs/1993-0502-2503.pdf.)**

Note: The referenced articles should be consulted for additional assumptions, calculations and rationale.

Cadmium

Like lead, cadmium poses serious health risks from exposure. Cadmium is a known carcinogen, is very toxic to the kidneys, and can also cause mental depression. However, studies to date have not identified recommended criteria for use in evaluating wipe and bulk samples. Thus, while FOH and NIOSH do not reference such criteria, it is noteworthy that many of the cadmium samples collected at Elkton showed concentrations that significantly exceeded the threshold criteria identified for lead. FOH and NIOSH intend to refine their assessment of cadmium exposure criteria as the review proceeds.

Appendix 1
Elkton FCI Wipe/Bulk/TCLP Data Table

Row	Sample #	Date & Who Collected	Sample Type W=Wipe B=Bulk	Building Name	Surface/Item	Elevation (feet)	Description	Lead ug/ft2	Lead mg/kg	Lead mg/l (extrac)	Cadmium ug/ft2	Cadmium mg/kg	Cadmium mg/l (extrac)
1	1-ELK	2/27/2007 [FOH]	W	Warehouse	Top of Fluorescent Light Fixture	~20 (~2' from ceiling)	Black dust quite evident	3,120			3,120		
2	2-ELK	2/27/2007 [FOH]	W	Warehouse	Top of Cold Water Pipe	~ 17' (~ 5' from ceiling)	Black dust quite evident	4,220			4,180		
3	3-ELK	2/27/2007 [FOH]	W	Warehouse	Top of Return Duct	~ 20'	Top surface of duct by ceiling	3,460			3,740		
4	4-ELK	2/27/2007 [FOH]	B	Warehouse	Ledge above middle bay door	~ 10'	Ledge with copious amounts of dust/particles		410			580	
5	5-ELK	2/27/2007 [FOH]	W	Warehouse	Blank	-	Wipe in centrifuge tube	<10			<1		
6	6-ELK	2/27/2007 [FOH]	W	Warehouse	Floor at base of steel column	0		220			13		
7	7-ELK	2/27/2007 [FOH]	W	Warehouse	Floor	0	From corner under stairs	377			106		
8	8-ELK	2/27/2007 [FOH]	B	Warehouse	On 3" steel ledge under top of stairs	8.5'			300			380	
9	9-ELK	2/27/2007 [FOH]	W	Warehouse	Stair rise (underside) by wall	6'		440			80		
10	10-ELK	2/27/2007 [FOH]	W	FSL	Beam support at column top	~ 20'	From angle iron support running; ~ 4' from ceiling	2,200			73		
11	11-ELK	2/27/2007 [FOH]	B	FSL	Ledge of cinder block wall	~ 17'	Bulk debris/dust from corner ledge		910			98	
12	12-ELK	2/27/2007 [FOH]	W	FSL	Wall notch	~ 5'	Notch formed by the abutting poured concrete sections	720			5		
13	13-ELK	2/27/2007 [FOH]	W	FSL	Floor at base of column 1	0		14			1		
14	14-ELK	2/27/2007 [FOH]	W	FSL	Wall	15'	Ledge midway between col. 1 and col. A between poured concrete sections	309			3		
15	15-ELK	2/27/2007 [FOH]	W	FSL	Beam by column A at wall	~ 20'	Top surface of beam at wall	38,800			127		
16	16-ELK	2/27/2007 [FOH]	W	FSL	Ledge	~ 15'	Ledge on cinder block	33,000			57		
17	17-ELK	2/27/2007 [FOH]	W	FSL	Ledge on wall	5'	Ledge between concrete slabs forming wall	5,760			9		
18	18-ELK	2/27/2007 [FOH]	W	FSL	Floor at base of column A	0		11,700			17		
19	19-ELK	2/27/2007 [FOH]	W	FSL	Steel support beam along wall	~ 20'		124,000			96		
20	20-ELK	2/27/2007 [FOH]	W	FSL	Ledge on wall	~ 11'	Top surface of channel	3,260			58		
21	21-ELK	2/27/2007 [FOH]	W	FSL	Ledge on wall	~ 5'	Ledge where poured concrete sections about	370,000			64		
22	22-ELK	2/27/2007 [FOH]	W	FSL	Floor	0	At base of column 2	9,110			18		
23	23-ELK	2/27/2007 [FOH]	W	FSL	Beam at ceiling (in middle of floor)	~ 20'		1,250			33		
24	24-ELK	2/27/2007 [FOH]	W	FSL	Top of return air duct at ceiling	~ 20'		2,110			31		
25	25-ELK	2/27/2007 [FOH]	W	FSL	Steel support beam at wall by col. 3	~ 20'		18,800			269		
26	--	--	--	--		--		--			--		
27	27-ELK	2/27/2007 [FOH]	W	FSL	Surface of beam on wall ~ 4' from col. 2 by door	3'		2,540			19		
28	28-ELK	2/27/2007 [FOH]	W	FSL	Floor	0	Base of column 3	10,100			21		
29	29-ELK	2/27/2007 [FOH]	W	FSL	Beam at ceiling	~ 20'	Near column B	4,460			27		
30	30-ELK	2/27/2007 [FOH]	W	FSL	Floor by base of column B	0		43,200			34		
31	31-ELK	2/27/2007 [FOH]	W	FSL	Book shelf by column B	2'	Wooden shelves	56			5		
32	32-ELK	2/27/2007 [FOH]	W	FSL	Steel Beam by column C	~ 20'		30,200			36		
33	33-ELK	2/27/2007 [FOH]	W	FSL	Beam/ceiling by Column D	~ 20'		20,700			27		
34	34-ELK	2/27/2007 [FOH]	W	FSL	Floor	0	Base at column C	480			80		
35	35-ELK	2/27/2007 [FOH]	W	FSL	Floor base of column D	0		453			69		
36	36-ELK	2/27/2007 [FOH]	W	FSL	Beam / ceiling column E	~ 20'		1,830			30		
37	37-ELK	2/27/2007 [FOH]	W	FSL	Floor by column E	0		807			48		
38	38-ELK	2/27/2007 [FOH]	W	FSL	Top surface of supply duct diffuser	~ 18'	Between Column E and Column 4	240,000			31		
39	39-ELK	2/27/2007 [FOH]	W	FSL	Steel beam support on wall	~ 18'		23,700			80		

Appendix 1
Elkton FCI Wipe/Bulk/TCLP Data Table

Row	Sample #	Date & Who Collected	Sample Type W=Wipe B=Bulk	Building Name	Surface/Item	Elevation (feet)	Description	Lead ug/ft2	Lead mg/kg	Lead mg/l (extrac)	Cadmium ug/ft2	Cadmium mg/kg	Cadmium mg/l (extrac)
40	40-ELK	2/27/2007 [FOH]	W	FSL	Top of old exhaust duct	~ 15'	By column 4	5,520			24		
41	41-ELK	2/27/2007 [FOH]	W	FSL	Beam on wall	~ 3'		1,170			12		
42	42-ELK	2/27/2007 [FOH]	W	FSL	Floor by column 4	0		98,200			39		
43	43 ELK	2/27/2007 [FOH]	W	FSL	Beam / ceiling by column F	~ 20'		400			35		
44	44-Elk	2/27/2007 [FOH]	W	FSL	Blank			<10			<1		
45	45-Elk	2/27/2007 [FOH]	W	FSL	Beam on far wall by bay door	8'		640			116		
46	46-ELK	2/27/2007 [FOH]	W	FSL	Inside surface of discarded duct opening with air damper	None given		219,000			21		
47	47-ELK	2/27/2007 [FOH]	W	FSL	duct opening in hood with air damper	None given		120,000			28		
48	48-ELK	2/27/2007 [FOH]	W	FSL	Discarded duct opening	None given	Where exhaust duct leaves top of hood	32,400			54		
49	49-ELK	2/27/2007 [FOH]	W	FSL	Top surface of 1" pipe in office	2'	In office 103	178			14		
50	50-ELK	2/27/2007 [FOH]	W	FSL	Floor	0	Behind office door office 103	120			9		
51	51-ELK	2/27/2007 [FOH]	W	FSL	Ledge of window sil	3	Inmate clerk office area	288			28		
52	52-ELK	2/27/2007 [FOH]	B	FSL	Scraped from floor around column 3 at door	0			160,000			38	
53	53-ELK	2/27/2007 [FOH]	CLP-Moppe	Recycling Factory	1000 ml collected 2 x 500 ml		Mop rinseate after mopping gb floor. Mopping occurred both in gb area and "feed" area			0.04			<0.001
54	54-ELK	2/28/2007 [FOH]	TCLP - Soli	Recycling Factory	Exterior upper surface of lower exhaust fan housing	~ 18'				62.00			0.40
55	55-ELK	2/28/2007 [FOH]	W	Recycling Factory	Top side of blade of fan inside exhaust duct	~ 18'		10,100			2,350		
56	56-ELK	2/28/2007 [FOH]	TCLP-Solid	Recycling Factory	Top surface of metal box over exhaust fan	~ 20'	Upper surface of top fan housing			47.00			0.45
57	57-ELK	2/28/2007 [FOH]	B	Recycling Factory	Top of return air duct	~ 20'			3,600			6000	
58	58-ELK	2/28/2007 [FOH]	W	Recycling Factory	Top of return air duct over material dissassembly area	~ 20'	Return air duct in NE corner of room	30,800			12,800		
59	59-ELK	2/28/2007 [FOH]	W	Recycling Factory	shipment area (near bay door)	~ 20'		123,000			3,770		
60	60-ELK	2/28/2007 [FOH]	W	Recycling Factory (roof)	Beam by window	~ 20'	On platform above gb area	28,500			735		
61	61-ELK	2/28/2007 [FOH]	B	Recycling Factory	In stone (ballast) directly beneath exhaust fan on roof	Roof	On SW corner of exhaust fan		8,800			900	
62	62-ElK	2/28/2007 [FOH]	B	Recycling Factory	Filter	None given	2" x 3" filter section HV5 south part of Roof		370			140	
63	63-ELK	2/28/2007 [FOH]	W	Recycling Factory	Top of electrical inverter	~ 18'	On platform on SW side of factory floor	12,400			173		
64	64-ELK	2/28/2007 [FOH]	W	FSL	Louver on exterior of building	~ 11"	Where fountains were vented to exterior	64,000			21		
65	65-ELK	**2/28/2007** [FOH]	W	FSL	Inside duct behind louvers on exterior of building	5'	Where pots were vented to exterior	403,000			202		
66	66-ELK	2/28/2007 [FOH]	W	FSL	Blank			<10			<1		
67	67-ELK	2/28/2007 [FOH]	TCLP Solid	Recycling Factory	Broken funnel glass	None given	From gb area from gaylord box			59.00			<0.001
68	68-ELK	2/28/2007 [FOH]	TCLP Solid	Recycling Factory	Broken glass from panel box	None given	None given			0.05			<0.001
69	69-ELK	2/28/2007 [FOH]	LP - Aqueo	Recycling Factory	Mop rinseate	None given	Mop water from mopping gb area (1st bucket)			0.12			<0.001
70	70-ELK	2/28/2007 [FOH]	W	Warehouse (Old)	Composite of dust from rafters	None given		18			34		
71	NIOSH 1	**3/2/2007** [NIOSH]	TCLP	Recycling Factory	"Monochrome Waste"		Dust from Gaylord box labeled "Monochrome waste"			1.40			0.02
72	NIOSH 2	3/2/2007 [NIOSH]	TCLP	Recycling Factory	"Mixed Waste"		Dust from Gaylord box labeled "Mixed waste"			110.00			<0.001

Appendix 1
Elkton FCI Wipe/Bulk/TCLP Data Table

Row	Sample #	Date & Who Collected	Sample Type W=Wipe B=Bulk	Building Name	Surface/Item	Elevation (feet)	Description	Lead ug/ft2	Lead mg/kg	Lead mg/l (extrac)	Cadmium ug/ft2	Cadmium mg/kg	Cadmium mg/l (extrac)
73	NIOSH 3	3/1/2007 [NIOSH]	TCLP	Recycling Factory	"ECXHx1"		Wash water from mop bucket after cleaning floor of glass breaking area.			0.04			<0.001
74	NIOSH 4	3/2/2007 [NIOSH]	TCLP	Recycling Factory	"ECXFx1"		Wash water from mop bucket after cleaning floor of glass breaking area during filter changeout.			0.07			<0.001
75	ECMFB01	3/2/2007 [NIOSH]	B	Recycling Factory	Bulk dust sample collected from floor of GBO	0'	Collected during filter change operation		14000			240	
76	ECMFB02	3/2/2007 [NIOSH]	B	Recycling Factory	Bulk dust sample collected from floor of GBO	0'	Collected during filter change operation		14000			240	
77	ECMFB03	3/2/2007 [NIOSH]	B	Recycling Factory	Bulk dust sample collected from floor of GBO	0'	Collected during filter change operation		9100			350	
78	ECMTW1	2/28/2007 [NIOSH]	W	Recycling Factory	On steel work bench	~0-5'	Copper stripping operation	362			25		
79	ECMTW2	2/28/2007 [NIOSH]	W	Recycling Factory	On work bench, smooth rubber, far end	~0-5'		2970			13		
80	ECMTW3	2/28/2007 [NIOSH]	W	Recycling Factory	On work bench, cardboard cover, far end	~0-5'		149			2		
81	ECMTW4	2/28/2007 [NIOSH]	W	Recycling Factory	On work bench, rough rubber, near end	~0-5'		660			56		
82	ECMTW5	2/28/2007 [NIOSH]	W	Recycling Factory	On work bench, smooth rubber near end	~0-5'		669			33		
83	ECMTW6	2/28/2007 [NIOSH]	W	Recycling Factory	On gray desk top in weigh station	~0-5'		24			2		
84	ECMTW7	3/1/2007 [NIOSH]	W	Recycling Factory	Charger bench in change room	~0-5'		1210			70		
85	ECMTW8	3/1/2007 [NIOSH]	W	Recycling Factory	Outside of locker door in change room	~0-5'		4			<0.7		
86	ECMTW9	3/1/2007 [NIOSH]	W	Recycling Factory	Back of aluminum bench inchange room	~0-5'		11			1		
87	ECMTW10	3/1/2007 [NIOSH]	W	Recycling Factory	Front of aluminum bench in change room	~0-5'		1390			9		
88	ECMTW11	3/1/2007 [NIOSH]	W	Recycling Factory	Right side of I-beam in breaking room	~0-5'		576			353		
89	ECMTW12	3/1/2007 [NIOSH]	W	Recycling Factory	Back of inlet jet at top front of hood, right side, breaking room	~0-5'		325			44		
90	ECMTW13	3/1/2007 [NIOSH]	W	Recycling Factory	Floor in breaking room adjacent to change room	~0-5'		10200			30		
91	ECMTW14	3/1/2007 [NIOSH]	W	Recycling Factory	Floor, middle of entry room to glass breaking	~0-5'		2140			11		
92	ELMTF-W1	2/28/2007 [NIOSH]	W	FSL	Table 1 north	~0-5'	End of shift	21			4		
93	ELMTF-W2	2/28/2007 [NIOSH]	W	FSL	Table 1 central	~0-5'	End of shift	77			8		
94	ELMTF-W3	2/28/2007 [NIOSH]	W	FSL	Table 3 south	~0-5'	End of shift	36			13		
95	ELMTF-W4	2/28/2007 [NIOSH]	W	FSL	Bailer 1	~0-5'		121			17		
96	ELMTF-W5	2/28/2007 [NIOSH]	W	FSL	Bailer 2	~0-5'		102			5		
97	ELMWF-W11	3/1/2007 [NIOSH]	W	FSL	Bailer (metal)	~0-5'		57			10		
98	ELMWF-W12	3/1/2007 [NIOSH]	W	FSL	Bailer (plastic)	~0-5'		72			4		
99	ELMWF-W13	3/1/2007 [NIOSH]	W	FSL	Table 1, north	~0-5'		186			8		
100	ELMWF-W14	3/1/2007 [NIOSH]	W	FSL	Table 1, south	~0-5'		177			4		
101	ELMWF-W15	3/1/2007 [NIOSH]	W	FSL	Table 3, central	~0-5'		86			167		

Guidance for Interpretating Lead Wipe Data
1. **40 ug/ft2** (HUD/EPA for floors)
2. **4000 ug/ft2** (Factor of 100 for above)
3. **200 ug/ft2** (Letter - OSHA Directive) for workplace surfaces
4. **1000 ug/ft2** (Lange study for non-lead free building's)
5. **1100 ug/ft2** (Lange study for lead free building's), and
6. **For general consideration** - Any extreme wipe and/or bulk results found in a facility would be compared to background measurements, that is, assuming the other data is low in comparison we might consider it as background and remediate to those levels.

Guidance for Interpretating extractable Lead and Cadmium Data (per EPA RCRA Toxic Characteristic Leaching Procedure (TCLP))
1) EPA TCLP limit for **Lead = 5 mg/l**
2) EPA TCLP limit for **Cadmium = 1 mg/l**

APPENDIX 2

Appendix 2
Elkton Filter Data

	SampleID	Building	Date	Area / Personal	Sample Description	Cd	Pb	TOTAL METALS
						mg/M3	mg/M3	mg/M3
1	ECMTFT1	Recycling Factory	2/26/2007	P	Worker stripping copper	<0.0006	<0.0004	0.031
2	ECMTFT2	Recycling Factory	2/26/2007	P	Worker stripping copper	<0.00008	*0.00061*	0.043
3	ECMTFT3	Recycling Factory	2/26/2007	P	Monitor tear-down between 4th & 5th work station from back	<0.00006	*0.00076*	0.047
4	ECMTFT4	Recycling Factory	2/26/2007	P	Material disassembly, front 1/2	<0.001	<0.008	0.293
5	ECMTFT5	Recycling Factory	2/26/2007	P	Orderly	<0.00008	*0.0013*	0.080
6	ECMTFT6	Recycling Factory	2/26/2007	P	Material disassembly, 3rd table from back	<0.00009	*0.00075*	0.052
7	ECMTFT7	Recycling Factory	2/26/2007	P	Material disassembly, Table 7 from back	*0.00009*	*0.0018*	0.096
8	ECMTFT8	Recycling Factory	2/26/2007	P	Material disassembly, Table 6 from front	<0.0001	*0.0015*	0.089
9	ECMTFT11	Recycling Factory	2/26/2007	P	Coordinator	0.00018	0.0027	0.041
10	ECMTFT12	Recycling Factory	2/26/2007	P	Glass breaking	*0.00005*	0.0010	0.016
11	ECMTFT13	Recycling Factory	2/26/2007	P	Intake	<0.00002	<0.0001	0.008
12	ECMWFT1	Recycling Factory	2/27/2007	P	Glass breaker	*0.00022*	0.00947	0.129
13	ECMWFT2	Recycling Factory	2/27/2007	P	Glass breaker	0.00058	0.0089	0.198
14	ECMWFT3	Recycling Factory	2/27/2007	P	Glass breaking, feeder	0.00032	0.0075	0.142
15	ECMWFT4	Recycling Factory	2/27/2007	P	Glass breaking, coordinator	0.00082	0.018	0.330
16	ECMWFT5	Recycling Factory	2/27/2007	P	Monitor disassembly, 4th bench from back	*0.00015*	*0.00110*	0.072
17	ECMWFT6	Recycling Factory	2/27/2007	A	Monitor disassembly, 8th bench from back	*0.00009*	*0.00079*	0.048
18	ECMWFT7	Recycling Factory	2/27/2007	P	Intake area, forklift driver	*0.00006*	*0.00050*	0.050
19	ECMWFT8	Recycling Factory	2/27/2007	A	Intake area, near weigh station	*0.00007*	*0.00067*	0.043
20	ECMWFT9	Recycling Factory	2/27/2007	A	Copper stripping area	<0.00006	0.00043	0.031
21	ECMWFT10	Recycling Factory	2/27/2007	P	Worker stripping copper	<0.00008	<0.0006	0.039
22	ECMWFT11	Recycling Factory	2/27/2007	P	Monitor disassembly, 8th bench from back	*0.00011*	*0.0012*	0.070
23	ECMWFT12	Recycling Factory	2/27/2007	P	Monitor disassembly, 2nd bench from back	*0.00015*	*0.0011*	0.073
24	ECMWFT13	Recycling Factory	2/27/2007	P	Monitor disassembly, 4th bench from back	0.00030	*0.0023*	0.167
25	ECMWFT14	Recycling Factory	2/27/2007	P	Monitor disassembly, material handler	*0.00009*	*0.0012*	0.073
26	ELMTF-P1	FSL	2/26/2007	P	Disassembly worker	0.00011	*0.0007*	0.080
27	ELMTF-P2	FSL	2/26/2007	P	Disassembly worker	*0.0001*	<0.0004	0.101
28	ELMTF-P3	FSL	2/26/2007	P	Disassembly worker	*0.00004*	*0.0009*	0.101
29	ELMTF-T1	FSL	2/26/2007	A	Area sample north	0.00006	<0.0003	0.059
30	ELMWF-A11	FSL	2/27/2007	A	North FSL area	0.00019	<0.0005	0.093
31	ELMWF-A12	FSL	2/27/2007	A	Area - Central FSL	0.00024	*0.0007*	0.162
32	ELMWF-A13	FSL	2/27/2007	A	Area south FLL (suspect tampering)	0.00027	0.013	0.244
33	ELMWF-P11	FSL	2/27/2007	P	Bailer (metal)	0.00026	<0.0005	0.101

Appendix 2
Elkton Filter Data

	SampleID	Building	Date	Area / Personal	Sample Description	Cd	Pb	TOTAL METALS
						mg/M3	mg/M3	mg/M3
34	ELMWF-P12	FSL	2/27/2007	P	Bailer (plastic cardboard)	0.00009	*0.0005*	0.090
35	ELMWF-P13	FSL	2/27/2007	P	Worker on line 1 (north)	0.00018	*0.0007*	0.101
36	ELMWF-P14	FSL	2/27/2007	P	worker on central line	0.00050	*0.0009*	0.127
37	ELMWF-P15	FSL	2/27/2007	P	Orderly	0.00016	*0.0005*	0.100
38			2/27/2007					
39	EWMWF03	Warehouse	2/27/2007	P	Clean-up, sweeping	0.00035	<0.0003	0.061
40	EWMWF04	Warehouse	2/27/2007	P	De-gausing, grinding	0.00043	<0.0003	0.074
41	EWMWF05	Warehouse	2/27/2007	P	Work on floor	0.0003	0.0005	0.078
42	EWMWF06	Warehouse	2/27/2007	A	Area sample, middle of warehouse	0.0001	<0.0003	0.057
43								
44								
45	**The following 7 samples were taken in the GBO during change of filters; LEV not operating;**							
46	**area visually VERY dusty; workers use wet rag to wipe visor on PAPR to see**							
47	ECMFF01	Recycling Factory/ GBO	3/2/2007	A	BZ level, near HEPA filter	*0.0306*	0.0710	1.7
48	ECMFF02	Recycling Factory/ GBO	3/2/2007	A	BZ level in right GBO station	0.268	0.3641	7.1
49	ECMFF03A	Recycling Factory/ GBO	3/2/2007	P	Worker doing filter change	2.36	2.6847	23.5
50	ECMFF03B	Recycling Factory/ GBO	3/2/2007	P	Worker doing filter change	*0.6491*	0.7637	14.2
51	ECMFF04A	Recycling Factory/ GBO	3/2/2007	P	Worker doing filter change	*0.6853*	0.8939	11.2
52	ECMFF04B	Recycling Factory/ GBO	3/2/2007	P	Worker doing filter change	*0.0182*	0.0249	0.696
53	ECMFF07	Recycling Factory/ GBO	3/2/2007	A	On computer monitor at desk of clerk, about 20 ft from GBO	*0.0030*	0.0057	0.135
					Evaluation criteria (mg/m3)	**Cd**	**Pb**	
					REL	na	0.05	
					PEL	0.005	0.05	
					TLV	0.01	0.05	

ATTACHMENT 3

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

National Institute for Occupational Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998

July 16, 2008
HETA 2008-0055

[redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
United States Department of Justice, Suite 13100
Washington D.C. 20530

Dear [redacted]

On November 27, 2007, the National Institute for Occupational Safety and Health (NIOSH) received your request for technical assistance in your health and safety investigation of the Federal Prison Industries (UNICOR) electronics recycling program at Federal Bureau of Prisons (BOP) institutions in Elkton, Ohio; Texarkana, Texas; and Atwater, California. You asked us to assist the United States Department of Justice, Office of the Inspector General (USDOJ, OIG) in assessing the existing medical surveillance program for inmates and staff exposed to lead and cadmium during electronics recycling, and to make recommendations for future surveillance. In addition, you asked us to assess past exposures to lead and cadmium, and to investigate the potential for take home exposure. This interim letter summarizes our findings and provides recommendations to improve the safety and health of the inmates and staff at the Federal Correctional Institution (FCI) in Elkton, Ohio. These findings will be included in a final report that will contain findings from the evaluations at all three institutions identified in your request.

Electronics recycling at FCI Elkton appears to have been performed from 1997 until May 2003 without adequate engineering controls, respiratory protection, medical surveillance, or industrial hygiene monitoring. The current GBO is a significant improvement, but can be further enhanced to limit exposure to those performing glass breaking, as well as limiting the migration of lead and cadmium from the room into other areas.

Background

FCI Elkton opened in 1997, and began electronics recycling soon thereafter. The recycling of electronic components is done in three separate buildings: 1) the main factory located within the FCI main compound (which will be referred to as the factory in this report); 2) the Federal Satellite Low (FSL); and 3) the warehouse.

The glass breaking operation (GBO) is where cathode ray tubes (CRTs) from computer monitors or televisions are processed. Disassembly and glass breaking occurred at the factory from 1997 until early 2003 and the warehouse until about 2003, although staff at Elkton were unsure when glass breaking ended at the warehouse. Based upon our review of documents and interviews with staff and inmates conducted by DOJ and by us, it appears that there was no respiratory protection used or any type of engineering control in place to minimize exposures during the GBO until about 2001. At this time a "sawdust collection system" was installed at the factory, but not in the warehouse. It was also reported that some inmates began to use respiratory protection at this time. The type of respiratory protection is unknown. In April of 2003, construction of a glass breaking room was completed in the factory.

The glass breaking room is divided into four areas by vinyl strip curtains hanging from the ceiling: an entry area, the GBO workstations, the ventilation discharge area, and the "clean area" where inmates don and doff coveralls and other personal protective equipment (PPE). There is a walk-off mat immediately outside the entrance to the room to reduce dust carryout on shoes. A local exhaust ventilation (LEV) system adapted from a spray painting operation is installed in the room. Two inmate glass breakers, who stand facing each other at the ends of a rectangular grated work surface (table), are oriented at 90 degrees to the LEV airflow entering the prefilter. Each workstation has two small rectangular hoods and fans mounted behind and just below the work surface that are intended to capture airborne dust above the Gaylord boxes containing broken CRT glass. The fans/hoods are not ducted, but discharge into the work area approximately 2 ½ to 3 feet from the face of the retrofitted spray painting LEV system. The discharge is directed toward the face of the LEV system.

An inmate receives large open-top wooden and cardboard boxes with CRTs for the GBO, and stages the boxes outside the glass breaking room. Periodically, he uses a manual pallet jack to roll the boxes through the strip curtain into the area where the operation actually occurs, and to remove Gaylord boxes of broken glass from the room.

Inmates who perform the GBO ("glass breakers") enter the clean area where they don cloth coveralls, gloves, and a hooded powered air purifying respirator (PAPR), and then enter the glass breaking area. CRTs are placed on the grate where they are manually shattered with hammers. The glass breakers reach through a strip curtain at opposite ends of the grate to break funnel glass at one work station, and panel glass at the other. Broken glass falls into Gaylord boxes positioned below the grate. When inmates finish breaking glass, they return to the clean area in their coveralls and PAPR, use a high-efficiency particulate air (HEPA) filtered vacuum on their coveralls before removing them, then remove their PPE and leave the area. Staff enter the room only when there is no glass breaking going on to put away tools and search the area, otherwise they observe the inmates in the glass breaking room through the window or vinyl curtains.

While housekeeping is a routine component of all production processes, a weekly extensive cleaning is conducted in the glass breaking area. During that operation no production takes place and all workers in this area remove settled dust by vacuuming and wet mopping. All surfaces, including walls, equipment, and floors are cleaned. The blanket pre-filter on the LEV system is vacuumed using the HEPA vacuum cleaner.

Additionally, at approximately monthly intervals, the filters in the LEV system are removed and either cleaned or replaced. Prior to an evaluation by Federal Occupational Health (FOH) and the NIOSH Division of Applied Research Technology (DART) in March 2007, filters were removed and cleaned by vacuuming, shaking, or banging on the floor to shake dust out. This took most of the work shift and reportedly created a thick cloud of dust within the enclosed glass breaking room. This process was changed after the FOH-NIOSH/DART evaluation, and is reported to now be a wet process where the filters are wetted, removed, and bagged for disposal and new filters used as replacements.

A chip recovery program began at the FSL in October 2005, and ended in October 2006. Computer chips were removed from the mother board by holding the mother board over either a lead solder pot or a lead solder wave fountain. Although the solder temperature was supposed to be maintained just above the melting point (reportedly 400 to 600 degrees F), staff reported that the solder temperature was set subjectively (i.e., the temperature was not measured), which may have resulted in overheating, producing lead fume. There was no LEV for the first several months of this operation until what was described by staff as a "make-shift PVC system" was installed. This LEV system was replaced the following year with a LEV system designed by a consultant. Despite the use of LEV at chip recovery stations, staff described a visible haze in the FSL, and expressed concern about exposure to lead fume from this operation.

Assessment

In response to your request we reviewed the following documents:

- Results of medical surveillance provided by your office;
- Results of biologic monitoring provided by the medical clinic at FCI Elkton;
- Work instructions for the GBO and maintenance;
- Rosters for inmates working in recycling that provided location and dates of work, provided by the factory manager;
- Timelines for recycling operations provided by the American Federation of Government Employees (AFGE) Local 607;
- DOJ interviews with staff and inmates;
- Industrial hygiene sampling performed by consultants to UNICOR;
- Findings and recommendations of industrial hygiene assessments performed by FOH; and
- Draft report of the industrial hygiene assessment performed by the NIOSH/DART

We conducted a site visit on February 21-22, 2008 with you and a representative of FOH . During this site visit we held an opening conference with FCI and UNICOR management, AFGE representatives, UNICOR recycling staff, and the health service administrators and regional medical director. After the conference we toured the FCI, including the recycling factory, the warehouse, and the FSL. We conducted informational meetings for FCI and UNICOR staff, and inmates. We spoke to several UNICOR staff who approached us after the meetings about their medical issues and how they might relate to exposures at the FCI. We also met with the safety manager, factory manager, and health services administrator. We ended the site visit with a closing conference where we presented our initial impressions and recommendations.

We were told that BOP has had an industrial hygienist on staff for several years, and that UNICOR recently hired one. Neither of these individuals was present during our visit, and it is unclear what, if any role, they may have had in setting up or monitoring the electronic recycling program.

On March 25, 2008, we conducted an industrial hygiene survey to determine if lead- and cadmium-bearing dust had migrated from the glass breaking room to other FCI buildings and work areas and if there was evidence of "take-home" contamination in inmate housing and privately-owned staff vehicles. The purpose of this survey was to gather additional information to complement the extensive body of industrial hygiene data collected by FOH and NIOSH/DART.

The survey was preceded by a brief opening meeting with FCI and UNICOR management, AFGE representatives, and UNICOR recycling staff to explain the purpose of the site visit. Following the meeting, we were escorted to the factory and automated data processing (ADP), where we set up area air sampling pumps to assess airborne concentrations of lead, cadmium, and other elements (minerals and metals). Air samples were collected, digested, and analyzed according to NIOSH Method 7303 [NIOSH 2003a] with modifications for digestion.

Wipe samples were collected from undisturbed dusty surfaces in ADP, as well as at air diffusers in ADP, inside air handling units serving the laundry, visiting room, education, chapel, ADP offices, and from the floor mat at the entrance to the glass breaking room. Wipe samples were collected from the floor in three inmate cubicles where inmates place their boots, and from combination locks on lockers in the cubicles. Wipe samples were collected from personal vehicles used by UNICOR staff. Flat surfaces (e.g., ADP work stations) were sampled by wiping a 100 square centimeter (cm^2) area (10 cm^2 x 10 cm^2) according to the sampling procedure outlined in NIOSH Method 9102 [NIOSH 2003b]. Surface area was not considered when collecting wipe samples from non-flat surfaces such as padlocks and vehicle steering wheels. Hand wipe samples were collected according to the dermal sampling procedure outlined in NIOSH Method 9105 [NIOSH 2003c] Hand wipe samples were collected after workers had washed their hands at the end of the workday. All wipe samples were collected using Ghost Wipes, which were digested and analyzed for elements according to NIOSH Method 9102 [NIOSH 2003b] with modifications for digestion. Bulk samples of material were collected from beneath the stone roof ballast on the factory roof at the exhaust fan of the sawdust collection system that was in use from 2001 until May 2003. Bulk samples were digested and analyzed for elements according to NIOSH Method 7303 [NIOSH 2003a] with modifications for digestion.

Results and Discussion[1]

Medical surveillance

Inmates

Medical surveillance began in March 2003, immediately prior to the installation of the glass breaking room, for inmates in glass breaking and disassembly, and staff. It is performed annually and consists of limited biological monitoring but no physical examinations. Biological monitoring consists of blood lead levels (BLL), blood cadmium (CdB), urine cadmium (CdU), and urine beta-2-microglobulin (B-2-M), although not all inmates involved in GBO and disassembly received all of these tests. In addition, some inmates had urine lead, blood or urine arsenic or mercury, and serum B-2-M, none of which seem to have been based upon work exposures or indicated by work history. Paper copies of test results are maintained in both the inmate's personal medical record and with UNICOR management; however, the factory manager has been unable to locate any medical surveillance results at this time. Each inmate's medical records are transferred with them; no medical records are retained at Elkton after an inmate is either transferred or released. Inmates are only informed of the results of their biological monitoring if the results are abnormal. Although start dates were not available to us for all inmates working in the GBO, it does not appear that any inmate had biological monitoring performed preplacement. Because smoking can increase cadmium and lead burdens in the body, it is important to note that smoking has been banned throughout the FCI for inmates since 2004, although staff may smoke in designated areas. The results of the available inmate biological monitoring are summarized below by area. Because measurements on individual inmates and staff were sporadic and the number tested small, no group analyses were performed.

Glass Breaking Operation

We received biological monitoring results for 26 inmates who performed glass breaking. Each inmate was tested 1 to 5 times, for a total of 54 rounds of testing. Table 1 shows inmate BLLs by year collected. The laboratory's limit of detection (LOD) for blood lead was 1.0 microgram per deciliter of whole blood (µg/dL). In general, BLLs declined over time. Five of the seven tests done in early 2003 were done in March or April and may reflect exposures to lead prior to installation of the glass breaking room, but do not reflect exposures prior to the installation of the sawdust ventilation system in 2001 because the half-life of lead in blood is too short.

There were 50 CdB tests done on inmates from 2003-2007. The laboratory's LOD for CdB was 0.5 microgram per liter (µg/L). Twenty-seven were below the LOD; the remainder ranged from 0.5-1.2 µg/L. The earliest CdB were done in June 2003. Six inmates were tested in June 2003, and three were below the LOD; the remainder ranged from 0.5-1.1 µg/L. These six CdB may

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[1] See *Occupational exposure limits and health effects* in Appendix .

reflect exposures to cadmium prior to installation of the glass breaking room, but do not reflect exposures prior to the installation of the sawdust ventilation system in 2001 because the half-life of cadmium in blood is too short.

There were 28 CdU measurements. More than one laboratory was used for this analysis. At the lab most commonly used the LOD was 1 µg/L and 23 measurements were below this LOD. Other labs had lower LODs. If the CdU was above the LOD, then it was adjusted to the urinary concentration of creatinine to control for the variability in urine dilution. The five that were above the LOD ranged from 0.5 micrograms per gram of creatinine (µg/g/Cr) to 1 µg/g/Cr. These CdU measurements do integrate exposure over time because the half-life of cadmium in the urine is years to decades. However, only one of these inmates worked in GBO prior to May 2001; his CdU was less than 1 µg/L. Six inmates had urinary B-2-M measured; these ranged from less than 10 to 54 µg/g/Cr.

Glass Breaking Room Maintenance

One inmate who performed cleaning and filter change-outs in the GBO was monitored for lead and cadmium exposure from April 2003 until 2007, prior to the change in the filter change-out process. His annual BLLs ranged from 10-4 µg/dL, with a progressive decline over time. His CdBs ranged from 0.5 to 0.8 µg/L, and his CdUs were less than the LOD of 1 µg/L. Another inmate who performs maintenance in the room was monitored in 2007 and 2008. His BLL was 5 in 2007, and was not done in 2008. CdB was 0.6 µg/L in 2007, and less than the LOD of 0.5 µg/L in 2008. CdUs were less than 1 µg/L.

Chip Recovery

We reviewed biological monitoring for 14 inmates who worked in the chip recovery area; all were tested on February 16, 2007, 4 months after the operation ceased. BLLs ranged from 1-5 µg/dL. CdB was below the LOD for four inmates, and the remainder ranged from 0.5-1.1 µg/dL. All but one CdU were below the LOD, and the remaining one was 0.6 µg/g/Cr. No inmates had urine B-2-M measured.

Factory (not GBO)

We reviewed the results of biological monitoring done in April 2007 for 14 inmates who worked in the factory, but did not perform glass breaking. Two had BLLs less than the LOD, and the others ranged from 1-3 µg/dL. A BLL of 8 µg/dL was found in one inmate monitored in 2003. Seven had CdBs below the LOD, and the remainder ranged from 0.5-1.0 µg/L. Twelve had CdU below the LOD of 1 µg/L, and the other two were 0.2 and 0.6 µg/g/Cr. None had urine B-2-M performed.

Warehouse

Fourteen inmates who worked in the warehouse, but did not perform glass breaking, had biological monitoring done in February 2007, almost 4 years after the GBO ceased in the warehouse. BLLs ranged from1-5 µg/dL. Seven had CdBs below the LOD, and the remainder ranged from 0.5-0.8 µg/L. All 14 had CdU below the LOD, and none had urine B-2-M performed.

Clerks

We reviewed biological monitoring results for 2 clerks, one from the factory and one from the FSL. One had testing annually from 2003-2005, the other was tested in 2007. There were three BLLs ranging from 1-2 µg/dL. Three of four CdBs were less than the LOD of 0.5 µg/L, and one was 0.6 µg/L. Two CdUs were less than the LOD of 1 µg/L, and one B-2-M was 40 µg/g/Cr.

Results of other tests

We reviewed biological testing results for which we were unable to determine the reason the testing was done on inmates. Two inmates had serum B-2-M above normal. This test is often used to determine prognosis in hematologic malignancies and for dialysis patients. It is difficult to interpret in this setting because no medical history is available. In addition, three inmates had elevated urinary total arsenic, and one also had an elevated blood arsenic. The arsenic results were speciated and found to be organic arsenic, the type of arsenic which is found in seafood and is not considered toxic. All other tests (urine lead, blood or urine arsenic and mercury) were within normal limits.

UNICOR Staff

UNICOR staff see their private physicians for medical surveillance so their exams are not standardized. We reviewed available medical records and found that most staff members had records for CdB, CdU, urine B-2-M, and zinc protoporphyrin (ZPP). Some had physical exams documented, some had urinalysis, complete blood count, pulmonary function tests, or chest x-rays.

We reviewed the biological monitoring and medical exams provided for 10 UNICOR staff, including nine of 11 recycling technicians who had worked in electronics recycling. Each was tested between 1 and 5 times between 2003 and 2007. Their testing was done by a number of different laboratories, and thus, the LOD and range of normal for the tests varied. For example the LOD for BLL was either 1 or 3 µg/dL. Eighteen BLLs were below the LOD, and seven ranged from 1-2.5 µg/dL. One employee had a BLL of 10 µg/dL, however his BLLs the year before and after were below the LOD. His urine B-2-M was elevated at 445 µg/g/Cr, but he had normal B-2-M levels the year before and after this test result. Standard medical practice usually dictates that a physician repeat a lone elevated test result to determine whether the result is spurious (such as from lab error) or actually elevated. The tests were not repeated at the time, so laboratory error cannot be ruled out. Twenty-five CdB were done; 12 were below an LOD of 0.5

µg/L, 2 were reported as zero, and the remainder ranged from 0.2-2.1 µg/L. Twenty-one CdU were done; 13 were below the LOD of 1 µg/L and the rest ranged from 0.1-0.7 µg/L. Eighteen urine B-2-M were done between 2003 and 2007, and all were normal with the exception noted above. Twenty-two ZPPs were done between 2003 and 2007, and all were normal.

Interviews with Staff

Five staff asked to speak with us after NIOSH's public meeting with concerned Elkton staff on February 21, two of the five worked in recycling. One of the recycling staff reported having been diagnosed with iron deficiency anemia in the past year. This condition is not related to recycling work or other occupational exposures at FCI Elkton. The other reported an increase in the blood zinc level over the past year, however, when we reviewed this employee's biological monitoring results, we found that it was the ZPP that had risen, and that the levels were still well within normal limits. ZPP is not related to blood zinc. Of note, both staff noted these reported conditions in the recent past, well after construction of the glass breaking room. An employee from an adjacent area reported bipolar disorder, and one from another building reported transverse myelitis, neither of which can be related to this workplace. Finally, another employee from the adjacent area reported seeing a private physician and being tested for lead and cadmium, and that both were below the LOD.

Industrial Hygiene

Records Review

The OIG provided consultant reports, industrial hygiene sampling results, and laboratory analysis results for 13 surveys conducted at FCI Elkton between summer 2001 and November 2007. Twelve surveys were conducted by consultants to UNICOR, and one was conducted by FOH in conjunction with a NIOSH/DART evaluation. Five reports contained sampling data indicating worker exposures to cadmium at levels exceeding the OSHA action level, and two reports documented exposures above the OSHA permissible exposure limit (PEL) for cadmium. One of the reports documented lead exposure above the PEL during a now-discontinued filter change procedure.

No industrial hygiene reports, sampling data, or laboratory analysis reports were provided for the period from 1998 until August 2001. According to information provided by the OIG, it appears that there are no industrial hygiene reports for this period; thus, we have no information or data to help us assess the potential for early exposures to lead, cadmium, and possible other agents when glass breaking occurred in other locations without local exhaust ventilation. Assuming that we received reports for all industrial hygiene evaluations and/or laboratory analyses conducted from 2001 through 2007, we noted that only two evaluations were conducted prior to 2004. Two surveys were performed in 2004; no industrial hygiene evaluations were conducted in 2005, other than an OSHA inspection which resulted in a serious citation for exposure above the cadmium PEL and inadequate engineering/work practice controls.

Our review of the consultant reports found that two consultants hired by UNICOR measured worker exposures exceeding the OSHA action level for cadmium, but did not discuss the findings or the implications of exceeding the action level. This omission occurred during one of two surveys conducted in 2004, and two of five surveys in 2006. The quality of the reports, i.e., observations, discussion, recommendations, was greatly improved in 2007 when the most recent consultant and FOH independently evaluated the glass breaking process, ventilation, and work practices.

2001

A laboratory report of sample analysis, dated August 20, 2001, was provided to us. This analytical report contains no information regarding the type of sample (personal sample versus area sample), sample volume, location, the work being performed, PPE, or exposure control methods. Lead was measured in one of the two air samples that were analyzed for lead; cadmium was not detected. Wipe samples indicated quantifiable amounts of lead and cadmium on surfaces.

June 2003

A laboratory report of sample analysis, dated June 3, 2003, was provided to us. Although this analytical report contains no information regarding sample type, work processes, PPE, or exposure control methods, the report does contain a record of sample volume along with results for cadmium and lead. Based on an average sample volume of 744 liters, and assuming that sampling was conducted at the usual rate of two liters per minute, the nine samples from late May 2003 provide an estimate of airborne concentrations throughout a 370 minute sampling period. The analytical results indicate that the airborne lead concentrations were likely below the OSHA action level; however, airborne cadmium concentrations may have exceeded the OSHA PEL in five of the nine samples, and may have exceeded the action level in one other sample (range: 3-37 micrograms per cubic meter of air [$\mu g/m^3$]). It is important to note that, at best, these samples only provide an estimate of airborne concentrations at unknown sampling locations under unspecified conditions. If sampling flow rates were higher or lower than the typical rate of two liters per minute, the concentration estimates could be higher or lower than those noted here.

2004

Consultant reports were provided for two evaluations conducted during June 2004. On June 2, personal breathing zone (PBZ) samples were collected for three glass breakers and one feeder; four area samples were collected on June 2. All results were below the action level for lead and cadmium. Wipe samples determined the presence of lead and cadmium on surfaces in the work area. Sampling was repeated on June 18, and the consultant reported that samples collected on this date revealed "no overexposure;" however, results in the sample summary sheet show that a PBZ sample collected on one of three glass breakers indicated exposure to airborne cadmium at the OSHA PEL of 5 $\mu g/m^3$. Although this sample did not prove statistical exceedance of the PEL, the report should have contained a recommendation for further evaluation, and guidance regarding OSHA requirements for periodic air and medical monitoring where workers are exposed above the action level. In addition, one of four area samples indicated an airborne cadmium concentration of 5 $\mu g/m^3$. Wipe samples collected on June 18 indicated that surface contamination had been reduced in locations previously sampled on June 2. Wipe sampling was repeated on July 9; results were similar to those for the June 18 wipe samples. The consultant measured air velocity at three locations on June 18 to assess the direction and velocity of air into and through the GBO. The consultant's report did not interpret these measurements with respect to the effectiveness of the LEV system.

2005

No consultant reports were provided for 2005. On September 8, 2005, OSHA conducted air monitoring for lead and cadmium that determined one of two glass breakers was exposed to cadmium above the PEL, and lead above the action level. UNICOR was cited for the overexposure and for inadequate engineering and work practice controls.

2006

A different environmental consulting firm was hired to conduct air sampling during glass breaking during site visits in January, February, June, July and September 2006.

PBZ sampling results for two glass breakers and two workers outside the booth did not exceed the action level for cadmium or lead on January 17. Several air velocity measurements were obtained "to determine if sufficient general ventilation is provided within the glass breaking area." No authoritative industrial hygiene references or guidelines were used to support the consultant's conclusion that adequate ventilation was provided.

Sampling and air velocity measurements were repeated on February 17. Air sampling results for this visit indicate that cadmium exposures exceeded the action level for one handler and one glass breaker. As in one of the 2004 consultant reports, this report did not note that the action level had been exceeded.

The consultant returned on June 26 and 27 to conduct air sampling and assess ventilation in the GBO and chip recovery. Sample results indicate that a glass breaker was exposed to cadmium above the PEL, and a handler was exposed above the action level. As in earlier consultant reports, the report for June 26 did not mention or discuss the significance of exceeding the action level, nor did it provide guidance regarding medical surveillance, a written compliance program, and other OSHA requirements triggered when air sampling indicates worker exposure above the PEL. Air sampling conducted on June 27 at chip recovery in the FSL did not detect lead or cadmium above the analytical LODs. The consultant also collected air samples for ethylene glycol and n-propanol at chip recovery. It is not clear why these chemicals were selected for evaluation.

The OIG provided two laboratory reports of sample analyses (both reports are dated July 10, 2006) which appear to be for wipe samples collected in GBO and chip recovery during the June evaluation. We did not find these laboratory results in the industrial hygiene reports that were provided to us. One report indicates small quantities of cadmium in five samples collected from surfaces in chip recovery (less than 4.8 μg/sample). The average quantity of lead in the five wipe samples was much greater: 1600 μg/sample (range 190 to 6800 μg/sample). Small quantities of cadmium and lead were measured in one sample collected from an inmate's hands. The other laboratory report indicates that the average quantities of cadmium and lead in six surface wipe samples collected in the GBO was 35 μg/sample and 290 μg/sample respectively. The average amount of cadmium and lead in three hand wipe samples was 40 μg/sample for both elements.

A consultant report for a July 7 survey indicates concentrations of cadmium and lead to be well below occupational exposure limits in five PBZ and five area air samples. A second report for this survey notes that cadmium and lead were measured in five surface wipe samples and three hand wipe samples. This report noted a need for more thorough cleaning of surfaces and hands.

On September 6, the consultant collected five PBZ and five area samples. All results were below OELs. Hand wipe samples from three individuals (one staff, two inmates) measured 5.8, 340, and 870 µg-cadmium on their hands. The corresponding quantities of lead in the hand wipes was 26, 250, and 710 µg-lead/sample. The average quantity of cadmium and lead in five surface wipe samples was 240 µg (range 10 to 640 µg), and 19,000 µg (range 57 to 85,000 µg) respectively.

<u>2007</u>
On February 27 and 28, FOH collected air, wipe, bulk dust, and waste samples in the factory, warehouse, and FSL where electronics recycling had been conducted in the past, or was currently being conducted. Air sampling during two days of glass breaking indicated that worker exposures were below applicable occupational exposure limits (OELs). The report noted that the LEV system was adequately controlling exposure at the GBO during routine operations; however, air sampling during LEV filter change-out, a maintenance function, found airborne cadmium and lead concentrations well above the PELs. This overexposure, which exceeded the respirator protection factor, resulted from poor change-out procedures that included banging the dirty filters together to knock the dust off. The results of personal air monitoring in the warehouse and FSL were well below OELs. (Note: chip removal in the FSL had been discontinued in 2006.) Wipe samples in the factory, warehouse, and FSL found significant lead and cadmium contamination on various surfaces. This report concluded that the surface contamination does not pose an "imminent inhalation threat," but could "be responded to in a prompt but well-coordinated manner." FOH noted that migration of lead- and cadmium-bearing dust from the current GBO could be reduced by installing a three-stage decontamination room.

On September 7, the third industrial hygiene consultant, for which we received reports, evaluated the GBO with PBZ sampling, surface wipe sampling, and assessment of the LEV system. Airborne cadmium was above the action level. Ventilation measurements and observations indicated apparent leakage in the LEV system. This report contained numerous recommendations regarding ventilation system repair, testing, and maintenance, as well as recommendations for improving work practices and use of PPE.

On November 6, the industrial hygiene consultant conducted a subsequent evaluation of the GBO. Although all air sampling results were below the action levels for lead and cadmium, the results for one glass breaker indicated that his exposure approached the action level for cadmium. Wipe samples found various concentrations of lead and cadmium on surfaces in the glass breaking area.

HHE Sampling, March 25, 2008

Wipe sample results are presented in Table 2. Wipe samples collected from three ceiling heating, ventilating and air-conditioning (HVAC) diffusers in ADP indicated concentrations of cadmium and lead ranging from 11-14 μg/100 cm^2 and 49-55 μg/100 cm^2 respectively. Lead and cadmium were found in a wipe sample of undisturbed dust on a ledge along the north wall of the ADP mezzanine, and in the mixed air plenum of air handler AH-3, which serves the factory tool room and ADP offices. These results indicate that undetermined concentrations of lead and cadmium migrated from the factory to ADP, possibly via the HVAC system. Given the low concentrations of airborne lead and cadmium determined by air sampling in 2007, it seems unlikely that significant migration of contaminants is occurring at this time. It is our opinion that the wipe sample results reflect much earlier workplace conditions, i.e., when glass breaking occurred in the middle of the factory with only a roof exhaust fan to remove airborne dust.

Wipe samples, collected in three air handlers serving the laundry, education, visiting room, and chapel found quantifiable concentrations of lead and cadmium. Concentrations inside these air handlers were much lower than those inside AH-3 in the ADP. The route whereby these contaminants migrated to these air handlers is not clear.

Two bulk samples of material beneath stone roof ballast on the factory roof at the exhaust fan of the sawdust collection system that was in use from 2001 until May 2003 contained 1000 and 1400 parts per million (ppm) lead (by weight), and 5000 and 7400 ppm cadmium (by weight). These samples provide evidence that glass breaking operations during the time the sawdust collection system was in use generated cadmium- and lead-bearing dust that was exhausted to the roof.

Cadmium and lead contamination was found on the return air damper of rooftop air handler AHU-5HV1, which serves the factory. Given the low contaminant concentrations indicated by air sampling conducted by FOH and the current industrial hygiene consultant, we believe contamination inside this unit primarily reflects conditions prior to construction of the present glass breaking room.

As shown in Table 2, quantifiable amounts of cadmium were present on the floor in three inmate cubicles where shoes are kept. Some lead was present in one cubicle. The presence of these metals on the floor indicates that some lead and cadmium is being tracked out of the glass breaking room. This finding is consistent with sample results showing lead on the soles of inmate and staff footwear (Table 2, samples W-27 and W-28).

Hand wipe samples following hand washing by inmate workers demonstrated lead contamination on hands ranging from approximately 1.5 to 130 μg/wipe. This demonstrates that handwashing needs to be improved.

Lead and cadmium contamination in two staff personal vehicles was generally below the limits of detection and/or quantitation; however, 3.3 μg-lead/100 cm^2 was present on the center of the steering wheel in one vehicle. This indicates a potential for take-home contamination, but the concentration is minimal.

Area air sampling results are shown in Table 3. One air sample indicated a quantifiable airborne concentration of lead and cadmium. This sample, which was collected within a few feet of the glass breaking operation (behind the strip curtain separating the GBO from the entry and change-out areas), was well-below applicable OELs. The area sample collected at the window in the GBO entry detected a trace concentration of lead and cadmium. The other six area air samples collected in the glass breaking room, factory, and ADP did not detect lead or cadmium.

Conclusions

Electronics recycling at FCI Elkton appears to have been performed from 1997 until May 2003 without adequate engineering controls, respiratory protection, medical surveillance, or industrial hygiene monitoring. Because of the lack of both biological monitoring and industrial hygiene data, we cannot determine the extent of exposure to lead and cadmium that occurred during that time frame, but descriptions of work tasks from staff and inmates indicate that exposures during that time frame were likely higher than current exposures. The current GBO is a significant improvement, but can be further enhanced to limit exposure to those performing glass breaking, as well as limiting the migration of lead and cadmium from the room into other areas. While some take-home contamination does occur, surface wipe sampling and biological monitoring suggest that take-home contamination does not pose a health threat at this time. Take-home contamination can be further reduced by changes to the GBO, work practices, and improved personal hygiene as recommended below.

We cannot determine the extent of exposure to lead that occurred in the chip recovery process because of the lack of data. Descriptions of work tasks from staff, and a BLL of 5 µg/dL in an inmate 4 months after the process ended indicate that exposure to lead during this process did occur. We found no evidence that actions were taken to prevent exposure to lead at the outset in the chip recovery process and found that no medical surveillance was performed until after the process ended.

Medical surveillance that has been carried out among inmates and staff has not complied with OSHA standards. No medical exams (including physical examinations) are done on inmates; staff receive inconsistent examinations and biological monitoring by their personal physicians; biological monitoring for lead is not done at established standard intervals; and results are not communicated to the inmates. Inappropriate biological monitoring tests have been done. Records of medical surveillance are not maintained by the employer for the appropriate length of time.

At this time, after careful review of existing records and current operations, we conclude that the only persons with current potential for exposure to either lead or cadmium over the action level are the inmates who perform glass breaking or the monthly filter change-out. We believe that medical surveillance can be discontinued for all other inmates and staff. Some former inmates and/or staff may require surveillance under the OSHA cadmium standard.

Wipe and bulk sample results indicated that lead- and cadmium-containing dust migrated out of the GBO in the past. Low levels of lead- and cadmium-containing dust on staff and inmate shoes and the floor mat outside the glass breaking room suggest that this is still occurring, although in small amounts. Contamination of inmate housing and staff vehicles is occurring, but is minimal;

we have no data regarding the extent of past contamination in these locations. Hand washing is less than optimal for some individuals, including both staff and inmates. There is legacy contamination of the factory, FSL, and warehouse, which is scheduled to be remediated. We concur with FOH that surface contamination does not present an imminent hazard at this time, and should be remediated in a "prompt but well-coordinated manner."

Recommendations

The following recommendations are provided to improve the safety and health of both the staff and inmates involved with electronics recycling at the Elkton FCI.

1. Continue to work with the current industrial hygiene consultant to increase the effectiveness of the LEV system. Improvements in the LEV system will not only reduce worker exposure to airborne contaminants, but will capture dust that would otherwise contribute to surface contamination, which could lead to an ingestion hazard (hand-to-mouth) or inhalation hazard if re-entrained. Conduct an industrial hygiene assessment to determine inmate exposure to lead and cadmium after the LEV is modified.

2. The change-out room should be reconfigured to ensure that GBO workers do not carry cadmium or lead out of the glass breaking room. Separate storage should be provided for non-work uniforms and GBO work apparel/PPE. All potentially-contaminated work clothing and PPE should remain in the "dirty" chamber of the change-out room; non-work clothing should never come in contact with work items. As a minimum requirement, workers should be required to wash hands and all potentially exposed skin after doffing PPE, before putting on uniforms when exiting the GBO. Work clothes and PPE should never be worn outside of the GBO to minimize migration of cadmium- and lead-contaminated dust to other parts of the institution. Laundry personnel should be made aware of the potential exposure to lead and cadmium from work clothes and take action to minimize exposure to themselves.

3. Ensure full compliance with all applicable OSHA standards, including the General Industry Lead standard [29 CFR 1910.1025], the Cadmium Standard [29 CFR 1910.1027], the Hazard Communication Standard [29 CFR 1910.1200], and the Respiratory Protection Standard [29 CFR 1910.134]. This includes record keeping requirements, communication requirements, compliance plans, and medical surveillance. In addition to the OSHA requirements, we recommend that the preplacement examination for cadmium exposure be identical to the periodic examinations so that baseline health status may be obtained prior to exposure.

4. Contract a board-certified, residency-trained occupational medicine physician who is familiar with OSHA regulations on exposures at the FCI to oversee the medical surveillance program. BOP may be able to find a local physician, or contract with Federal Occupational Health. This contractor should also oversee medical clearance for respirators.

5. Carefully evaluate the qualifications and expertise of any consultant who may be hired to assess occupational or environmental health and safety issues. Anyone can present him/herself as an "industrial hygienist," regardless of education, training, or expertise. One useful benchmark for vetting individuals who provide industrial hygiene services is the designation of Certified

Industrial Hygienist (CIH). Certification by the American Board of Industrial Hygiene (ABIH) ensures that prospective consultants have met ABIH standards for education, ongoing training, and experience, and have passed a rigorous ABIH certification examination. The UNICOR and/or BOP industrial hygienists can assist in the selection of your consultants.

6. Perform a detailed job hazard analysis prior to beginning any new operation or before making changes to existing operations. This will allow BOP to identify potential hazards prior to exposing staff or inmates, and to identify appropriate controls and PPE. Involve the BOP and/or UNICOR industrial hygienists in these job hazard analyses. If medical surveillance is needed then BOP should perform pre-placement evaluations of exposed staff and inmates.

7. Appoint a union safety and health representative. This individual should be a regular participant on the joint labor-management safety committee that meets quarterly. Since inmates do not have a mechanism for representation on this committee, ensure that they are informed of its proceedings and that they have a way to voice their concerns about and ideas for improving workplace safety and health.

This interim letter will be included in a final report that will include visits to two other BOP facilities. Please post a copy of this letter for 30 days at or near work areas of affected staff and inmates. Thank you for your cooperation with this evaluation. If you have any questions, please do not hesitate to contact us at 513-841-4382.

Sincerely yours,

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cc:
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Paul Laird, Assistant Director, UNICOR

Tables

Table 1. Blood lead levels of inmates doing glass breaking, by year

HETA 2008-0055, Federal Bureau of Prisons, FCI Elkton, Elkton, OH

Year	Mean BLL (µg/dL)	Median BLL (µg/dL)	Range (µg/dL)	Number sampled
2003	5.6	4.5	3-9	7
2004	3.7	3.0	2-7	7
2005	3.7	3.9	2-10	12
2006	2.3	2.0	1-5	13
2007	1.7	1.5	1-4	10

Table 2.
Wipe sampling results, March 25, 2008

HETA 2008-0055
Federal Bureau of Prisons
FCI Elkton, Elkton, OH

Sample ID	Location	Surface	Approx. Elevation (feet)	Description	Area Wiped	Cadmium		Lead	
					cm²	µg/wipe	µg/100 cm²	µg/wipe	µg/100 cm²
W-1	ADP	HVAC diffuser	~15	row ADP4 above workstation C116	200	27	14	110	55
W-2	ADP	desktop	2½	Workstation C116	100	nd	--	nd	--
W-3	ADP	HVAC diffuser	15	near center of room; Row ADP4 above workstation C025	200	21	11	97	49
W-4	ADP	desktop	2½	workstation C025	100	trace	--	nd	--
W-5	ADP	HVAC diffuser	15	southwest corner of ADP; Row ADP1 above workstation C007	200	28	14	110	55
W-6	ADP	desktop	2½	workstation C007	100	nd	--	nd	--

HETA 2008-0055
Federal Bureau of Prisons
FCI Elkton, Elkton, OH

Table 2. (Continued)
Wipe sampling results, March 25, 2008

Sample ID	Location	Surface	Approx. Elevation (feet)	Description	Area Wiped	Cadmium		Lead	
					cm²	µg/wipe	µg/100 cm²	µg/wipe	µg/100 cm²
W-7	Factory Mezzanine	C-beam	8	ledge along north wall	100	820	820	970	970
W-8	Factory Mezzanine	mixed air plenum, AH-3	n/a	serves offices along north wall from factory tool room to ADP	315	70	22	430	140
W-9	ADP Mezzanine	C-beam	8	ledge along north wall	100	53	53	55	55
W-10	Factory Roof	return air damper AHU-5HV1	n/a		not determined	1400		1200	
W-11	Mechanical Room - laundry	filter brace - return air 5-AH2	n/a	serves laundry	not determined	4.9		32	
W-12	Mechanical Room - laundry	Mixed air plenum 5-AH2	n/a	serves laundry	315	2.1	0.67	19	6.0
W-13	Mechanical Room	Outside air plenum 5-AH4	n/a	serves education	270	8.3	3.1	46	17
W-14	Mechanical Room	mixed air plenum 5-AH5	n/a	serves visiting room and chapel	100	2.7	2.7	16	16
W-15	C/D Unit D-A cube 51U	floor, inmate cubicle	0	where shoes are kept	100	0.14	0.14	nd	--
W-16	C/D Unit D-A cube 51U	combination lock on inmate locker	1½		not determined	13		nd	
W-17	C/D Unit D-A cube 29L	floor, inmate cubicle	0	where shoes are kept	100	0.19	0.19	nd	--
W-18	C/D Unit D-A cube 29L	combination lock on inmate locker	1½		not determined	0.19		nd	
W-19	C/D Unit D-B cube 005	floor, inmate cubicle	0	where shoes are kept	100	0.23	0.23	2.2	2.2
W-20	C/D Unit D-B cube 005	combination lock on inmate locker	1½		not determined	0.10		nd	
W-21	Factory	hands, inmate #1	n/a	hand wipe after washing hands at end of workday in glass breaking	not determined	28		130	
W-22	Factory	hands, inmate #2	n/a	hand wipe after washing hands at end of workday in glass breaking	not determined	7.2		41	
W-23	Factory	hands, inmate #3	n/a	hand wipe after washing hands at end of workday in glass breaking	not determined	0.23		trace	
W-24	Factory	hands, inmate #4	n/a	hand wipe after washing hands at end of workday in glass breaking	not determined	0.51		4.3	
W-25	Factory	hands, inmate #5	n/a	hand wipe after washing hands at end of workday in glass breaking	not determined	11		41	

Table 2. (Continued)
Wipe sampling results, March 25, 2008

Sample ID	Location	Surface	Approx. Elevation (feet)	Description	Area Wiped	Cadmium		Lead	
					cm^2	µg/wipe	µg/100 cm^2	µg/wipe	µg/100 cm^2
W-25	Factory (continued)	hands, inmate #5	n/a	hand wipe after washing hands at end of workday in glass breaking	not determined	11		41	
W-26		hands, inmate #6	n/a			2.2		3.1	
W-27		sole of right shoe, staff	n/a	worn in glass breaking	not determined	3.1		120	
W-28		sole of sneaker, inmate #4	n/a	sneaker not worn while working	not determined	4.3		200	
W-29		exterior, locker #2	6	locker door in glass breaking decon area	100	trace	--	nd	
W-30		bench seat	1½	glass breaking decon area	100	0.30	0.30	9.8	9.8
W-31		floor mat	0	entry to glass breaking room	100	3.9	3.9	490	490
W-32		floor mat	0		100	7.2	7.2	1000	1000
W-39	personal vehicle (Jeep)	steering wheel	n/a	center of steering wheel	100	trace	--	3.3	3.3
W-40		steering wheel	n/a		not determined	trace		trace	
W-41		driver's seat	n/a		100	trace	--	nd	--
W-42	personal vehicle (Mazda)	console-arm rest	n/a		100	0.14	0.14	trace	--
W-43		steering wheel	n/a		not determined	0.098		2.3	
W-44		carpet	n/a	left side at foot rest	100	nd	--	trace	--

Table 3. Area air sampling for lead and cadmium

HETA 2008-0055, Federal Bureau of Prisons, FCI Elkton, Elkton, OH

Location	Sampling Period (minutes)	Sample Volume (liters)	Cadmium Concentration ($\mu g/m^3$)	Lead Concentration ($\mu g/m^3$)
HEPA discharge area behind glass breaking	407	810	nd	nd
At window in glass breaking	408	816	trace	trace
Stanchion next to glass breaking	376	753	0.31	4.6
Change-out area near clock	406	808	nd	nd
Mezzanine rail above glass breaking	403	802	nd	nd
At vinyl strip curtain in glass breaking entry	387	774	nd	nd
ADP, east center	380	760	nd	nd
ADP, west center	381	762	nd	nd
NIOSH REL-TWA			Ca	50
OSHA PEL-TWA			5	50
ACGIH TLV			10	50

"nd" (not detected) indicates that the sample result is below the analytical limit of detection. The limits of detection for cadmium and lead are 0.02 ug/wipe and 0.6 ug/wipe, respectively.

"trace" indicates that the sample result is between the analytical limits of detection and quantitation. The limits of quantitation for cadmium and lead are 0.077 ug/wipe and 1.9 ug/wipe, respectively.

See the Appendix for a discussion of NIOSH recommended exposure limits (RELs), OSHA permissible exposure limits (PELs), and ACGIH Threshold Limit Values (TLVs).

"Ca" indicates that NIOSH regards cadmium as a potential occupational carcinogen and that exposures should be reduced to the lowest feasible concentration.

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Appendix

Occupational exposure limits and health effects

In evaluating the hazards posed by workplace exposures, NIOSH investigators use both mandatory (legally enforceable) and recommended occupational exposure limits (OELs) for chemical, physical, and biological agents as a guide for making recommendations. OELs have been developed by Federal agencies and safety and health organizations to prevent the occurrence of adverse health effects from workplace exposures. Generally, OELs suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. However, not all workers will be protected from adverse health effects even if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the exposure limit. Also, some substances can be absorbed by direct contact with the skin and mucous membranes in addition to being inhaled, which contributes to the individual's overall exposure.

Most OELs are expressed as a time-weighted average (TWA) exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday. Some chemical substances and physical agents have recommended short-term exposure limit (STEL) or ceiling values where health effects are caused by exposures over a short-period. Unless otherwise noted, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during a workday, and the ceiling limit is an exposure that should not be exceeded at any time.

In the U.S., OELs have been established by Federal agencies, professional organizations, state and local governments, and other entities. Some OELs are legally enforceable limits, while others are recommendations. The U.S. Department of Labor Occupational Safety and Health Administration's (OSHA) permissible exposure limits (PELs) (29 CFR[2] 1910 [general industry]; 29 CFR 1926 [construction industry]; and 29 CFR 1917 [maritime industry]) are legal limits enforceable in workplaces covered under the Occupational Safety and Health Act. NIOSH recommended exposure levels (RELs) are recommendations based on a critical review of the scientific and technical information available on a given hazard and the adequacy of methods to identify and control the hazard. NIOSH RELs can be found in the *NIOSH Pocket Guide to Chemical Hazards* [NIOSH 2005]. NIOSH also recommends different types of risk management practices (e.g., engineering controls, safe work practices, worker education/training, personal protective equipment, and exposure and medical monitoring) to minimize the risk of exposure and adverse health effects from these hazards. Other OELs that are commonly used and cited in the U.S. include the threshold limit values (TLVs) recommended by the American conference of Governmental Industrial Hygienists (ACGIH), a professional organization, and the Workplace

[2] *Code of Federal Regulations*. See CFR in references.

environmental exposure limits (WEELs) recommended by the American Industrial Hygiene Association, another professional organization. ACGIH TLVs are considered voluntary exposure guidelines for use by industrial hygienists and others trained in this discipline "to assist in the control of health hazards" [ACGIH 2007]. WEELs have been established for some chemicals "when no other legal or authoritative limits exist" [AIHA 2007].

Outside the U.S., OELs have been established by various agencies and organizations and include both legal and recommended limits. Since 2006, the Berufsgenossenschaftlichen Institut für Arbeitsschutz (German Institute for Occupational Safety and Health) has maintained a database of international OELs from European Union member states, Canada (Québec), Japan, Switzerland, and the U.S. [http://www.hvbg.de/e/bia/gestis/limit_values/index.html]. The database contains international limits for over 1250 hazardous substances and is updated annually.

Employers should understand that not all hazardous chemicals have specific OSHA PELs, and for some agents the legally enforceable and recommended limits may not reflect current health-based information. However, an employer is still required by OSHA to protect its employees from hazards even in the absence of a specific OSHA PEL. OSHA requires an employer to furnish employees a place of employment free from recognized hazards that cause or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970 (Public Law 91–596, sec. 5(a)(1))]. Thus, NIOSH investigators encourage employers to make use of other OELs when making risk assessment and risk management decisions to best protect the health of their employees. NIOSH investigators also encourage the use of the traditional hierarchy of controls approach to eliminate or minimize identified workplace hazards. This includes, in order of preference, the use of: (1) substitution or elimination of the hazardous agent, (2) engineering controls (e.g., local exhaust ventilation, process enclosure, dilution ventilation), (3) administrative controls (e.g., limiting time of exposure, employee training, work practice changes, medical surveillance), and (4) personal protective equipment (e.g., respiratory protection, gloves, eye protection, hearing protection). Control banding, a qualitative risk assessment and risk management tool, is a complementary approach to protecting worker health that focuses resources on exposure controls by describing how a risk needs to be managed [http://www.cdc.gov/niosh/topics/ctrlbanding/]. This approach can be applied in situations where OELs have not been established or can be used to supplement the OELs, when available.

Lead

Occupational exposure to lead occurs via inhalation of lead-containing dust and fume and ingestion from contact with lead-contaminated surfaces. In cases where careful attention to hygiene (for example, handwashing) is not practiced, smoking cigarettes or eating may represent another source of exposure among workers who handle lead. Industrial settings associated with exposure to lead and lead compounds include smelting and refining, scrap metal recovery, automobile radiator repair, construction and demolition (including abrasive blasting), and firing range operations [ACGIH 2001]. Occupational exposures also occur among workers who apply and/or remove lead-based paint or among welders who burn or torch-cut metal structures.

Acute lead poisoning, with blood lead levels (BLLs) usually over 70 micrograms per deciliter of whole blood (µg/dL), presents with abdominal pain, hemolytic anemia, neuropathy, and has in very rare cases progressed to encephalopathy and coma [Moline and Landrigan 2005]. Symptoms of chronic lead poisoning include headache, joint and muscle aches, weakness, fatigue, irritability, depression, constipation, anorexia, and abdominal discomfort [Moline and Landrigan 2005]. Overt symptoms usually do not develop until the BLL reaches 30-40 µg/dL [Moline and Landrigan 2005]. Overexposure to lead may also result in damage to the kidneys, anemia, high blood pressure, impotence, and infertility and reduced sex drive in both sexes. Studies have shown subclinical effects on heme synthesis, renal function, and cognition at BLLs <10 µg/dL [ATSDR 2007]. Inorganic lead is reasonably anticipated to cause cancer in humans [ATSDR 2007].

In most cases, an individual's BLL is a good indication of recent exposure to lead, with a half-life (the time interval it takes for the quantity in the body to be reduced by half its initial value) of 1-2 months [Lauwerys and Hoet 2001; Moline and Landrigan 2005; NCEH 2005;]. The majority of lead in the body is stored in the bones, with a half-life of years to decades. Bone lead can be measured using x-ray techniques, but these are primarily research based and are not widely available. Elevated zinc protoporphyrin (ZPP) levels have also been used as an indicator of chronic lead intoxication, however, other factors, such as iron deficiency, can cause an elevated ZPP level, so the BLL is a more specific test for evaluating occupational lead exposure.

In 2000, NIOSH established an REL for inorganic lead of 50 micrograms per cubic meter of air (µg/m3) as an 8-hour TWA. This REL is consistent with the OSHA PEL, which is intended to maintain worker BLLs below 40 µg/dl; medical removal is required when an employee has a BLL of 60 µg/dL, or the average of the last 3 tests at 50 µg/dL or higher [29 CFR 1910.1025; 29 CFR 1962.62]. NIOSH has conducted a literature review of the health effects data on inorganic lead exposure and finds evidence that some of the adverse effects on the adult reproductive, cardiovascular, and hematologic systems, and on the development of children of exposed workers can occur at BLLs as low as 10 µg/dl [Sussell 1998]. At BLLs below 40 µg/dl, many of the health effects would not necessarily be evident by routine physical examinations but represent early stages in the development of lead toxicity. In recognition of this, voluntary standards and public health goals have established lower exposure limits to protect workers and their children. The ACGIH TLV for lead in air is 50 µg/m^3 as an 8-hour TWA, with worker BLLs to be controlled to ≤ 30 µg/dl. A national health goal is to eliminate all occupational exposures that result in BLLs >25 µg/dl [DHHS 2000]. The Third National Report on Human Exposure to Environmental Chemicals (TNRHEEC) found the geometric mean blood lead among non-institutionalized, civilian males in 2001-2002 was 1.78 µg/dL [National Center for Environmental Health 2005].

OSHA requires medical surveillance on any employee who is or may be exposed to an airborne concentration of lead at or above the action level, which is 30 µg/m^3 as an 8-hour TWA for more than 30 days per year [29 CFR 1910.1025]. Blood lead and ZPP levels must be done at least every 6 months, and more frequently for employees whose blood leads exceed certain levels. In addition, a medical examination must be done prior to assignment to the area, and should include detailed history, blood pressure measurement, blood lead, ZPP, hemoglobin and hematocrit, red cell indices, and peripheral smear, blood urea nitrogen (BUN), creatinine, and a urinalysis. Additional medical exams and biological monitoring depend upon the circumstances, for example, if the blood lead exceeds a certain level.

Cadmium

Cadmium is a metal that has many industrial uses, such as in batteries, pigments, plastic stabilizers, metal coatings, and television phosphors [ACGIH 2001]. Workers may inhale cadmium dust when sanding, grinding, or scraping cadmium-metal alloys or cadmium-containing paints [ACGIH 2001]. Exposure to cadmium fume may occur when materials containing cadmium are heated to high temperatures, such as during welding and torching operations; cadmium-containing solder and welding rods are also sources of cadmium fume. In addition to inhalation, cadmium may be absorbed via ingestion; non-occupational sources of cadmium exposure include cigarette smoke and dietary intake [ACGIH 2001]. Early symptoms of cadmium exposure may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or cough. Short-term exposure effects of cadmium inhalation include cough, chest pain, sweating, chills, shortness of breath, and weakness [Thun et al. 1991]. Short-term exposure effects of ingestion may include nausea, vomiting, diarrhea, and abdominal cramps [Thun et al. 1991]. Long-term exposure effects of cadmium may include loss of the sense of smell, ulceration of the nose, emphysema, kidney damage, mild anemia, and an increased risk of cancer of the lung, and possibly of the prostate [ATSDR 1999].

The OSHA PEL (29 CFR 1910.1027) for cadmium is 5 $\mu g/m^3$ TWA [CFR 1993]. The ACGIH has a TLV for total cadmium of 10 $\mu g/m^3$ (8-hour TWA), with worker cadmium blood level to be controlled at or below 5 µg/dL and urine level to be below 5 µg/g creatinine, and designation of cadmium as a suspected animal carcinogen [ACGIH 2007]. NIOSH recommends that cadmium be treated as a potential occupational carcinogen and that exposures be reduced to the lowest feasible concentration [NIOSH 1984].

Blood cadmium levels measured while exposure is ongoing reflect fairly recent exposure (in the past few months). The half-life is biphasic, with rapid elimination (half-life approximately 100 days) in the first phase, but much slower elimination in the second phase (half-life of several years) [Lauwerys and Hoet 2001; Franzblau 2005]. Urinary cadmium levels are reflective of body burden and have a very long half-life of 10-20 years [Lauwerys and Hoet 2001].

OSHA requires medical surveillance on any employee who is or may be exposed to an airborne concentration of cadmium at or above the action level, which is 2.5 $\mu g/m^3$ as an 8-hour TWA for more than 30 days per year [29 CFR 1910.1027]. A preplacement examination must be provided, and shall include a detailed history, and biological monitoring for urine cadmium (CdU) and beta-2-microglobulin (B-2-M), both standardized to grams of creatinine (g/Cr), and blood cadmium (CdB), standardized to liters of whole blood (lwb). OSHA defines acceptable CdB levels as < 5 µg/L, CdU as < 3 µg/g/Cr, and B-2-M as < 300 µg/g/Cr. NHANES III found geometric mean CdB of 0.4 µg/L among men in 1999-2000. The geometric mean CdU for men in 2001-2002 was 0.2 µg/g/Cr. Smokers can have CdB levels double that of nonsmokers

[Lauwerys and Hoet 2001]. Periodic surveillance is also required one year after the initial exam and at least biennially after that. Periodic surveillance shall include the biological monitoring, history and physical examination, a chest x-ray (frequency to be determined by the physician after the initial x-ray), pulmonary function tests, blood tests for BUN, complete blood count (CBC), and Cr, and a urinalysis. Men over 40 years of age require a prostate examination as well. The frequency of periodic surveillance is determined by the results of biological monitoring and medical examinations. Biological monitoring is required annually, either as part of the periodic surveillance or on its own. We recommend that the preplacement examination be identical to the periodic examinations so that baseline health status may be obtained prior to exposure. Termination of employment examinations, identical to the periodic examinations, are also required. The employer is required to provide the employee with a copy of the physician's written opinion from these exams and a copy of biological monitoring results within 2 weeks of receipt.

Biological monitoring is also required for all employees who may have been exposed at or above the action level unless the employer can demonstrate that the exposure totaled less than 60 months. In this case it must also be conducted one year after the initial testing. The need for further monitoring for previously exposed employees is then determined by the results of the biological monitoring.

Zinc

Zinc is a very common element in the earth's crust, and is found in air, soil, water, and foods. It has many industrial uses. For example, metallic zinc is used to galvanize other metals, and zinc compounds are used in paints, ceramics, rubber products, and in many drug products, like ointments, sunscreen, vitamins, and shampoos. Zinc is an essential element, which means it is required for the body to function properly. Zinc is not well absorbed through the skin, but is absorbed through the gastrointestinal system. Inhalational exposure to high levels of zinc oxide fume (generally above 75 mg/m^3) can cause metal fume fever. [ATSDR 2005]. Metal fume fever is a syndrome of cough, shortness of breath, fever, aches, chills, and a high white blood cell count that occurs within hours of exposure, and can last up to 4 days. Normal serum or plasma zinc levels are about 1 mg/mL [ATSDR 2005]. The OSHA PEL and the NIOSH REL for zinc oxide are 5 mg/m^3. This is 100 times higher than the PEL for lead, and reflects the relatively low toxicity of zinc. There is no mandated medical surveillance for workers exposed to zinc.

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Thun JM, Elinder C, Friberg L [1991]. Scientific basis for an occupational standard for cadmium. American Journal of Industrial Medicine *20*:629–642.

62 Fed. Reg. 206 [1997]. National Institute for Occupational Safety and Health; occupational exposure to inorganic lead: request for comments and information.

bcc:

B. Bernard (electronic copy)
N. Burton (electronic copy
E. Page (electronic copy)
D. Sylvain (electronic copy)
J. Riley (electronic copy)
HETAB file room, HETA 2008-0055 (paper copy)

ATTACHMENT 4

OSHA Occupational Safety and Health Administration
www.osha.gov

U.S. Department of Labor **Cleveland Area OSHA Office**

February 27, 2006

noted TR

[redacted]
FCI Elkton Prison
P. O. Box 89
Elkton, OH 44415

RE: 309307023

Dear [redacted]:

On August 24, 2005, the Occupational Safety and Health Administration (OSHA) conducted an onsite inspection at your worksite. Your response to citations issued has been received in the Cleveland Area Office.

Based on our review of the information provided in your response we have determined that our file on this matter can be closed and no further action on this inspection is anticipated at this time.

Please note, however, that the complainant will also be given the opportunity to review the information provided in your response. If the complainant disputes the accuracy of the response, it may be necessary for OSHA to contact you for additional information or documentation of corrective action in order to resolve these issues. In some situations, it may be necessary to conduct a follow-up inspection of your workplace.

We appreciate your prompt response to these cited items and in your interest in safety and health of the workers. Please feel free to contact this office if we can be of additional assistance to you.

Sincerely,

Robin Medlock
Area Director

OSHA Occupational Safety and Health Administration
www.osha.gov

U.S. Department of Labor **Cleveland Area OSHA Office**

OSHA SAMPLING RESULTS FOR LEAD AND CADMIUM
UNICOR OPERATIONS, GLASS BREAKING AREA
FEDERAL BUREAU OF PRISONS – ELKTON, OH
OSHA INSPECTION #309307023; SAMPLE DATE – 09/08/2005

WORK POSITION	TIME	SUBSTANCE	SAMPLES	TWA	AL PEL	OVEREXPOSURE?
[redacted] breaker	249	Lead	0.0377 @ 101 0.0791 @ 110 0.0987 @ 38	**0.034**	0.03 0.05	**YES – AL** NO – PEL
		Cadmium	0.0034 @ 101 0.294 @ 110 0.0294 @ 38	**0.07**	0.0025 0.005	**YES – AL** **YES – PEL**
[redacted] breaker	253	Lead	0.008 @ 103 n/d @ 110 0.0347@ 40	0.004	0.03 0.05	NO – AL NO – PEL
		Cadmium	0.0023 @ 103 0.0022 @110 0.0107 @ 40	0.0018	0.0025 0.005	NO – AL NO – PEL
[redacted] helper	248	Lead	0.0151 @ 98 0.0121 @ 110 0.0373 @ 40	0.0089	0.03 0.05	NO – AL NO – PEL
		Cadmium	0.0034 @ 98 0.002 @ 110 0.0129 @ 40	0.0022	0.0025 0.005	NO – AL NO - PEL

WORK POSITIION	- worker and where the worker was located during sampling
TIME	- total time sampled, in minutes
SUBSTANCE	- materials sampled
SAMPLES	- detected levels (mg/M3) and duration of exposure per cassette (minutes)
TWA	- time weighted average; (concentration x time) + (concentration x time) + etc. divided by 8 hrs. or 480 minutes [(ct) + (ct) + .../480 minutes]; per 29 CFR 1910.1000; in mg/M3.
AL/PEL	– Action Level (AL) / Permissible Exposure Level (PEL), per 29 CFR 1910.1025 (lead, mg/M3) and 29 CFR 1910.1027 (cadmium, mg/M3)
OVEREXPOSURE?	- Was worker overexposed to the Action Level or the Permissible Exposure Level

1240 East Ninth Street, Room 899
Cleveland, Ohio 44199

216-522-3818
216-771-6148 (FAX)

120335

U.S. Department of Labor
Occupational Safety and Health Administration
FEDERAL OFFICE BUILDING RM 899
1240 EAST 9TH STREET
CLEVELAND, OH 44199-2050
Phone: (216)522-3818 FAX: (216) 615-4234

RECEIVED
Federal Correctional Institution
DEC 20 2005
Elkton, Ohio
WARDEN'S OFFICE

Notice of Unsafe or Unhealthful Working Conditions

Inspection Number: 309307023
Inspection Date(s): 08/24/2005-11/29/2005
Issuance Date: 12/07/2005

To:
FCI Elkton Prison
P. O. Box 89
Elkton, OH 44415

The violation(s) described in this Notice is (are) alleged to have occurred on or about the day(s) the inspection was made unless otherwise indicated within the description given below.

Inspection Site:
8730 Scroggs Road
Elkton, OH 44415

This Notice of Unsafe or Unhealthful Working Conditions (Notice) describes violations of the Occupational Safety and Health Act of 1970, the Executive Order 12196, and 29 CFR 1960, Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters. You must abate the violations referred to in this Notice by the dates listed unless within 15 working days (excluding weekends and Federal holidays) from your receipt of this Notice you request an Informal Conference with the U.S. Department of Labor Area Office at the address shown above.

Posting - The law requires that a copy of this Notice be posted immediately in a prominent place at or near the location of the violation(s) cited herein, or, if it is not practicable because of the nature of the employer's operations, where it will be readily observable by all affected employees. This Notice must remain posted until the violation(s) cited herein has (have) been abated, or for 3 working days (excluding weekends and Federal holidays), whichever is longer.

Notification of Corrective Action - For **each** violation which you do not contest, you are required by 29 CFR 1903.19 to submit an Abatement Certification to the Area Director of the OSHA office issuing the citation and identified above. The certification **must** be sent by you within **10 calendar days** of the abatement date indicated on the citation. For **Willful** and **Repeat** violations, documents (examples: photos, copies of receipts, training records, etc.) demonstrating that abatement is complete must accompany the certification. Where the citation is classified as **Serious** and the citations states that abatement documentation is required, documents such as those described above are required to be submitted along with the abatement certificate. If the citation indicates that the violation was corrected during the inspection, no abatement certification is required for that item.

All abatement verification documents must contain the following information: 1) Your name and address; 2) the inspection number (found on the front page); 3) the citation and citation item number(s) to which the submission relates; 4) a statement that the information is accurate; 5) the signature of the employer or employer's authorized representative; 6) the date the hazard was corrected; 7) a brief statement of how the hazard was corrected; and 8) a statement that affected employees and their representatives have been informed of the abatement.

The law also requires a copy of all abatement verification documents, required by 29 CFR 1903.19 to be sent to OSHA, also be posted at the location where the violation appeared and the corrective action took place.

Employer Discrimination Unlawful - The law prohibits discrimination by any person against an employee for filing a complaint or for exercising any rights under this Act. An employee who believes that he/she has been discriminated against may file a complaint with the U.S. Department of Labor Area Office at the address shown above.

Informal Conference - An informal conference is not required. However, if you wish to have such a conference you may request one with the Area Director within 15 working days after receipt of this Notice. As soon as the time, date, and place of the informal conference have been determined please complete the enclosed "Notice to Employees" and post it where the Notice is posted. During such an informal conference you may present any evidence or views which you believe would support an adjustment to the Notice. In addition, bring to the conference any and all supporting documentation of existing conditions as well as any abatement steps taken thus far.

Inspection Activity Data - You should be aware that OSHA publishes information on its inspection and citiation activity on the Internet under the provisions of the Electronic Freedom of Information Act. The information related to your inspection will be available 30 calendar days after the Citation Issuance Date. You are encouranged to review the information concerning your estab lishment at WWW.OSHA.GOV. If you have any dispute with the accuracy of the information displayed, please contact this office.

U.S. Department of Labor
Occupational Safety and Health Administration

NOTICE TO EMPLOYEES

An informal conference has been scheduled with the Occupational Safety and Health Administration (OSHA) to discuss the Notice of Unsafe or Unhealthful Working Conditions (Notice) issued on 12/07/2005. The conference will be held at the OSHA office located at FEDERAL OFFICE BUILDING RM 899, 1240 EAST 9TH STREET, CLEVELAND, OH, 44199-2050 on _______________ at _______________. Employees and/or representatives of employees have a right to attend an informal conference.

U.S. Department of Labor
Occupational Safety and Health Administration

Inspection Number: 309307023
Inspection Dates: 08/24/2005 - 11/29/2005
Issuance Date: 12/07/2005

Notice of Unsafe or Unhealthful Working Conditions

Company Name: FCI Elkton Prison
Inspection Site: 8730 Scroggs Road, Elkton, OH 44415

Citation 1 Item 1 Type of Violation: Serious

29 CFR 1910.1027(c): The employer did not assure that no employee is exposed to an airborne concentration of cadmium in excess of five micrograms per cubic meter of air calculated as an eight (8) hour time-weighted average exposure:

A breaker operator in the tube breaking area was exposed to levels of cadmium above the permissible exposure limit (PEL) of 0.005 milligrams per cubic meter (mg/M3) or 5 micrograms per cubic meter (ug/M3); the breaker was exposed for 249 minutes to an 8-hour time weighted average (TWA) of 0.07 mg/M3 or 70 ug/M3, approximately 14 times the PEL. Zero exposure is assumed for time not sampled.

Abatement documentation required on this item.

Date By Which Violation Must be Abated: 02/08/2006

U.S. Department of Labor
Occupational Safety and Health Administration

Inspection Number: 309307023
Inspection Dates: 08/24/2005 - 11/29/2005
Issuance Date: 12/07/2005

Notice of Unsafe or Unhealthful Working Conditions

Company Name: FCI Elkton Prison
Inspection Site: 8730 Scroggs Road, Elkton, OH 44415

Citation 1 Item 2 Type of Violation: **Serious**

29 CFR 1910.1027(f)(1)(i): The employer did not implement engineering and work practice controls to reduce and maintain employee exposure to cadmium at or below the PEL:

For the breaker operator in the tube breaking area discussed in citation 1, item 1

General methods of control applicable in these circumstances include, **but are not limited to** the following:

1) Reevaluate the existing exhaust system in order to ensure the most adequate capture velocity for the system that would assist in reducing personal exposures below the PEL;

2) Reevaluate the existing work practices and/or administrative controls to ensure proper placement of the tubes that would reduce airborne particulates reaching the breathing zone of the worker.

Step 1: Effective respiratory protection shall be provided and used by exposed employees as an interim protective measure until feasible engineering and/or whatever such controls fail to reduce employee exposure to within permissible exposure limits. ABATEMENT ON THIS ITEM COMPLETED DURING INSPECTION.

Step 2: Submit to the Area Director a written plan of abatement outlining a schedule for the implementation of engineering and/or administrative measures to control employee exposure to hazardous substances as referenced in this citation. This plan shall include, at a minimum, target dates for the following actions which must be consistent with the abatement dates required by this citation:

1) Reevaluation of the current engineering/administrative control options;

2) Selection of optimum control methods for this system and completion of design;

3) Procurement, installation, and operation of selected improvement measures; and

4) Testing and acceptance or modification/redesign of controls.

NOTE: All proposed control measures shall be approved for each particular use by a competent industrial hygienist or other technically qualified person. Abatement must be completed by January 24, 2006

See pages 1 through 3 of this Notice for information on employer and employee rights and responsibilities.

U.S. Department of Labor
Occupational Safety and Health Administration

Inspection Number: 309307023
Inspection Dates: 08/24/2005 - 11/29/2005
Issuance Date: 12/07/2005

Notice of Unsafe or Unhealthful Working Conditions

Company Name: FCI Elkton Prison
Inspection Site: 8730 Scroggs Road, Elkton, OH 44415

Step 3: Abatement shall have been completed by the implementation of feasible engineering and/or administrative controls upon verification of their effectiveness in achieving compliance. Abatement must be completed by February 8, 2006

Abatement documentation required on this item.

Date By Which Violation Must be Abated: 02/08/2006

ROBIN R. MEDLOCK
Area Director

See pages 1 through 3 of this Notice for information on employer and employee rights and responsibilities.

ATTACHMENT 5

4/23/08

MULTIMEDIA INSPECTION REPORT

FEDERAL BUREAU OF PRISONS
FEDERAL CORRECTIONAL INSTITUTION ELKTON
FEDERAL PRISON INDUSTRIES (UNICOR)
8730 SCROGGS ROAD
ELKTON, OHIO 44415

BY:
Charmagne Ackerman, USEPA Region 5 - ARD
Duncan Campbell, USEPA Region V – LCD
Mark Moloney, USEPA Region 5 – RMD Cleveland Office
Cher Salley, USEPA Region 5 – RMD Cleveland Office

U.S. ENVIRONMENTAL PROTECTION AGENCY

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EXECUTIVE SUMMARY

INTRODUCTION

At the request of the USEPA, Region 5, Enforcement Compliance Assistance Team, the Cleveland Office coordinated a multimedia compliance investigation at the Electronic Recycling Facilities located at the Elkton Federal Correctional Institution. The facility is located at 8730 Scroggs Road in Elkton, Ohio 44415. The multimedia inspection was conducted on December 10 through the 13, 2007. The inspection was performed by USEPA Region 5 personnel from the Cleveland Office, Air and Radiation Division, and the Land and Chemicals Division. The inspection was coordinated with a Federal Occupational Health Service (FOH) and National Institute for Occupational Safety and Health (NIOSH) personnel conducting a health and safety investigation of the site.

The Federal Correction Institution (FCI) in Elkton, Ohio is a low security facility housing male offenders. The site has an adjacent satellite low facility that houses low and minimum security male offenders. Federal Prison Industries (commonly referred to as FPI or by its trade name UNICOR) is a wholly-owned, Government Corporation established by Congress on June 23, 1934. Its mission is to employ and provide job skills training to the greatest practicable number of inmates confined within the Federal Bureau of Prisons (BOP). UNICOR currently operates an electronics recycling process at the FCI Elkton facility.

Objective

The specific objective of the investigation was to determine compliance with:

- Air Pollution Control regulations under the Clean Air Act (CAA) and the Federally approved portions of Ohio's State Implementation Plan
- NPDES Permit requirements under the Clean Water Act
- Hazardous waste management regulations under the Resource Conservation and Recovery Act (RCRA) and Rules adopted under the State of Ohio's hazardous waste program

Investigation Methods

The multimedia inspection of the electronic recycling facilities at FCI Elkton included:

- Discussion of plant operations with facility representatives
- On-site examination of the facility's operations
- Reviewing and obtaining copies of selected facility documents/records
- and sample collection of solid waste, water/wastewater samples

Background

The electronics recycling operations at FCI-Elkton are currently contained in three buildings at the site. These include the UNICOR Recycling Factory, the Warehouse building and the Federal Satellite Low (FSL) building. Recycling operations begin with receiving, testing and auditing obsolete electronics. The equipment is assessed to determine if it can be used for its original purpose by reconditioning. If reconditioning is not possible, the equipment is de-manufactured for recycling. Non-functional equipment is mined for functional components such as memory, wire, circuit boards, mice and Ethernet cards during this process. All nonfunctional equipment is then separated into its residual material type (ferrous or nonferrous metals) and recycled through recycling processors. The glass breaking booth is utilized to separate the panel and funnel types of glass found in both televisions and cathode ray tubes (CRTs) of nonfunctional equipment so that it can be recycled. After the separation process, these two different types of glass are sent to processors to be recycled.

The total amount of obsolete electronics recycled by the UNICOR operations at Elkton was:
FY05: 6,799,295 pounds
FY06: 5,997,934 pounds
FY07: 4,454,018 pounds (YTD reported 9/21/07)

CRT glass processed within the glass breaking booth by UNICOR Elkton was:
FY05: 835,211 pounds
FY06: 701,086 pounds
FY07: 827,015 pounds (YTD reported 9/21/07)

Based upon the response to a July 27, 2007 USEPA Region 5 Air Division information request and the observations by U.S. EPA inspectors during the December 10-13, 2007, multimedia inspection, the electronic recycling facility at FCI Elkton currently has one active air emission unit. This is a glass breaking booth that is equipped with a three stage air filtration system. The first stage is a blanket filter that covers the entire height and width of the filtration system. The second stage is a bank of 36 pocket filters. The third stage is a high efficiency particulate air (HEPA) filtration system with a fan unit. Two exhaust fans draw air from the glass breaking booth and subsequently vent outside the building. The glass breaking booth and air filtration system were installed in 2003. Air pollutants of concern during glass breaking operations would include lead and cadmium.

The FCI-Elkton electronic recycling facility also reportedly had two air emission sources which are no longer in service. A paint booth was installed in the FSL building in September 2005. This unit was designed to perform touch-up painting on CRT monitors that had been reconditioned prior to packaging for resale. UNICOR ceased utilizing this paint booth in May 2006. A circuit chip recycling operation, which utilized small fans and hoods in a de-soldering chip pulling process, was installed in November 2005. Fans and hoods were connected to a separate ventilation system. This system was dismantled in August 2006. The duct work is still in place but is not operational. This process was conducted in the FSL building.

No air emission permits have been issued by Ohio EPA for past or current electronics recycling processes at the FCI-Elkton facility. A copy of an 005 e-mail, provided by [redacted] of the Department of Justice, tha[redacted], UNICOR's Factory Manager of Recycling at FCI-Elkton, did contac[redacted] at Ohio EPA's Northeast District Office regarding the installation of the paint booth in the FSL building and, according to the e-mail, was told that it would fall under the "de minimis" air contaminant exemption (OAC 3745-15-05).

The FCI-Elkton facility is a Conditionally Exempt Small Quantity Generator (CESQG). The RCRA ID for the FCI Elkton Site is OHR000103416. Expected waste streams for the glass processing operations would include: air pollution control filters, glass breaking clean-up wastes and worker PPE.

Figures 1, 2 and 3 are site diagrams for the UNICOR Recycling Factory, the Warehouse building and the Federal Satellite Low (FSL) building.

FIGURE 1

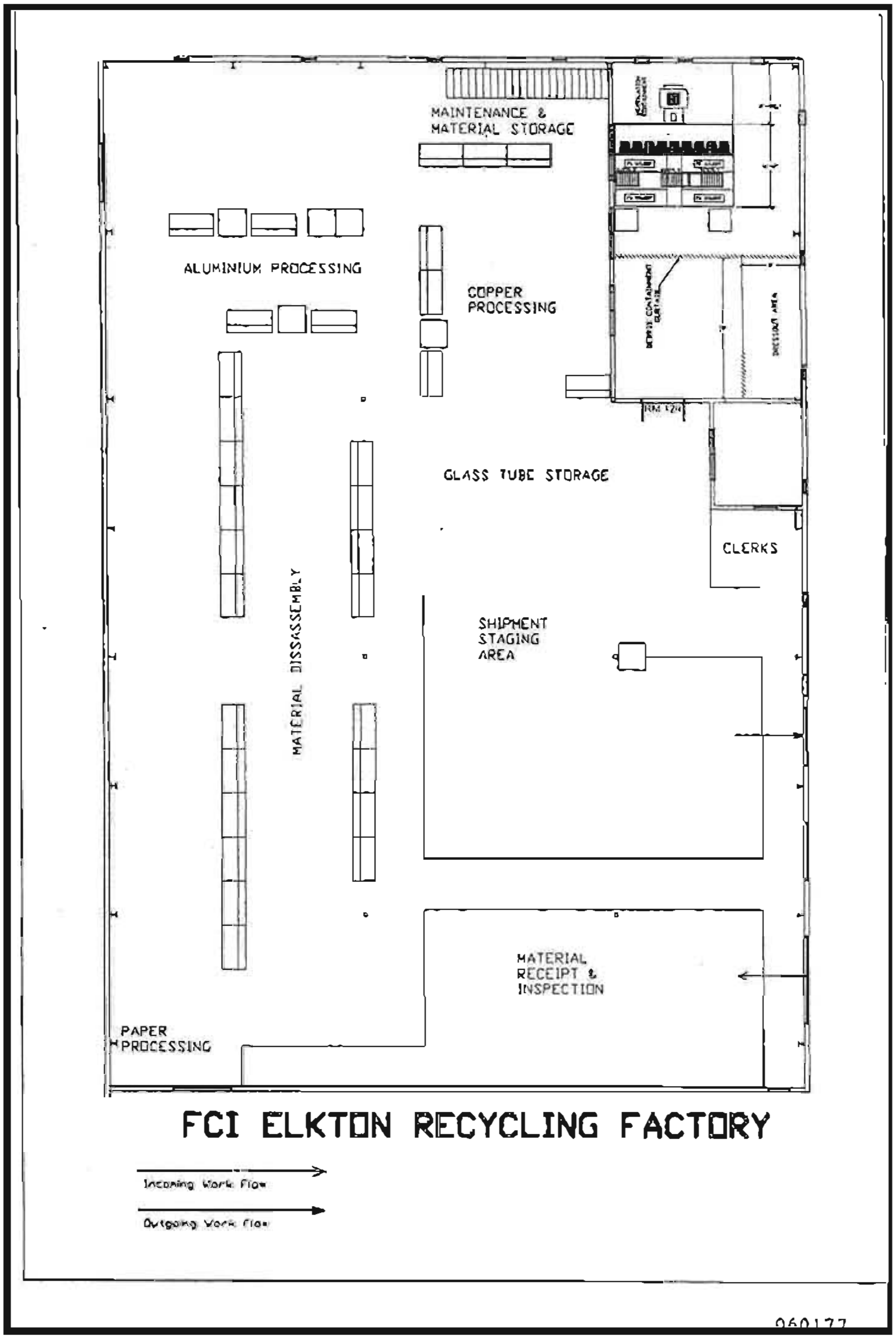
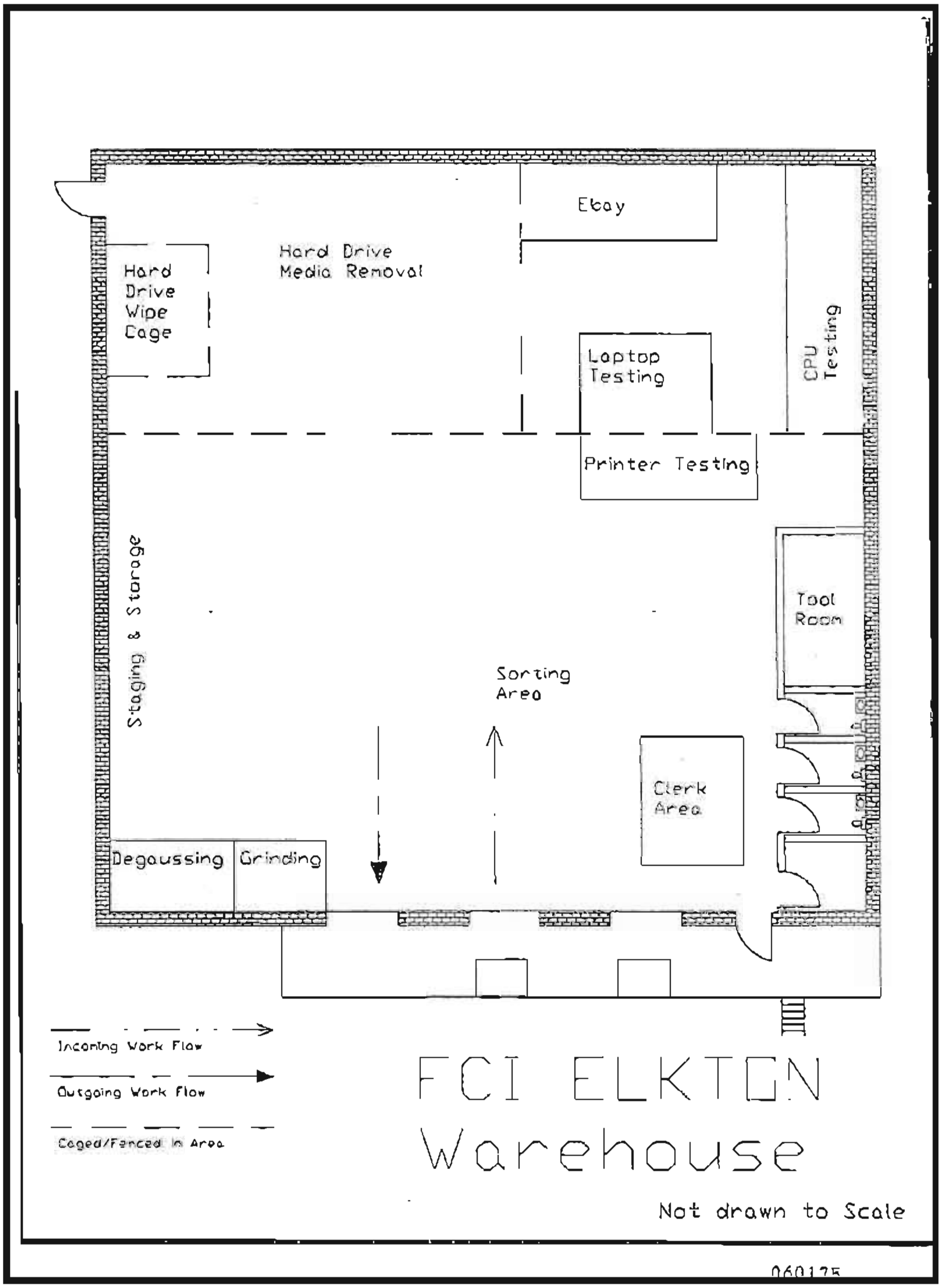
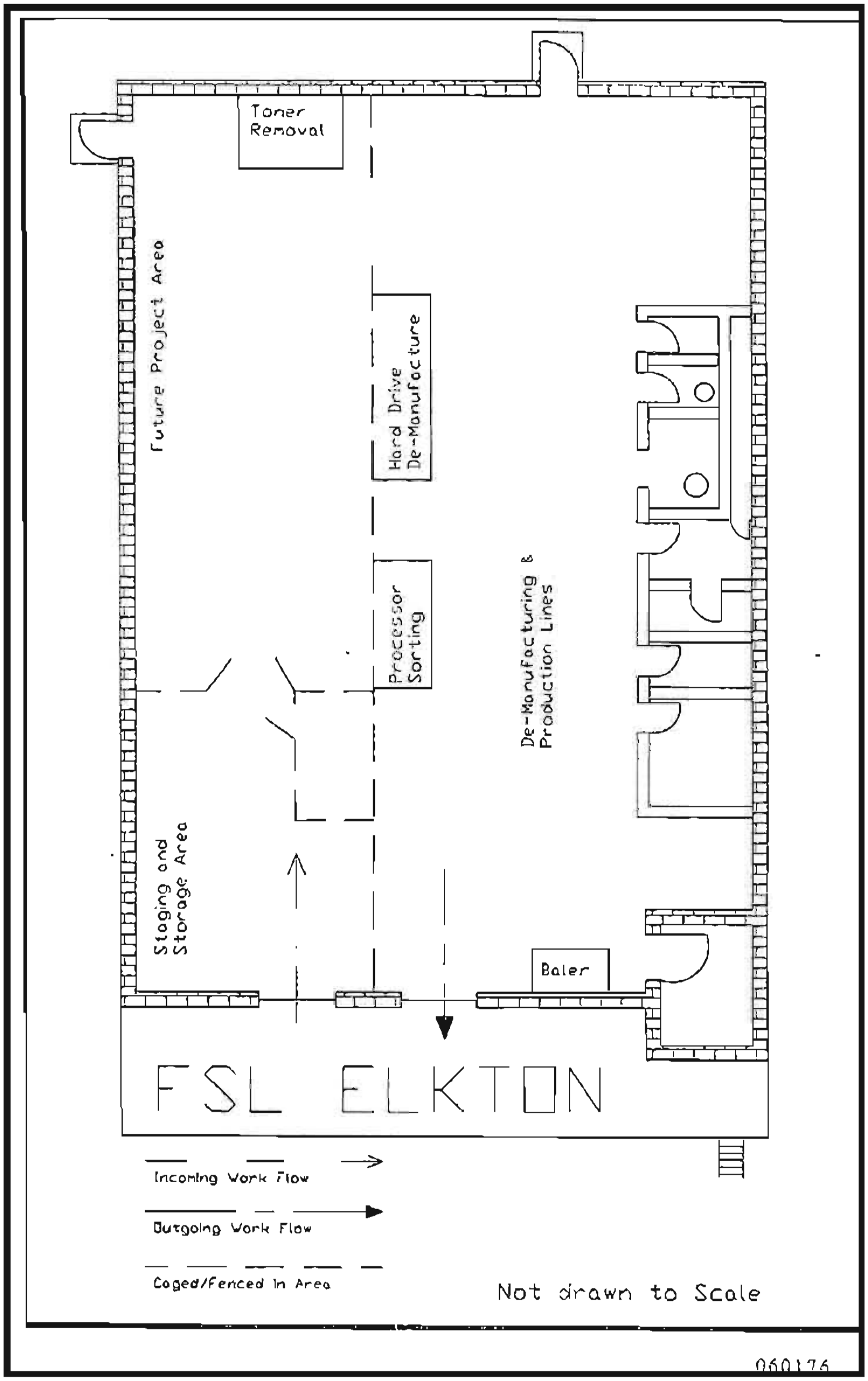


FIGURE 2



Ebay
Hard Drive Media Removal
Hard Drive Wipe Cage
Laptop Testing
CPU Testing
Printer Testing
Staging & Storage
Tool Room
Sorting Area
Clerk Area
Degaussing
Grinding
Incoming Work Flow
Outgoing Work Flow
Caged/Fenced In Area
FCI ELKTON
Warehouse
Not drawn to Scale

FIGURE 3



Toner Removal
Future Project Area
Hard Drive De-Manufacture
Processor Sorting
De-Manufacturing & Production Lines
Staging and Storage Area
Baler
FSL ELKTON
Incoming Work Flow
Outgoing Work Flow
Caged/Fenced In Area
Not drawn to Scale
060176

In February and March 2007 the FOH and NIOSH conducted a health and safety investigation of the electronic processing operations at the FCI-Elkton site. Wipe samples, bulk samples and filtered air samples were collected and analyzed. Elevated levels of lead and cadmium were found near areas where glass breaking operations and de-soldering chip pulling operations were preformed.

SUMMARY OF FINDINGS

The significant findings of this multimedia inspection are summarized as follows.

CLEAN WATER ACT

The CWA inspection consisted of a review of wastewater streams generated at the electronic processing facilities located at FCI-Elkton. The multimedia inspection revealed the following wastewater discharges from UNICOR operations: maintenance/cleanup wastewaters, generated during CRT glass breaking operations; sanitary wastewater generated and discharged from the three buildings, where recycling operations are conducted; and storm water runoff from the area around the maintenance building where recycled e-waste was being stored outside.

- UNICOR operations at FCI-Elkton generate and discharge process wastewater from the e-waste glass breaking operation. These wastewaters are generated during routine mopping of the floor and equipment surfaces inside the glass breaking booth. The cleaning is performed routinely in order to reduce dust levels inside the booth. Dusts inside the booth are known to contain concentrations of lead and cadmium. The wastewater is dumped into a sink located inside the glass breaking booth at the factory building. This sink reportedly drains to the sanitary sewer serving the FCI Elkton facility.

  U.S. EPA personnel collected samples of the mop wastewater being discharged from the glass breaking booth to the sink on December 12 and 13, 2007. In order to characterize this discharge, the wastewater was analyzed for both total metals and TCLP metals. The samples taken on December 12th were collected while UNICOR was performing a typical weekly cleanup and the samples taken on December 13th were collected while UNICOR was performing the monthly glass booth filter change and cleanup operation. Photograph 53 shows the sink in the glass breaking booth, where mop water is disposed.

  Preliminary sample results indicate that the wastewater samples contain high concentrations of total lead, total cadmium and total zinc. Total lead concentrations ranged from 14.0 to 33.1 mg/l. Total cadmium concentrations ranged from 1.30 to 2.43 mg/l. Total zinc concentrations ranged from 17.7 to 40.3 mg/l. Preliminary sample results for TCLP metals indicate that concentrations of lead and cadmium are below detection levels and all metals are below RCRA regulatory levels.

- UNICOR operations at FCI Elkton involve the recycling of electronic waste (e.g. computers, printers, etc.) and the dismantling and breaking of CRTs. During this inspection USEPA personnel observed the storage of some e-waste materials outside near the warehouse building. UNICOR's operations appear to fall under SIC Code 5093 and thus is a storm water discharge associated with industrial activity [40 CFR § 122.26 (14) (vi)]. The storm water generated in this area may require UNICOR or FCI Elkton to apply to Ohio EPA for a NPDES permit or a "no exposure permit exemption". Neither FCI Elkton nor UNICOR has applied for or been issued a NPDES permit from the Ohio EPA for storm water discharges at the site. The Photographs 1 through 16 and 37 through 39 show the storage of e-waste materials outside of the warehouse building. This e-waste material is being stored by UNICOR prior to processing.

CLEAN AIR ACT

A Clean Air Inspection was conducted at the electronic recycling facilities located at the FCI Elkton and air emission sources and air pollution control equipment at the facility were inspected. In addition, air emissions documents were reviewed during this inspection.

- U.S. EPA inspectors were unable to obtain any information which would indicate that UNICOR has notified the Ohio EPA or a local air agency of the existence of the air emission sources associated with the glass breaking operations and de-soldering operation. There is also is no information that would indicate that UNICOR has applied to the Ohio EPA or a local air agency for a permit to install (PTI) or a permit to operate (PTO) for any of the electronic recycling operations air emissions sources (past or present).

  Ohio Administrative Code (OAC) 3745-31-02 (A)(1) requires the following – *Except as provided in rule 3745-31-03 of the Administrative Code, no person shall cause, permit, or allow the installation of a new source of air pollutants, or cause, permit or allow the modification of an air contaminant source, without first obtaining a permit-to-install from the director.*

  Ohio Administrative Code (OAC) 3745-35-02 (A) also prohibits – *No person may cause, permit or allow the operation or other use of any air contaminant source without applying for and obtaining a permit-to-operate from the director in accordance with the requirements of this rule except:.....*

  While it is possible that current and past air emission sources at the electronic processing facilities located at the FCI Elkton could be exempt from obtaining a PTI or PTO under the OAC. The facility did not provide any information to demonstrate that an exemption to these permitting requirements is applicable. Photographs 50 through 55 show the current glass breaking booth in the recycling factory building. Photographs 42 through 47 show the site of the de-soldering operation and the paint booth located in the FSL building.

- UNICOR's September 21, 2007 response to U.S. EPA's Clean Air Act 114 request may be inaccurate. The response states:

  "Prior to the installation of the glass breaking booth, no emissions were generated necessitating the venting to outside air emissions. The glass breaking booth was installed to ensure the health and safety needs of the workers at this operation and to handle the potential increasing amounts of e-scrap materials."

  Based upon conversations with UNICOR staff during the multimedia inspection, glass breaking was conducted in the center of the factory building prior to the construction of the glass breaking booth. Glass breaking at this location reportedly occurred from the summer of 2002 to May 2003, when the glass breaking booth was put into operation. Glass breaking, during this period, was reportedly vented directly through the roof. A vent is currently visible at this location and the dismantled ductwork is reportedly being stored on top of the current glass breaking booth.

Photographs 60 and 61 show the vent in the center of the factory building and Photograph 56 shows the dismantled ductwork located on top of the glass breaking booth.

In addition prior to glass breaking being performed in the factory building it was reportedly performed at various locations in the warehouse building.

RESOURCE CONSERVATION AND RECOVERY ACT - HAZARDOUS WASTE

The RCRA inspection of the electronic processing facilities located at the Elkton Federal Correctional Institution included a visual inspection of the waste generation points, and hazardous waste storage areas. Hazardous waste manifests and waste analysis records were also reviewed during the inspection.

- During the multimedia inspection the trailer where boxes of waste filters from the glass breaking booth were being stored was observed to be leaking. Rain water and snow melt water were found in the trailer during the inspection. The trailer contained a total of 14 boxes containing glass booth filters and was located near the warehouse building. The filters have been tested by UNICOR and the TCLP value is above the RCRA regulatory level for lead. Photographs 17 through 36 shows the trailer where boxes of waste filters are stored by UNICOR.

- During this multimedia inspection wastewater being generated at the glass breaking booth by mopping operations was discharged to a sink located in the booth. The sink reportedly drains to the sanitary sewer system. U.S. EPA personnel collected samples of this wastewater in order to characterize the waste stream. Preliminary sample results indicate that the TCLP metals results were below the RCRA regulatory limit for lead and cadmium.

- Currently UNICOR is using a RCRA ID number issued to FCI Elkton to ship hazardous waste off-site. Since UNICOR operates as a separate agency, it made need its own RCRA ID, if required for waste shipments based upon its generator status.

- During this inspection, the log of wastes being stored at a small Hazardous Waste storage building, operated by the Bureau of Prisons, was reviewed The only potential hazardous waste identified on this log which dated from 1997 to the present was 13 gallons of mineral spirits placed in the hazardous waste storage building On October 9, 2007. A check of the storage building verified that this waste was still on-site. No records were available to indicate that hazardous waste has ever been shipped from BOP operations at the site.

  Other wastes generated at the site may need to be characterized. All wastes generated in Ohio must be evaluated to determine if it is a hazardous waste. Ohio Administrative Code rule 3745-52-11 applies regardless of how small the volume of waste or how infrequent the waste is generated.

- Bureau of Prisons personnel were unable to detail how used fluorescent light bulbs are being disposed. In addition it was not clear on who has responsibility for the fluorescent light bulbs at the site. We were unable to establish if the fluorescent lights are owned by FCI – Elkton and thus their waste generation. We were also unable to determine if the bulbs are being recycled or disposed of in a dumpster. Should the facility dispose of these units in a dumpster they potentially would be hazardous waste.

- The manifests used to ship waste glass booth filters from UNICOR to Michigan Disposal Waste Treatment Plant were reviewed during this inspection. These manifests included:

Manifest #	Date	HW code	Amount
000195389 JJK	3/27/07	D008	4 cubic yds. (4 boxes)
000195101 JJK	11/21/06	D008	6 cubic yds. (6 boxes)
MI 10028800	6/7/06	D008	7 cubic yds. (7 boxes)
MI 10028731	2/28/06	D008	6 cubic yds. (6 boxes)
MI 10028702	12/12/05	D008	3 cubic yds. (3 boxes)
MI 9556871	9/1/05	D008	4 cubic yds. (4 boxes)
MI 9556868	8/3/05	D008	3 cubic yds. (3 boxes)

All of these manifests included a RCRA ID number that was incorrect. The number included on the manifests was OHD000105416. This manifest number matches no facilities in the system. The correct FCI-Elkton number should be OHR000103416.

GENERAL COMMENTS

UNICOR's mission is to employ and provide job skills training to the greatest practicable number of inmates confined within the Federal Bureau of Prisons (BOP). Based upon the observations of U.S. EPA personnel at FCI Elkton there appears to be a need to assess the environmental impacts of business operations developed at the prison. A consistent approach is needed to assess the waste streams (air emissions, water discharges and solid waste streams) being generated by UNICOR processes; apply for and obtain the required environmental permits; and ensure that all federal state and local environmental standards are being achieved. Because process operations are routinely changed and or modified, the assessment of environmental impacts needs to be an on-going activity.

There may also a need for UNICOR and Bureau of Prisons to coordinate their environmental control efforts. UNICOR operates a process but relies on the utility operations controlled by the BOP. For example, wastewater generated at UNICOR is discharged through sewers at the BOP site and air emissions generated by UNICOR are vented from BOP buildings. Waste generated by UNICOR may contaminate property owned by BOP. Since both organizations potentially have responsibility for environmental activities at the site, it is critical that the organizations coordinate these activities to prevent environmental problems from being overlooked.

APPENDIX 1 – MULTIMEDIA INSPECTION PHOTOGRAPHS

ATTACHMENT 6

From:	tonetti.robert@epamail.epa.gov
To:	[redacted] PPryor@psc.gov
Cc:	lnovicky@central.unicor.gov
Subject:	Assessment of UNICOR Electronics Recycling Operations
Date:	Thursday, February 08, 2007 4:14:31 PM
Attachments:	guidelines504.pdf oecd pc guidelines final.pdf FEC Stewardship Conf 2-07.ppt

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Gentlemen:

I have become aware of your ongoing assessment in the course of my frequent contacts with UNICOR recycling personnel. This correspondence with you is completely unsolicited by UNICOR personnel. I feel compelled, based upon my professional experience and knowledge, to let you know of my perspectives, as well as to make sure that you have some information about how UNICOR's recycling operations compare to those of the private sector, in terms of safety, health and environmental protection.

I am a senior environmental scientist here in EPA's Office of Solid Waste. I have over 35 years of experience in the waste management and recycling fields. My experience is not only in the public sector with EPA, but includes experience in the waste recycling industry. I am the author of the EPA guidelines on safe reuse and recycling of used electronics, which were issued in 2004. I was also the author of international guidelines on the safe reuse and recycling of computers, which were issued by the Organization for Economic Cooperation and Development (OECD - an organization of 30 "developed" countries) in 2003. (Both the EPA and OECD guidelines are attached.) I represent the U.S. government in other international efforts related to safe reuse and recycling of used electronics, such as various partnership efforts under the Basel Convention, which is a UNEP convention including 168 nations. All of these efforts involve development of guidelines related not only to protection of the environment, but worker safety and public health as well.

In my role as the lead EPA person regarding safe electronics recycling over the last 6 years, I have visited some 40 electronics recyclers in the U.S., Canada and Europe. Five of those recycling operations have been UNICOR facilities (i.e., I have visited 5 of the 7 UNICOR recycling facilities). Through the years, I have informally made several recommendations to UNICOR personnel about improvements they could make in environmental aspects of their operations. These were not major deficiencies, and UNICOR personnel were extremely responsive in implementing the improvements. (The most recent advice was less than a month ago in relation to a new rule that EPA issued.)

Having seen so many electronics recyclers in both the U.S. and abroad, I can tell you, unequivocally, that the UNICOR facilities are among the best electronics recyclers in the country, and likely are among the best in the world in some regards, such as their handling of CRT glass. There are no operations anywhere that I am aware of that provide the level of PPE that UNICOR provides to their inmate workers in CRT glass-breaking operations. Yes, some private sector recyclers have negative air flow equipment, as UNICOR has, but no one provides anywhere near the level of PPE that UNICOR workers are provided. I am also unaware of any other CRT glass breaking operations that have separate rooms or partitioned areas (with clothing change-out areas) for glass breaking that isolate the glass breaking from other worker areas.

There are numerous areas where UNICOR operations are either the best or among the best electronic recycler workplaces in the U.S. Here is a list of some of those areas, based upon my experience:

1. Worker protection in glass breaking operations, which includes no skin exposure by use of fit-tested, full-face respirators, disposable Tyvek coveralls and gloves which are sealed with tape to the sleeves. (No other domestic glass breaking operation is equal to UNICOR's level of personal protective equipment. And, of course, this is in addition to negative air flow equipment.)
2. Health monitoring of workers, including blood testing, personal air monitoring and workplace area air monitoring. (A very few other domestic operations do similar monitoring.)
3. Worker EH&S training. (There are probably some other electronics recycling operations that do comparable training.)
4. Recordkeeping. (On an EMS audit I observed at the Texarkana facility, the auditor declared "I wish the private sector did it like this.")
5. Maximizing reuse of used electronics through refurbishment and repair. (Not likely that there is any domestic operation that is equal to UNICOR's monitor refurbishment practices.)
6. Maximizing material recovery. (For example, few domestic processors hand-dismantle equipment such as keyboards into many specific subcomponents, each of which is marketed to different recyclers.)
7. Certifications. ISO 9001 and IAER EMS certifications are completed or in process at all 7 UNICOR facilities. ISO 14001 certification processes have begun. (UNICOR is among the best recyclers in the U.S. in terms of having various certifications.)
8. OSHA inspections. (Very few electronics recyclers have been inspected for worker safety. UNICOR has invited OSHA to conduct inpections.)

As recently as yesterday, I spoke at a federal agency conference (the Federal Electronics Challenge (FEC)) regarding safe management of obsolete electronics generated by the federal sector. I have attached that Powerpoint presentation--slides 20-23 may be of most interest to you. Federal government agencies are extensively using UNICOR facilities for their electronics recycling. Personnel from numerous agencies, often after visiting both UNICOR and private sector facilities, have compared UNICOR operations to those in the private sector and determined that UNICOR is their recycler of choice. As you can see in my attached Powerpoint, the FEC (led by the White House Office of the Federal Environmental Executive) promotes two principal options for federal agencies to use for their electronics recycling--UNICOR and an EPA contract called the "READ" contract, which includes 7 prime contractors. UNICOR is actually the recycling subcontractor for one of the READ contractors. And, UNICOR was originally a READ prime contractor, but was later removed as a prime contractor because they were determined to not qualify as a small business for recycling services. But, out of 42 recyclers who bid on the READ contract, UNICOR was judged by EPA (I was one of 3 technical reviewers) to be among the best technically--highest consideration was given to EH&S aspects. Of the 41 other bidders, UNICOR's worker safety and worker training manuals were unmatched.

By the way, we are currently involved in a multistakeholder effort to develop "best management practices" (BMPs) that would be used by independent auditors as part of a voluntary program for the "certification" of electronics recyclers in the U.S. EPA is representing the interests of the federal government in that effort, and we are working most closely with OSHA, as the BMPs will address environment, safety and health.

I would be happy to communicate further with you, if you believe that would be helpful.

Thank you.

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(See attached file: guidelines504.pdf)(See attached file: oecd pc guidelines final.pdf)(See attached file: FEC Stewardship Conf 2-07.ppt)

FCI FT. DIX

EVALUATION OF ENVIRONMENTAL, SAFETY, AND HEALTH INFORMATION RELATED TO UNICOR E-WASTE RECYCLING OPERATIONS AT FCI FT. DIX

PREPARED FOR THE UNITED STATES DEPARTMENT OF JUSTICE OFFICE OF THE INSPECTOR GENERAL

Submitted to: [redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
U.S. Department of Justice

Submitted by: Mr. George Bearer, CIH
FOH Safety and Health Investigation Team
Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

April 28, 2010

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1.0 INTRODUCTION

At the request of the U.S. Department of Justice (DOJ) Office of the Inspector General (OIG), the Federal Occupational Health Service (FOH) coordinated environmental, safety and health (ES&H) assessments of electronics equipment recycling operations at a number of Federal Bureau of Prisons (BOP) facilities around the country. The assessments were conducted as a result of whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium at electronics recycling operations overseen by Federal Prison Industries (UNICOR).[1] The allegations stated that these exposures were occurring from the breaking of cathode ray tubes (CRTs) and other activities associated with the handling, disassembly, recovery, and recycling of electronic components found in equipment such as computers and televisions (i.e. e-waste).[2] It was further alleged that appropriate corrective actions had not yet been taken by BOP and UNICOR officials and that significant risks to human health and the environment remained.

This FOH report[3] consolidates and presents the findings of technical assessments recently performed on UNICOR's e-waste recycling operations at Federal Correctional Institution (FCI) Fort Dix, Fort Dix, New Jersey. Information relied upon for this report includes the results of FOH assessments performed on-site at FCI Ft. Dix as well as documents assembled by the OIG which provide information from various consultants, state regulatory agencies, BOP staff and inmates, and others. The purpose of this report is to characterize current (i.e., 2003 to present) operations and working conditions at FCI Ft. Dix especially with respect to the potential for inmate and staff exposures that may result from present day e-recycling activities as well as from legacy contamination on building components from e-recycling operations which took place in the past.[4] In light of the whistleblower allegations, it is intended that this report be used by stakeholders to help identify where exposures, environmental contamination/degradation, and violations of governmental regulations and BOP policies may still exist so that prompt corrective actions may be taken where appropriate.

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[1] FPI, (commonly referred to by its trade name UNICOR) is a wholly-owned, Government corporation that operates factories and employs inmates at federal correctional institutions.

[2] E-waste is defined as a waste type consisting of any broken or unwanted electrical or electronic device or component.

[3] FOH prepared this report in December 2008 and its findings and conclusions address e-waste recycling conditions known to FOH at that time. FOH provided the report to the OIG, which shared it with the BOP and sought feedback on it. The BOP and UNICOR later provided their comments to FOH about the report's contents, which resulted in FOH making limited changes to some text and figures, as reflected herein.

[4] It is important to emphasize that, as used in this report, the term "exposure" refers to the airborne concentration of a contaminant (e.g., lead or cadmium) that is measured in the breathing zone of a worker but outside of any respiratory protection devices used. Unless otherwise noted, "exposure" should not be confused with the ingestion, inhalation, absorption, or other bodily uptake of a contaminant. Concentrations reported and discussed in this report are not adjusted based on respirator protection factors. However, when reported, it is indicated whether the exposure was within the protective capacity of the respirator.

FCI Ft. Dix is the second of eight BOP institutions that have ongoing e-waste recycling operations for which, to date, an assessment report has been prepared by FOH. On October 10, 2008, FOH issued a separate report entitled "*Evaluation of Environmental, Safety, and Health Information Related to Current UNICOR E-Waste Recycling Operations at FCI Elkton*" detailing current exposure conditions at FCI Elkton based on the findings of industrial hygienists, occupational physicians, and environmental specialists representing several federal agencies including FOH, the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH), the Occupational Safety and Health Administration (OSHA) and the United States Environmental Protection Agency (U.S. EPA). The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, pertinent regulatory requirements, and other information that provides additional context to this FCI Ft. Dix report. FOH will be preparing assessment reports for the remaining six BOP institutions that perform recycling upon completion of their respective ES&H assessments.

Currently, e-waste recycling operations (distinct from testing/refurbishing operations) at FCI Ft. Dix are limited primarily to receipt of waste electronics from various locations around the country, deconstruction and sorting activities ('breakdown'), and the associated material handling and facilities maintenance required to support these operations. Demanufacturing activities are conducted in Building 5713 which is where the discontinued CRT glass breaking operations were once performed. These facilities are described below in Section 2.0 in greater detail.

2.0 UNICOR E-WASTE RECYCLING FACILITIES AND OPERATIONS AT FCI FT. DIX

UNICOR's recycling center at FCI Ft. Dix is a consumer electronics demanufacturing facility located at the Ft. Dix Army Base, Building 5713 on Block 21 (Dough Boy Loop), Lot 1, in New Hanover Township, Burlington County, New Jersey. It is a regional recycling center that was established in 1999 to receive consumer electronics, including computers and CRTs from businesses, consumers, and government. The recycling center is also utilized for finished product storage and equipment storage.

E-waste is initially received and examined for contraband in Building 5735. From there it is brought to Building 5713 where it is disassembled by prison inmates. Components such as circuit boards and sheet metal are sorted and stored in bins pending shipment to various facilities for reprocessing (i.e., recovery of precious metals, copper, aluminum, etc.). Some components, such as memory boards, key boards, hard drives and cases, are examined for functionality and, if suitable, are utilized to remanufacture a functional computer. Printers are similarly remanufactured with toner cartridges sent away to California for processing. Monitors, if functional, may be resold.

A photograph and diagram of the interior of Building 5713 are provided below (Image 1 and Figure 1).

Image 1. Breakdown tables in computer demanufacturing area factory, Building 5713.

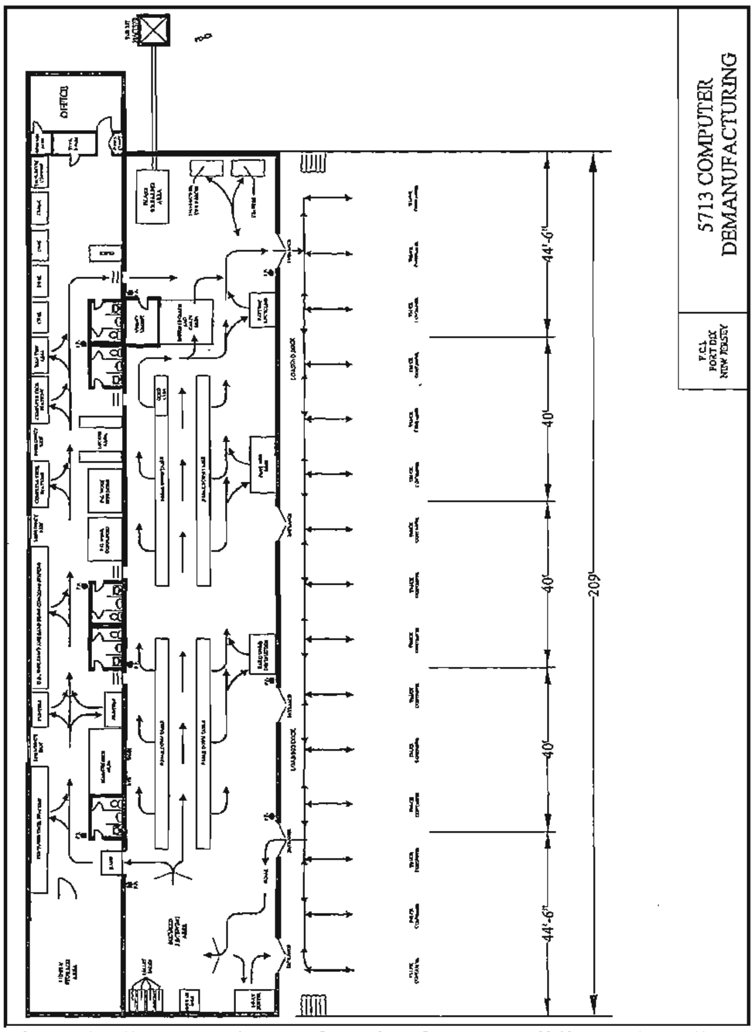

Figure 1. Computer demanufacturing factory, Building 5713, FCI Ft. Dix.

Before the process was discontinued in 2005, CRTs recovered from monitors were recycled in a glass breaking booth where some components were recovered and the glass was packaged and shipped off-site for further processing.

According to current UNICOR staff at FCI Ft. Dix, glass breaking was initiated in 2003 and performed adjacent to the breakdown area (see Image 2 and Figure 1).[5] Here, CRTs from computer monitors and TVs were processed for recycling. This involved inmate workers manually shattering the CRT glass with hammers followed by the recovery of certain components for recycling or discarding unwanted materials for disposal. A retrofitted paint spray booth was in place in 2003 which connected to a local exhaust ventilation (LEV) system consisting of a "down-flow air tort machine with a 6 bag dust capture system driven by a 15 horsepower motor" (see Figure 2). The LEV drew air from the glass breaking booth and through a filter chamber where heavy particulates would fall into a 35 gallon drum while the smaller particulates were captured in the HEPA filter bag located in a bag house outside the building.

Image 2. Current conditions (January 2008) at the location where CRT glass breaking operations were once performed (glass breaking facilities are no longer there). Note the exhaust air duct in the wall (covered by mesh grille) which leads to the outside bag house as well as the FOH air sampling station in foreground.

The glass breaking work area was comprised of two workstations (one for breaking funnel glass and the other for breaking panel glass) enclosed in a 10'x10'x7' space (i.e., the retrofitted paint spray booth) with three walls being metal plate and the fourth wall consisting of a clear plastic strip curtain used as the ingress/egress to the interior of the booth. LEV was installed such that glass breaking operations were performed under hoods which were exhausted through pre-filters and a Torit 3DF24 bag house. For both

[5] This report does not address exposure conditions prior to 2003, including any exposures generated from the shattering of funnel glass to remove the electron gun from the CRT.

of the two workstations, a maximum production rate of 50 CRTs per hour was established due to State of New Jersey environmental considerations.

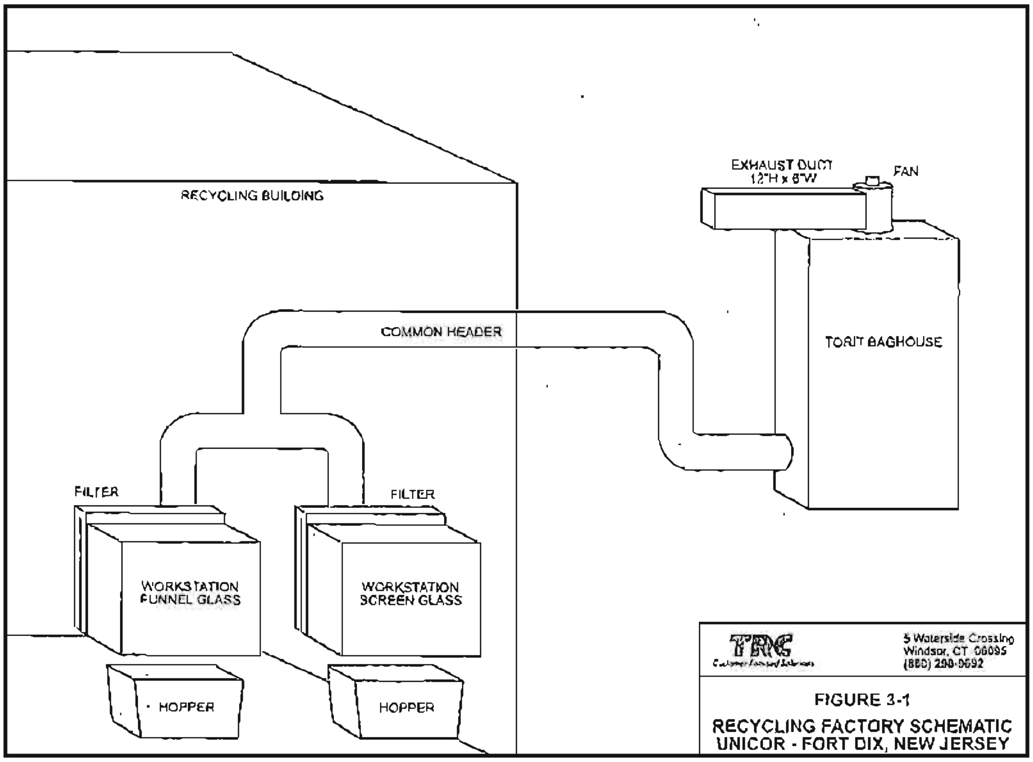

Figure 2. Schematic of Glass Breaking Work Stations and LEV

3.0 BOP/UNICOR SAFETY AND HEALTH PROCEDURES AND PRACTICES AT FT. DIX

Under 29 CFR 1960 each federal agency is obligated to develop a comprehensive and effective safety and health program. Such programs establish requirements and processes for controlling occupational hazards and meeting federal occupational safety and health regulations. The BOP has established an ES&H program entitled Occupational Safety, Environmental Compliance, and Fire Protection (BOP Program Statement 1600.09). UNICOR's compliance with this policy will be evaluated in the OIG's final report.

Various OSHA standards require written programs or plans to address occupational hazards or implement hazard control measures. Examples applicable to UNICOR's e-waste recycling activities dating from 2003 and particularly for glass breaking include:

- 29 CFR 1910.1025, Lead requires a written lead compliance plan;
- 29 CFR 1910.1027, Cadmium requires a written cadmium compliance plan;
- 29 CFR 1910.134, Respiratory Protection requires a written respiratory protection program; and

- 29 CFR 1910.95, Occupational Noise Exposure requires a written hearing conservation program.

Even when specific hazards do not meet the exposure threshold for a written standard specific plan/program, a good practice approach warrants that a general safety and health plan should be in place to identify workplace hazards and specify appropriate hazard controls and safe work practices. UNICOR's safety and health practices and programs for recycling conducted at FCI Ft. Dix are discussed below for glass breaking performed between 2003 and 2005, as well as for demanufacturing activities currently performed.

3.1 Safety and Health Practices and Programs for Glass Breaking Operations

FOH reviewed FCI Ft. Dix safety and health documents for glass breaking operations conducted between 2003 and 2005, as well as for current e-waste recycling operations conducted on the factory floor (e.g., demanufacturing). For example, FCI Ft. Dix described "Inmate Safety Precautions" in a two page memo from the UNICOR Factory Manager to "All Staff Concerned" on April 25, 2003. Among other practices, the memo itemized the following safety precautions in use at FCI Ft. Dix:

- A local exhaust ventilation system (i.e., an engineering control) employed to capture airborne toxic metals emissions;
- Biological testing for lead and cadmium;
- Training in personal protective equipment (PPE) and respiratory protection usage;
- Other respiratory protection practices such as fit testing and cleaning; and
- Various safety items such as hazard communication signage, shower and eyewash stations, exposure monitoring and surface testing, and documentation.

UNICOR respiratory protection records from 2003 through 2005 documented training program content, fit testing, and a physician's acknowledgement of medical fitness to wear respirators. Other records documented lead training and additional respiratory fit testing. As discussed in Section 4.0 below, UNICOR consultants performed exposure monitoring, area air monitoring, and surface testing for lead and cadmium in 2003 and 2004 (see Section 4.1 for an evaluation of the quality and results of this testing). Also, a consulting firm documented PPE used including protective clothing, respiratory protection, eye and face protection, hand protection, hearing protection, and others.

These records document an on-going effort between 2003 and 2005 to implement safety and health practices and hazard control measures to protect workers against exposure to toxic metals during glass breaking operations and other e-waste recycling at FCI Ft. Dix. These practices, however, were not captured and delineated in formal written plans, such as a lead and cadmium compliance plan. For instance, a 2003 study conducted by a consulting firm (see Section 4.1, below) recommended the development of a cadmium compliance plan based on exposure monitoring results that were above the exposure limit. A cadmium compliance plan was not developed by UNICOR for FCI Ft. Dix glass breaking operations. The Factory Manager at FCI Ft. Dix confirmed that these written programs were not developed for FCI Ft. Dix glass breaking operations. Another program inadequacy was that baseline biological monitoring for lead and cadmium was apparently not conducted prior to the start of glass breaking. Records indicated that biological monitoring was initiated in 2004, while glass breaking started in 2003.

3.2 Safety and Health Practices and Programs for Current Demanufacturing

For current demanufacturing operations and associated activities conducted at FCI Ft. Dix on the general factory floor, exposures to lead, cadmium, and other toxic metals would be expected to be much lower than for glass breaking. This was confirmed with exposure monitoring performed by UNICOR consultants and FOH (see Section 4.0). Therefore, the need for written compliance plans for lead and cadmium is not a current requirement.

According to the Factory Manager at FCI Ft. Dix, lead and cadmium exposure monitoring has not been performed on the general factory floor since the latest April 2004 monitoring episode conducted during glass breaking. He did mention that UNICOR is in the process of developing an exposure monitoring regimen for all UNICOR recycling factories. Such a program should be implemented to document continued effective control measures and the effectiveness of other safety and health and work practices (see Section 6.0, Recommendations).

The Factory Manager stated that respiratory protection is not required for current operations, although nuisance dust masks are available as a precautionary measure (i.e., for use on a voluntary basis). He also stated that hearing protection is made available as a precaution and that exposure monitoring has been conducted for noise with all results below the action level and exposure limit. Based on this information a written respiratory protection program and a written hearing conservation program are not required. If nuisance dust masks and hearing protection are provided, however, training in their proper use should be performed. Training for the nuisance dust respirators should, per OSHA requirements regarding voluntary respirator use, include having inmate workers read and sign Appendix D of 29 CFR 1910.134, and UNICOR and FCI Ft. Dix should maintain the Appendix D signed records.

The Factory Manager at FCI Ft. Dix also stated that Material Safety Data Sheets (MSDS) for hazardous materials are available and maintained by the Safety Department in accordance with the OSHA Hazard Communication Standard.

FCI Ft. Dix has various written work procedures for current recycling operations. FOH reviewed approximately 20 of these procedures. These procedures contain only very limited safety and health information or precautions. For instance, the only information provided is that, for some procedures, the "tools" sections specify the need for safety glasses, gloves, and/or aprons.

When asked about safety and health procedures for recycling at FCI Ft. Dix, the Factory Manager provided a document entitled UNICOR's Inmate Pre-Industrial Manual dated May 2005 that applies to e-waste recycling operations. Among other topics, this manual contains sections for general factory rules, PPE, hazard communication, hazardous material identification, material recognition and handling, and various industrial safety practices. It also provides a section on glass breaking procedures. This manual provides useful general information for all factories, but does not provide facility specific implementation details or define facility specific safety and health practices.

According to the Factory Manager, in addition to the Pre-Industrial Manual, UNICOR is in the process of identifying and assembling applicable safety and health standards, regulations, and requirements into a standard operating procedures (SOP) manual that is to be implemented by the UNICOR recycling factories. UNICOR held a factory manager's meeting with managers from all recycling factories where the draft SOP manual was presented and discussed. When complete, these SOPs are to be implemented at the factories, as applicable. Among other content, the Factory Manager specifically mentioned noise, ventilation, air contaminants, training, and heat stress as elements of the intended SOP manual.

Although various safety practices are applied at the FCI Ft. Dix recycling factory, a written safety and health document to define existing workplace hazards and control measures is not in place for UNICOR recycling activities conducted specifically at FCI Ft. Dix. As a "good practice" approach, such a document should be developed and implemented and would serve to concisely define the safety and health practices and requirements specific to FCI Ft. Dix recycling, such as PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Such a document could also be used as an implementing mechanism for UNICOR's safety and health SOP manual when it is completed. See Section 6.0, Recommendations for possible content of a safety and health practices document for FCI Ft. Dix.

4.0 FIELD INVESTIGATIONS AND MONITORING RESULTS

In 2003 and 2004, UNICOR and FCI Ft. Dix retained consulting firms to conduct various field investigations to evaluate contamination in the recycling areas, determine personal exposures, and study environmental emissions related to toxic metals associated with electronic recycling activities. In 2005, the New Jersey Department of Environmental Protection (NJDEP) performed an inspection of the recycling facilities as part of its permitting process for e-waste recycling, and OSHA made an inquiry with FCI Ft. Dix after receiving a complaint regarding alleged hazardous working conditions at the recycling facilities. Finally, as part of the DOJ OIG investigation, FOH conducted a field investigation in 2008 to determine present-day personal exposures, area airborne lead and cadmium concentrations, and existing surface contamination on various building components. Results of these industrial hygiene and environmental investigations are discussed in this section.

Toxic metals of greatest interest for e-waste recycling include lead, cadmium, and barium. Beryllium can also be associated with e-waste materials and is also of interest because of its high toxicity, adverse health effects, and low exposure limit. These metals were the focus of the field investigations. See generally FCI Elkton report referenced in Section 1.0 for details regarding e-waste hazards.

Exposure monitoring results are compared to PELs established by OSHA. In addition, non-mandatory American Conference of Governmental Industrial Hygienist (ACGIH) threshold limit values (TLVs) and NIOSH recommended exposure limits (RELs) are also available for reference. Personal exposure limits are often based on 8-hour time weighted average (TWA) exposures and the TWAs are applicable to the exposures discussed in this report. Table 1 provides exposure limits for the metals lead, cadmium, barium and beryllium.

Table 1
Occupational Exposure Limits[1]

	LEAD ($\mu g/m^3$)	CADMIUM ($\mu g/m^3$)	BARIUM ($\mu g/m^3$)	BERYLLIUM ($\mu g/m^3$)
OSHA PEL	50	5.0	500	2[5]
OSHA ACTION LEVEL[2]	30	2.5	N/A	N/A
ACGIH TLV (Total Exposure)	50	10.0	500	0.05[4]
ACGIH TLV (Respirable Fraction)	N/A	2.0	N/A	N/A
NIOSH REL	50	*Ca*[3]	500	0.5

Notes:

1. All limits are based on an 8-hour time weighted average (TWA) exposure. NIOSH RELs are based on TWA concentrations of up to a 10-hour workday during a 40-hour workweek.
2. The action level is an exposure level (often around half of the PEL) that triggers certain actions, such as controls, monitoring, and/or medical surveillance under various OSHA standards.
3. *Ca* (Potential Occupational Carcinogen). NIOSH RELs for carcinogens are based on lowest levels that can be feasibly achieved through the use of engineering controls and measured by analytical techniques. [NIOSH 2005]
4. ACGIH TLV 2009 adoption.
5. OSHA also has 5 $\mu g/m^3$ ceiling and 25 $\mu g/m^3$ peak exposure limits.

4.1 FCI Ft. Dix Industrial Hygiene Monitoring Results

UNICOR and FCI Ft. Dix retained consulting firms to conduct field investigations involving area and personal exposure monitoring and other testing services to evaluate potential exposure to toxic metals. Testing included:

- Personal exposure monitoring for toxic metals associated with e-waste recycling, particularly for lead, cadmium, beryllium, and barium;

- Area air monitoring in various work areas where recycling activities were performed; and

- Surface wipe sampling in recycling areas to determine levels of toxic metal contamination.

Prior to April 2003, no industrial hygiene monitoring was performed to evaluate personal exposures to toxic metals. FCI Ft. Dix retained consulting firms to perform industrial hygiene monitoring evaluations in 2003 and 2004, including a three phase study conducted from April through June 2003, a study conducted in November 2003, and another conducted in April 2004. These studies involved personal exposure monitoring, area air (ambient) monitoring, and surface wipe sampling. Metals evaluated included cadmium and lead, and some studies also included barium and beryllium.

Results of these consultant studies are discussed in Section 4.1.1 and 4.1.2, below.

4.1.1 Three Phase Industrial Hygiene Study Conducted April – June 2003

The first study conducted in 2003 involved three monitoring and sampling episodes that were conducted by one consulting firm retained by UNICOR at FCI Ft. Dix.

Phase I was conducted on April 30, 2003 and included surface wipe samples and area air monitoring inside and outside the glass breaking area. Two air samples were collected. One ambient air sample was collected near the shower outside the glass breaking area. The lead exposure was less than the detection limit and well below the lead PEL. A second air sample was collected inside the glass breaking area, but during the lunch break when no activity was in progress. This sample was also analyzed for lead and was below the detection limit and well below the PEL. However, neither of these samples represented personal exposure monitoring during glass breaking.

Phase II was conducted on June 4, 2003 and represented similar monitoring as Phase I, but after glass breaking operations had been underway for 30 days. Again, two ambient air samples were collected. One sample was taken inside the glass breaking room after work was completed (i.e., no work was underway). The other was taken outside the glass breaking room near the shower. Samples were analyzed for lead and were at non-detectable levels well below the PELs. Cadmium results for these locations were also below the PEL, but the limit of detection was so high that it was at or above the cadmium action limit, indicating that these data are of limited value. Most importantly, neither of these samples represented personal exposure monitoring during glass breaking.

Phase III was conducted on June 25, 2003 and included personal exposure monitoring inside and outside the glass breaking room while glass breaking was being performed. All lead and cadmium results were reported as "low". However, the results in a data table indicated that two exposures in the glass breaking room were 21 and 26 $\mu g/m^3$ for cadmium which is four or five times higher than the PEL of 5 $\mu g/m^3$. These results were for the duration sampled; therefore, it is possible that as 8-hour TWAs, these exposures were less than the PEL. This possibility cannot be determined with certainty because the report does not state whether the durations monitored were for the entirety or only a portion of daily exposure. In addition to the report's deficiencies in describing the results, the detection limit for some other cadmium results was more than the cadmium PEL, which make these data of little value.

The conclusions drawn by FOH from reviewing this three phase study are that the first two phases contributed nothing of value to determine personal exposures among workers engaged in glass breaking, and the third phase represented exposures as "low" which was not accurate. Additionally, based on these reports, UNICOR and FCI Ft. Dix were not provided with the information necessary to evaluate personal exposures and implement effective control measures. Strictly from these reports, UNICOR and FCI Ft. Dix could have been under the impression that lead and cadmium personal exposures were well controlled. Indeed, the Factory Manager at Ft. Dix stated that he was under the impression that results were low until later informed by other UNICOR personnel that exposures were actually elevated.

Finally, surface wipe samples were in the range of those found by FOH in its investigation. See Section 5.2.2, below, for a discussion of FOH surface wipe results.

4.1.2 Industrial Hygiene Studies Conducted in November 2003 and April 2004

A different consulting firm conducted industrial hygiene monitoring studies of FCI Ft. Dix e-waste recycling operations in November 2003 and April 2004. Again, personal exposure monitoring, ambient air monitoring, and surface wipe sampling were performed.

In November 2003, personal exposure monitoring was conducted in the glass breaking room during glass breaking activities. Three persons were monitored. All three personal exposures exceeded the PEL for cadmium with the range being from 44 $\mu g/m^3$ to 110 $\mu g/m^3$. These were approximately six hour samples; therefore, even as 8-hour TWAs, these exposures were still well above the PEL for cadmium of 5 $\mu g/m^3$. The three personal lead exposures ranged from 7.1 $\mu g/m^3$ to 85 $\mu g/m^3$. The higher result was above the lead PEL of 50 $\mu g/m^3$, while the other two were less than the PEL and action limit. Barium and beryllium results were non-detectable or very low.

Several area air samples were also collected inside and outside the glass breaking room. These results were less than the action limits and PELs for lead and cadmium.

The report provided a detailed description of exposures and included several general recommendations to reduce exposures. Example recommendations included developing a cadmium exposure control plan, implementing procedures to comply with the lead and cadmium standards, and modifying work practices.

In April 2004, a follow up study was conducted that was similar to the study in November 2003. Personal exposure results for this study were well below the action limits and PELs for both lead and cadmium. Barium and beryllium were also non-detectable or very low.

The consultant report does not offer an explanation or reason that exposures were lower in April 2004 than the previous monitoring episode. For instance, the report does not contain information regarding any work practice or exposure control improvements that might have been implemented based on the consultant's prior recommendations. One contributing factor to the lower exposures could be that the shift monitored in April 2004 was only about 2.5 hours in duration versus the 6 hour duration of the previous study. This shorter shift, however, would not fully account for the lower exposure levels found in April 2004 versus November 2003, especially since the results reported are for the duration of the samples.

The Factory Manager at FCI Ft. Dix was asked about the reason for the reduced exposures found in April 2004. He attributed the lower exposures to the placement of plastic panels around the glass breaking area. These panels provided a barrier between the source of lead and cadmium emissions and the breathing zone of inmate workers.

During both studies, the consultant reports noted that workers wore half-faced HEPA respirators (i.e., air purifying respirators with HEPA cartridges). These respirators have a protection factor of 10. Except for the highest cadmium personal exposure in the November 2003 study, all other exposures were within the protective capacity of the respirators worn. However, OSHA lead and cadmium standards require that these exposures be controlled at or below the PELs through the use of engineering and work practice controls. Other personal protective equipment (PPE) was also noted in the reports and included safety goggles, face shields, hearing protection, gloves, cotton sleeves, cloth jumpsuits, and leather aprons.

In addition to the air sampling discussed above, both the November 2003 and the April 2004 consultant studies included limited surface testing for metals including lead and cadmium. Wipe sampling revealed detectable levels of both lead and cadmium on surfaces. More specifically, wipe samples collected from the floor of the CRT breaking booth and nearby staging areas after these surfaces were mopped at the end of the day showed surface concentrations ranging from 50 to 150 $\mu g/ft^2$ lead and 12 to 20 $\mu g/ft^2$cadmium. Other samples taken from surfaces 1 to 50 feet outside the booth showed a range of 12-66 $\mu g/ft^2$ lead and 5-35 $\mu g/ft^2$ cadmium. Two wipe samples from an inmate's hands showed a trace of lead (i.e., 0.5 μg /16 in^2) prior to washing (cadmium was undetectable) and no detectible lead or cadmium following the hand washing.

4.2 FOH Area and Air Monitoring Results

FOH conducted air, surface wipe, and bulk dust sampling of FCI Ft. Dix e-waste recycling operations on January 17, 2008. Analyses were conducted for 31 metals, including lead and cadmium. Types of samples collected included the following:

- Personal exposure monitoring and ambient air (area) monitoring at various locations on the general factory floor; and

- Surface wipe and bulk dust samples from various factory surfaces and air handling units serving the factory.

The FOH study presents exposure information for the current demanufacturing and related factory activities. It does not assess past glass breaking activities that were discontinued in 2005, except to the extent that those past activities could have contributed to legacy surface contamination remaining in the factory areas. Results from these sampling activities are presented below. (See Attachments for additional details.)

4.2.1 Area Air and Personal Monitoring Results

FOH conducted personal exposure monitoring and area air monitoring for lead and cadmium, as well as other metals, at various locations on the general factory floor at FCI Ft Dix where e- waste recycling operations (primarily demanufacturing) are performed. In addition, total airborne particulates were measured in these areas using a real-time direct reading instrument. Results are as follows:

- Lead and cadmium results for five area samples collected on the upper and lower levels of the recycling building were all below the limit of detection (LOD).

- Cadmium exposure results for five personal samples collected during recycling activities were below the LOD. Lead personal exposure results were below the LOD for four of five samples. The one detectable personal lead exposure result was 1.4 $\mu g/m^3$ for the period sampled (or about 0.7 $\mu g/m^3$ as an 8-hour TWA), assuming no additional exposure over the work shift. This exposure is well below the lead PEL of 50 $\mu g/m^3$.

- All other metals were found at low or non-detectable levels and were not of exposure concern.

- Total particulate monitoring conducted using a direct reading instrument showed no detectable concentrations of airborne particulates in any of the areas tested. The LOD is approximately 20 $\mu g/m^3$. This testing showed that no detectable releases of airborne dusts occurred on the general factory floor either from the recycling activities conducted or from dusts that were present on surfaces.

Lead and cadmium summary results for these samples are shown in Table 2. See Attachment 1 for complete results for all samples and all metals determined during the FOH study. Based on these results, lead and cadmium inhalation exposure on the general factory floor and associated facilities at FCI Ft. Dix during recycling activities is minimal.

Table 2
Air Sampling Results Collected January 17, 2008
Sampling/Laboratory Methodology: NIOSH Method 7300

Sample #	Building	Sample Information	Air Volume Collected (L)	Sample Duration (min.)	Lead µg/m³	Cadmium µg/m³
AP1	UNICOR Electronics Recycling Building	Personal: Activities – Breakdown table	589	269	ND	ND
AP2	UNICOR Electronics Recycling Building – Lower level	Area: Maintenance adjacent to tool room- on stand	951	315	ND	ND
AP3	UNICOR Electronics Recycling Building - Upper level	Area: Near office in breakdown Line #1 on sign above table	879	295	ND	ND
AP4	UNICOR Electronics Recycling Building – Lower level	Area: Quality assurance – desktop cleaning area – on exhaust	951	314	ND	ND
AP5	UNICOR Electronics Recycling Building	Personal: Activities - Motherboards and cards area	582	258	1.4	ND
BP1	UNICOR Electronics Recycling Building - Upper level	Area: Glass booth area next to boiler (compacter)	903	304	ND	ND
BP2	UNICOR Electronics Recycling Building	Personal: Activities - Breakdown table	572	261	ND	ND
BP3	UNICOR Electronics Recycling Building – Lower level	Area: Scrap laptops and parts on stand	954	317	ND	ND
BP4	UNICOR Electronics Recycling Building	Personal: Activities - Breakdown table	567	259	ND	ND
BP5	UNICOR Electronics Recycling Building	Personal: Activities - Breakdown table	562	250	ND	ND

Notes:

1. Sampling was performed to characterize airborne lead and cadmium concentrations at various locations on the general factory floor in/near recycling operations (primarily de-manufacturing). The purpose of this sampling was to characterize general ambient air exposures presumably from the dust deposits found on various surfaces.
2. Detection limits: 'ND' denotes 'None detected' or <0.2 µg Pb/sample (equivalent to 0.0004 mg/m³ based on 500 liters of air sampled) and <0.04µg/sample Cd (equivalent to 0.00008 mg/m³ based on 500 liters of air sampled).
3. In addition to the time-weighted average data shown above, an airborne dust survey was performed throughout the sampling day using a real-time, direct-reading instrument (HAZDUST-1100). The purpose of this testing was to identify whether any elevated concentrations or 'dust release' trends could be discerned. Special emphasis was placed on testing air immediately adjacent to the various de-manufacturing work activities being conducted in the building and during other activities which might generate contaminated dusts to which personal may be exposed. The instrument showed no detectible concentrations of any airborne particulates in any of the areas surveyed. The HD-1100 instrument identifies particulates on a semi quantitative basis ranging from 0.1 µm to 50 µm in size (detection limit: approximately 0.02 mg/m³).

4.2.2 Surface Wipe and Bulk Dust Sampling Results

FOH collected surface wipe and bulk dust samples from various surfaces and air handling units in the UNICOR recycling factory at FCI Ft. Dix. Wipe samples were collected from various factory surfaces and elevations such as floors, walls, trusses, lights, fan blades, ducts, and pipes. Bulk dust samples were collected from surfaces where visible accumulations of dusts were found. Locations of surface wipe and bulk samples included areas normally out of the reach of workers, but these areas were indicative of the release and accumulation of contaminants. One wipe sample was collected from worker gloves. All samples were analyzed for total lead and total cadmium. Results are presented in Tables 3 and 4 below and are summarized as follows:

- Lead and cadmium contamination was found at detectable levels on all surfaces tested. Lead results ranged from 49 $\mu g/ft^2$ to 2,160 $\mu g/ft^2$. Cadmium results ranged from 48 $\mu g/ft^2$ to 930 $\mu g/ft^2$.

- Seven bulk dust samples were collected from surfaces. These samples had detectable levels of lead and cadmium. Lead results ranged from 330 mg/kg to 970 mg/kg. Cadmium results ranged from 48 mg/kg to 250 mg/kg.

- One wipe sample was taken from worker gloves. Lead was found at 26 µg/wipe and cadmium at 2.9 µg/wipe.

Definitive criteria have not been developed for acceptable levels of lead or cadmium surface contamination or dust concentrations in industrial areas where activities are performed involving lead and/or cadmium bearing materials. As points of reference, some guidelines that are available are noted below and are further described in the Appendix, Guidance for Evaluating Surface Samples:

- The Department of Housing and Urban Development (HUD) has established clearance levels for lead on surfaces after lead abatement. These levels range from 40 to 800 $\mu g/ft^2$, depending on the type of surface. These levels, however, apply to occupied living areas where children reside, and are not intended for industrial operations. HUD proposed a decontamination guideline of 200 $\mu g/ft^2$ for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas. In situations where employees are in direct contact with lead-contaminated surfaces, such as working surfaces or floors in change rooms, storage facilities, and lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level.

- Lange [2001] proposed a clearance level for floors of 1,000 $\mu g/ft^2$ in non-lead free buildings. This level was suggested for commercial facilities occupied by adults, but does not consider a facility where work is routinely conducted with lead-bearing materials.

- The U.S. EPA has proposed standards for residential soil-lead levels. The level of concern requiring some degree of risk reduction is 400 ppm (mg/kg), and the level requiring permanent abatement is 2,000 ppm.

As noted above, none of these levels are directly applicable to UNICOR's e-waste recycling; however, they offer perspective for FCI Ft. Dix operations. The range of lead surface contamination in the FCI Ft. Dix factory was 49 to 2,160 $\mu g/ft^2$, and the average surface lead contamination was about 830 $\mu g/ft^2$. While 7 of 26 samples were somewhat above the clearance guideline suggested by Lange [2001] for commercial facilities, the average contamination level is lower than Lange's clearance guideline of 1,000 $\mu g/ft^2$. Again, this guideline is conservative in that it is for commercial facilities not associated with work on lead-bearing materials or equipment. Also, the range of lead in bulk dusts is generally above the U.S. EPA residential level in soil that requires some risk reduction, but well below the level that requires remediation.

The levels of lead and cadmium contamination found at the FCI Ft. Dix recycling factory are not judged by FOH to be significant enough to warrant remediation efforts. Nevertheless, based on some levels above the suggested Lange and EPA guidance, UNICOR and FCI Ft. Dix should implement procedures to reduce the risk of exposure to surface dusts and dust accumulations. UNICOR and FCI Ft. Dix should implement an operations and maintenance (O&M) plan to limit contact with existing lead and cadmium contamination, limit its accumulation, prevent and/or control any releases of the contamination to the air, and generally prevent potential for inhalation and ingestion (i.e., hand-to-mouth contact) exposure. With proper controls established, this plan could include periodic clean-up of surfaces by inmate workers. Elements of an O&M plan are discussed in Section 6.0, Recommendations.

Use of gloves and effective hand washing and hygiene practices are also important to maintain based on the levels of surface contamination and the fact that some lead and cadmium was found on the one pair of gloves sampled.

A point of interest in the data is that the levels of lead and cadmium in bulk dust on surfaces are somewhat lower than, but similar to levels found on the AHU filters (also see Section 4.4.3, below). Since filters are changed quarterly according to UNICOR staff, these data indicate that some degree of lead and cadmium contamination is released to the air from current recycling activities on the factory floor. However, FOH personal and area air monitoring results indicated that these releases are minimal from a personal exposure (inhalation) perspective.

See Tables 3 and 4 for data on surface wipe and bulk dust results, respectively. Also see Attachment 1 for complete data.

Table 3
Surface Wipe Sample Results
Data Collected: 01/17/2008

Sample #	Building Name	Surface /Item	Elevation	Description	Area Wiped	Lead	Cadmium
			(feet)		(Sq. Inches)	µg/ft²	µg/ft²
W-1	UNICOR Computer Demanufacturing Building (#5713)	Sheet metal ducting	8	Inside of round duct going through wall - outside glass breaking area	72	320	320
W-2	UNICOR Computer Demanufacturing Building (#5713)	Sheet metal ducting	-	Top of horizontal pipe right next to wall - outside glass breaking area	60	912	288
W-3	UNICOR Computer Demanufacturing Building (#5713)	Fluorescent light	13	Top of fluorescent light in the center of previous glass breaking area	54	1,280	320
W-4	UNICOR Computer Demanufacturing Building (#5713)	Exhaust fan	3	Blade of exhaust fan leading outside - clerk area	24	780	120
W-5	UNICOR Computer Demanufacturing Building (#5713)	Light fixture	14	Top of light fixture (incandescent) - across from utility closet	36	1,280	344
W-6	UNICOR Computer Demanufacturing Building (#5713)	Metal pipe	12	Metal pipe over main corridor	48	2,160	930
W-7	UNICOR Computer Demanufacturing Building (#5713)	Metal truss	13	Metal truss in front of exit door (Breakdown area #1)	48	1,800	660
W-8	UNICOR Computer Demanufacturing Building (#5713)	Fan blade	10	Fan blade of exhaust fan over door	40	349	115
W-9	UNICOR Computer Demanufacturing Building (#5713)	Floor	0	Floor - in corner of former glass breaking area.	144	120	19
W-10	UNICOR Computer Demanufacturing Building (#5713)	Wall	5	Wall in former glass breaking area in corner above floor sample (W-9)	144	49	12
W-11	UNICOR Computer Demanufacturing Building (#5713)	Floor	0	Floor at corner directly under exhaust duct in glass breaking area	9	1,280	384
W-12	UNICOR Computer Demanufacturing Building (#5713)	Metal support	-	Metal support (horizontal surface) of boiler next to exhaust fan	36	328	96
W-13	UNICOR Computer Demanufacturing Building (#5713)	Metal conduit	2.5	Metal conduit on exterior wall next to scale - Outside battery recycling	12	948	132
W-14	UNICOR Computer Demanufacturing Building (#5713)	Conduit	7	Conduit over door near former glass breaking area	30	331	48
W-15	UNICOR Computer Demanufacturing Building (#5713)	Ledge of mirror	6	On top ledge of mirror above slop sink	6	1,340	228
W-16	UNICOR Computer Demanufacturing Building (#5713)	Window panel	-	Refurbish/testing area (downstairs) - top of bottom window panel	12	408	112
W-17	UNICOR Computer Demanufacturing Building (#5713)	Floor	0	Floor corner exterior wall under window - middle of facility	24	600	174
W-19	UNICOR Computer Demanufacturing Building (#5713)	Cinder block ledge	6	Top of cinder block ledge behind electrical panel B	12	1,070	516
W-20	UNICOR Computer Demanufacturing Building (#5713)	Metal Pipes	6	Metal pipes (in between section bolts)	9	352	96

Table 4
Bulk Dust Sample Results
Data Collected: 01/17/2008

Sample #	Building Name	Surface /Item	Elevation	Description	Area Wiped	Lead	Cadmium
			(feet)		(sq. inches)	mg/kg	mg/kg
B-1	UNICOR Computer Demanufacturing Building (#5713)	Pipe	13	Pipe (high) inside former glass breaking area	40	440	110
B-2	UNICOR Computer Demanufacturing Building (#5713)	Metal truss	13	Metal truss by ceiling by small bay door	42	390	95
B-3	UNICOR Computer Demanufacturing Building (#5713)	Window ledge	11	Window ledge of side wall	96	970	160
B-4	UNICOR Computer Demanufacturing Building (#5713)	Metal Pipe	12	Metal pipe over main corridor	54	790	250
B-5	UNICOR Computer Demanufacturing Building (#5713)	Metal Pipe	12	Top pipe surface in breakdown line #1 & 2 - across from bay door	36	670	68
B-6	UNICOR Computer Demanufacturing Building (#5713)	Metal Truss	12	Metal truss just outside office	48	330	67
B-7	UNICOR Computer Demanufacturing Building (#5713)	Floor	0	Floor - corner of exterior wall next to second boiler	-	560	48
F-1	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters[1]	13	Dust shaken from the air handling unit filters		990	220
F-2	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters[1]	13	Dust shaken from the air handling unit filters		690	170
F-3	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters[1]	13	Dust shaken from the air handling unit filters		1100	220
F-4	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters[1]	13	Dust shaken from the air handling unit filters		1200	220
F-5	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters[1]	13	Dust shaken from the air handling unit filters		1300	220
F-6	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters[1]	13	Dust shaken from the air handling unit filters		980	230

4.3 Legacy LEV System and Bag House

The glass breaking operations conducted between 2003 and 2005 used a Torit LEV system with a bag house that captured toxic metal dusts, such as lead and cadmium. This system and bag house are still located at FCI Ft. Dix and, according to the UNICOR Factory Manager there, the LEV system has not been decontaminated, and filters in the bag house have never been changed. Therefore, the system and bag house contain levels of lead and cadmium that, if disturbed or disposed of without proper controls, have the potential for personal exposure and environmental degradation. Glass breaking has been permanently suspended at FCI Ft. Dix, so this system is not intended to be used by UNICOR at FCI Ft. Dix for e-waste recycling.

UNICOR should decontaminate and decommission (D&D) this system and bag house. The Factory Manager stated that this action was under consideration for 2009. Once

D&D is complete, UNICOR could then dispose of the system in any manner it deems appropriate, such as use for other applications or facilities, disposal, recycling, or sale. UNICOR should produce and retain all records for this process, including records documenting that the system is free of contamination. See Section 5.0, Conclusions and Section 6.0, Recommendations for further information on this process.

4.4 Environmental Compliance and Testing

A review was performed of available information relative to environmental compliance and testing at the FCI Ft. Dix e-waste recycling facilities since 2003. Information is provided below pertaining to testing of air emissions from the glass breaking LEV and dusts from the general building ventilation system along with a review of an inspection performed by the NJDEP.

4.4.1 Environmental Compliance

Current e-waste recycling operations at FCI Ft Dix are conducted under the authority of a Class D permit issued by the NJDEP. This permit, issued for the period of August 8, 2005 to June 6, 2010, dictates the scope of allowable recycling operations and establishes numerous requirements for the receipt, storage, processing, or transfer of recyclable consumer electronics materials. The permit is limited to demanufacturing and specifically prohibits the crushing of CRTs. Other environmental requirements are not addressed in the permit; for example, the permit indicates that discharge of pollutants to New Jersey waters shall not be done without prior acquisition of other necessary approvals from the NJDEP.

FCI Ft Dix's Class D permit specifies over 60 requirements addressing such matters as shipment routes to the factory, signage and labeling, compliance with OSHA regulations, establishing fire-fighting and emergency contingencies, material inventories, periodic reporting mechanisms, and approval of process modifications. In conjunction with the issuance of the permit, NJDEP conducted a compliance inspection in November 2005. The inspection encompassed numerous assessment elements relative to the above-referenced permit requirements. In its final report, NJDEP indicated that no violations were found and that the facility was in compliance with its Class D permit. In a written summary of findings, the report indicated that:

> *Work and storage areas were clean and properly maintained and housekeeping was satisfactory. Containers and palletized recyclable materials and residues were appropriately labeled. Facility personnel continue to maintain a detailed computer database of materials received and processed. No hazardous waste was received, discovered or generated at the facility.*

The NJDEP report of findings went on to emphasize the importance of annual reporting requirements and that a report was due in early 2006.

Based on the NJDEP report, it appears that the facility was in substantial compliance with all environmental requirements as of 2006. No additional salient information was reviewed for subsequent years.

4.4.2 Air Emissions

Since air emissions were produced as a result of the glass breaking operations and the use of the LEV discharging to the outside through an exterior bag house, NJDEP regulations required periodic emissions testing be performed under the facilities' Preconstruction Permit. Specifically, stack emissions testing for barium, cadmium, lead, phosphorus and visible emissions observations was required so that comparison to New Jersey emission limits could be performed. On August 29, 2003, the NJDEP issued UNICOR an Administrative Order and Notice of Civil Administrative Penalty Assessment totaling $6,000 for not submitting a stack test protocol and failing to perform stack testing within the requisite periods. In November 2004 at the request of UNICOR, TRC Environmental Corporation prepared a detailed test plan for submission to the NJDEP, Bureau of Technical Services. Although the testing was tentatively scheduled for fall 2004, it was never performed. On June 23, 2005, glass breaking operations at FCI Ft. Dix were suspended by UNICOR and never resumed.

Limited testing of ambient outdoor air in proximity to the bag house was performed in June 2003. As stated in the testing firm's report, the purpose of the testing was to determine whether exhaust emissions from the bag house outside Building 5713 "has any impact on the outside environment." Two samples were collected near and downstream from the exhaust of the air filtration equipment serving as the LEV for the glass breaking operation being conducted inside the building. The samples did not show concentrations of lead and cadmium above the analytical detection limit and the report's stated conclusion was that "both samples were low and did not indicate a concern for the outside ambient air quality."

4.4.3 Dust Composition from Building Ventilation System Air Filters

Testing was performed on dusts captured by air filters from the general mechanical ventilation system serving Building 5713 (see Image 4) to determine whether the captured dust from the general factory air contained elevated concentrations of lead and cadmium and therefore may contribute to exposures of building occupants. In addition, a second test was performed to determine whether these filters should be treated as hazardous waste.

Testing was performed on six very dusty air handling filters (size: 20"x20"x1") which were provided to FOH on January 17, 2008 by a UNICOR supervisor at FCI Ft. Dix. The filters were wrapped in the same plastic bag which had the label "Changed 1/2/08; air handler filters". The supervisor indicated that the filters had been taken from the different ceiling air handling units serving the e-waste breakdown area in Building 5713 on January 2, 2008. He indicated that filters from the air handling units are replaced on a quarterly basis, although a UNICOR official stated that factory logs indicated that the filters are changed 2 or 3 times annually.

Image 3. Air filters from the general factory ventilation system, Building 5713

In order to test for total lead and cadmium in the filters' dust, each respective filter was shaken over clean paper and the fallen deposits collected and placed in sampling containers. As shown in Table 4, Samples F1-F6, the dust samples had concentrations of total lead ranging from 690 to 1,300 mg/kg. Total cadmium ranged from 170 to 230 mg/kg. This suggests that dust levels in the general factory air creates some potential for personal lead and cadmium exposures (although low) and reinforces the need for a sound operations and maintenance plan that minimizes the disturbance of accumulated dust and provides workers (particularly those involved in building maintenance, filter changing, etc.) with the awareness, training, and equipment to protect against the hazards. Despite some potential for exposure, FOH air sampling results on the general factory floor indicate that airborne exposure in this area is minimal.

In addition to testing for total lead and cadmium, a sample of dust was analyzed for extractible lead and cadmium via the Toxic Characteristic Leaching Procedure (TCLP) method. A composite sample from all six samples was obtained by shaking all the filters in the bag simultaneously and collecting the extracted dust. Testing showed that the extractible lead concentration was 0.78 mg/l (EPA limit is 5 mg/l) and the extractable cadmium concentration was 1.8 mg/l (EPA limit is 1 mg/l). This indicates that the dust from the filters exceeds the cadmium limit for disposal as hazardous waste; however, UNICOR should confirm the hazardous waste status for the dust-laden filters by testing the filters during subsequent change-out periods. [See Attachments for additional details]

4.5 OSHA Inquiry Regarding FCI Ft. Dix Recycling Operations

In response to a complaint of alleged hazardous working conditions and/or violations of OSHA standards at UNICOR's recycling operations at FCI Ft. Dix, OSHA sent a request for information to FCI Ft. Dix on April 15, 2005. OSHA stated that it did not intend to conduct an inspection of the FCI Ft. Dix recycling facilities, but left open the option to do so should it not receive a timely response to the allegations.

Seven allegations were listed by OSHA. A summary of the points in the allegations included:

- Failure to provide areas for the consumption of food and beverages that are free of toxic metal contamination;

- Preparation of food in a manner that does not protect against contamination;

- Work being conducted in areas of toxic metal contamination and use of compressed air to clean contaminated areas and surfaces;

- Adverse health effects such as skin and eye irritation from dusts containing lead and cadmium; and

- Insufficient training to deal with work place hazards and lack of access to safety related records.

The BOP Warden at FCI Ft. Dix responded to the OSHA inquiry on April 25, 2005. The response refuted each of the allegations and described the prevailing conditions and practices that he claimed were maintained at the institution's recycling facilities. After receiving the BOP's information, OSHA closed the matter.

5.0 CONCLUSIONS

Conclusions concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at FCI Ft. Dix are provided below under the following subsections:

- Heavy Metals Exposures;
- Safety and Health Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

These conclusions are supported by the results, findings, and analyses presented and discussed in Sections 3.0 and 4.0 of this report, as well as the documents assembled by the OIG.

5.1 Heavy Metals Exposures

1. Based on FOH monitoring results in January 2008 and on an assessment of monitoring information collected by UNICOR starting in 2003, current routine e-waste recycling operations conducted on the FCI Ft. Dix factory floor (primarily demanufacturing and not including glass breaking that was discontinued in 2005), have minimal inhalation exposure potential to lead, cadmium, and other toxic metals. Lead, cadmium, and other metals exposures were either very low or non-detectable.

2. Current lead and cadmium surface contamination in the factory is not at levels that require remediation. Maintenance of existing housekeeping practices and implementation of an operations and maintenance (O&M) plan will suffice to control potential exposure from existing contamination. An element of the O&M plan could include periodic clean-up of surfaces by inmate workers; however, this would have to be performed using proper hazard controls.

3. According to assessments performed by UNICOR consultants, personal exposures to lead and/or cadmium during glass breaking operations conducted in 2003 were above the action limits and PELs, at times. One cadmium exposure was elevated enough to where it was above the protective capacity of the respirator worn. Other cadmium and lead exposures above the PELs were within the protective capacity of the respirators in use. However, OSHA lead and cadmium standards require that these exposures be controlled through the implementation of work practice and engineering controls, rather than respiratory protection. During this time period, glass breaking was conducted in a glass breaking room using local exhaust ventilation (an engineering control) and defined work practices, but these controls were not adequate to consistently maintain exposures at levels below the PELs.

4. Personal exposures during the last episode of sampling during glass breaking conducted in April 2004 showed lead and cadmium exposures to be well below PELs. This confirmed that the improved engineering controls involving placement of plastic panels around the glass breaking area were effective in reducing personal exposures.

5. Exposure monitoring data are not available during the period 1999 through 2002.

6. The LEV system and bag house that was used at FCI Ft. Dix during glass breaking operations between 2003 and 2005 is still located at the facility and contains lead and cadmium contamination. The system does not represent an immediate worker exposure or environmental hazard, so long as it is not disturbed. However, at some point this system should be properly and safely decontaminated. The system represents a potential source of lead and cadmium hazards until decontamination is conducted.

7. The air handling filters for the general ventilation system serving current factory operations contained lead and cadmium contamination. The cadmium level exceeded the TCLP level that defines the dusts as a hazardous waste. In addition to the environmental implications, this condition represents a potential for worker exposure during the change-out of these filters which is conducted on a quarterly basis. This filter change-out activity has not been monitored for worker exposure to lead and cadmium.

5.2 Safety and Health Programs, Plans, and Practices

8. Although certain safety and health practices are in place for UNICOR's current recycling activities at FCI Ft. Dix, a written facility-specific safety and health document has not been developed to define safety and health requirements such as PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely.

9. According to the FCI Ft. Dix Factory Manager, UNICOR is in the process of identifying and assembling applicable safety and health standards and regulations into a standard operating procedures (SOP) manual that is to be implemented by the recycling factories. When complete, these SOPs are to be implemented at the factories, as applicable. Among other content, the Factory Manager specifically mentioned noise, ventilation, air contaminants, training, and heat stress as elements of the intended SOP manual.

10. Based on exposures determined by FOH in January 2008, exposures during current e-waste recycling (mostly demanufacturing) conducted on the factory floor are not at the levels that require written lead and cadmium compliance plans. However, FOH believes that safety and health practices to ensure continued lead and cadmium exposure control are important to incorporate into an overall written facility-specific safety and health document. Controls for lead and cadmium hazards that should be specified in a safety and health document include any required personal protective equipment, housekeeping practices, hygiene practices, work practices to prevent uncontrolled releases, response to any unanticipated releases, periodic inspections and monitoring, training, and others as deemed appropriate by UNICOR.

11. For glass breaking operations conducted between 2003 and 2005, FCI Ft. Dix implemented engineering controls, work practices, use of personal protective equipment and respiratory protection, and other protective measures. These practices, however, were not formalized into written compliance plans or programs as required by various OSHA standards. Written plans for lead compliance and cadmium compliance were not in place. Between 1999 and 2002, safety and health practices were not well documented.

5.3 Health and Safety Regulatory Compliance

12. Current routine FCI Ft. Dix operations conducted on the factory floor (primarily demanufacturing and not including glass breaking that was discontinued in 2005) are in compliance with the OSHA lead and cadmium standards regarding control of employee exposure.

13. During glass breaking operations conducted between 2003 and 2005, FCI Ft. Dix was in partial compliance with OSHA lead and cadmium standards and efforts to reduce exposures were implemented. Areas that were not in full compliance included (a) exposures were not consistently maintained at or below the PELs through the use of engineering and work practice controls, (b) written lead and cadmium compliance plans were not in place, (c) exposure monitoring did not initially include personal exposure monitoring for glass breakers during glass breaking, (d) change rooms were not compliant, (e) baseline biological monitoring for lead and cadmium was not conducted prior to start of glass breaking and was not conducted until approximately one year after glass breaking, and (f) employee notifications of exposure monitoring with intended corrective actions were not provided in writing.

5.4 Environmental Compliance

14. A 2005 inspection performed by the NJDEP to evaluate the e-waste recycling facilities with respect to the environmental requirements associated with its Class D permit identified no violations. Limited outdoor air emissions testing, also performed in 2005, showed no measurable release of lead and cadmium dusts from the outside bag house used as part of the LEV system associated with the glass breaking operation.

15. Dust deposits collected from air filters from the general air handling system serving the general factory floor showed the presence of some lead and cadmium contamination, and the dust itself exceeded the TCLP limit for cadmium. UNICOR should perform further TCLP testing of the dust-laden filters to determine if they should be treated as hazardous waste.

16. UNICOR was issued citations by the NJDEP starting in 2003 for not performing stack testing within the period required. Prior to the completion of the requisite stack testing, glass breaking operations at FCI Ft. Dix were suspended by UNICOR and never resumed.

6.0 RECOMMENDATIONS

Recommendations concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at FCI Ft. Dix are provided below under the following subdivisions:

- Heavy Metals Exposures;
- Safety and Health Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

Recommendations are limited to current e-waste recycling (mostly demanufacturing) conducted on the factory floor.

6.1 Heavy Metals Exposures

1. UNICOR should periodically conduct at least a limited amount of personal exposure monitoring that characterizes exposures resulting from current work activities conducted on the factory floor. This monitoring will serve to document continued control of the lead and cadmium hazards. An annual monitoring program would be appropriate. Monitoring should also be performed for any future changes that could result in an increased level of exposure, such as changes in work operations, work processes/practices, or quantities or types of materials processed. The monitoring program should also capture non-routine activities with potential exposure to lead and cadmium. Given the low exposures found by FOH, the recommendation for annual monitoring goes beyond the requirements of the OSHA lead and cadmium standards, but would provide important documentation to establish consistently low exposures.

2. UNICOR should perform a hazard analysis and implement exposure appropriate controls (e.g., possibly PPE, dust control measures, dust clean-up measures, bagging techniques) for the change-out of the filters for the general ventilation system. FOH found that the filters provided to it for testing contained lead and cadmium dusts. Depending on the hazard analysis results and the duration of the change-out process, exposure monitoring (at least during the next initial change-out) should be conducted, if warranted.

3. UNICOR should develop and implement an operations and maintenance (O&M) plan to ensure that surface contamination is minimized and that existing contamination is not released that could result in inhalation or ingestion exposures. Elements of this plan could include:

    - Identification of activities that could disturb contamination (e.g., HVAC maintenance, filter change and disposal, and various building maintenance functions);

- Processes to identify and control hazards for routine and non-routine activities (e.g., job hazard analysis process prior to conducting certain work with identification of mitigating actions);

- Mitigating techniques and procedures during activities of concern (e.g., dust suppression and/or clean-up and capture, filter removal and bagging processes, and use of PPE and respiratory protection);

- Training and hazard communication;

- Disposal of contaminated materials; and

- Periodic inspection, monitoring and evaluation of existing conditions, as appropriate.

The O&M plan should also include safe work procedures and hazard controls to change-out the filters on the general air handling system, particularly if these filters are confirmed as needing to be treated as hazardous waste.

At UNICOR's discretion, the O&M plan could also include periodic clean-up of surfaces by inmate workers. If this element were adopted, however, UNICOR should ensure that practices to control exposures are included in the plan and implemented, such as appropriate PPE, respiratory protection, exposure monitoring, clean-up methods (e.g., HEPA vacuuming and wet methods), waste disposal, hygiene practices, and others deemed appropriate by UNICOR. Initial exposure monitoring should be conducted to determine whether exposure during clean-up is above the action limits for lead and cadmium. Controls for future clean-up activities should then be based on exposure results.

4. UNICOR and FCI Ft. Dix should incorporate PPE requirements and practices, housekeeping practices (e.g., surface wet cleaning and HEPA vacuuming, disposal of contaminated PPE, etc.) in work areas, hygiene practices (e.g., hand washing), and other safe work practices that effectively control airborne, surface, and skin contamination into a written safety and health document (see Section 6.2 for further information).

5. UNICOR should decontaminate and decommission the Torit LEV system and associated bag house and filters that served the glass breaking operations conducted between 2003 and 2005. In performing this D&D operation, UNICOR should draw upon the experience and lessons learned from FCI Elkton and FCI Mariana regarding filter change-out and remediation processes. UNICOR should ensure the following:

    - A written plan for worker and environmental protection should be developed following completion of a hazard evaluation. This plan should include appropriate work practices, hazard controls, and waste disposal methods.

- Work practices should include such techniques as wet methods, HEPA vacuuming, containment of emissions, bagging methods, housekeeping, and final cleanup. UNICOR's FCI Elkton and FCI Mariana filter change-out and other remediation methods should be reviewed for applicability to FCI Ft. Dix.

- Worker protection should include appropriate PPE, respiratory protection, hygiene practices, and other hazard control measures.

- Personal and area exposure monitoring should be conducted. Surface sampling should be used to confirm successful decontamination.

- Hazardous waste sampling should be performed to determine and implement proper disposal techniques, and those techniques should be applied and documented.

- Records should be developed and maintained to demonstrate worker protection, environmental compliance, and successful decontamination.

6.2 Safety and Health Programs, Practices, and Plans

6. As a "good practice" approach, UNICOR should prepare a concise written safety and health document specifically for its recycling operations at FCI Ft. Dix, as well as for each of its other recycling factories that lack such a document. Such a document should be developed and implemented and would serve to concisely define the safety and health practices and requirements specific to FCI Ft. Dix recycling, such as PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely, Such a document could also be used as an implementing mechanism for UNICOR's safety and health SOP manual when it is completed. Specifically for FCI Ft. Dix, the document could specifically define roles and responsibilities, describe workplace hazards, provide for hazard analysis and control processes, establish the safety and health and hazard control requirements for current operations, identify which UNICOR safety and health SOPs are applicable to FCI Ft. Dix based on its hazards and operations, and ensure implementation of applicable UNICOR SOPs.

7. The safety and health document should also include training requirements. These requirements should include training for use of hearing protection and nuisance dust masks even if used only in a voluntary or precautionary manner. See Section 3.2 for more details on training and documentation requirements for nuisance dust mask use.

6.3 Health and Safety Regulatory Compliance

8. FCI Ft. Dix should conduct activity-based job hazard analysis (JHA) for any new, modified, or non-routine work activity prior to the work being conducted. The JHA process is intended to identify potential hazards and implement controls for the specific work activity prior to starting the work. For instance, the JHA process should be integral to an effective O&M plan, as described in Section 6.1. This hazard analysis process should also be specified in the written safety and health document recommended in Section 6.2, above.

6.4 Environmental Compliance

9. FCI Ft. Dix should conduct/continue periodic internal inspections for compliance with environmental regulations and, in particular, the requirements of the Class D permit should be performed. The report of findings issued in 2005 by the NJDEP provides a good listing of criteria for these assessments.

10. UNICOR should perform TCLP analysis of the air filters from the general factory to determine if filters are to be treated as hazardous waste. This testing should be conducted after the filters are next changed to confirm the findings reported in Section 4.4.3 of this report. During the filter change-out process, appropriate safety and environmental precautions should be implemented to ensure that workers are protected against possible lead and cadmium exposure and to ensure that the filters are properly bagged and stored pending test results. Future filter change-out procedures should be developed based on the test results and these procedures should be incorporated into an O&M plan (also see Recommendations 2 and 3 in Section 6.1).

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APPENDIX

Guidance for Evaluating Surface Samples

Federal standards or other definitive criteria have not been developed for acceptable levels of lead or cadmium surface contamination or dust concentrations in industrial areas where activities are performed involving lead and/or cadmium bearing materials. However, several recommendations or guidelines, primarily for lead, provide points of reference to subjectively evaluate the significance of surface contamination. Some guidelines are available and are noted below (see the NIOSH/DART Elkton report for a more detailed discussion of guidelines):

- OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace (i.e., 29 CFR 1926.62) can be summarized and/or interpreted as follows: all surfaces shall be maintained as 'free as practicable' of accumulations of lead; the employer shall provide clean change areas for employees whose airborne exposure to lead is above the PEL; and the employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination. The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of the Department of Housing and Urban Development's (HUD) initially proposed a decontamination guideline of 200 $\mu g/ft^2$ for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas. In situations where employees are in direct contact with lead-contaminated surfaces, such as working surfaces or floors in change rooms, storage facilities, and lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level.

- For other surfaces (e.g., work surfaces in areas where lead-containing materials are actively processed), OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of lead contamination meets the definition of "practicable." Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of lead dust does not become a source of employee lead exposures. OSHA [29 CFR, Part 1910.1025] has stated that any method that achieves this end is acceptable.

- Lange [2001] proposed a clearance level of 1,000 $\mu g/ft^2$ for floors of non-lead free commercial buildings and 1,100 $\mu g/ft^2$ for lead-free buildings. These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions.

- HUD [24 CFR 35] has established clearance levels for lead on surfaces after lead abatement. These levels range from 40 to 800 µg/ft^2, depending on the type of surface. The level of 200 µg/ft^2 is most commonly used. These levels, however, apply to occupied living areas where children reside, and are not intended for industrial operations.

- Regarding lead in bulk dust or soil samples, the U.S. EPA [EPA n.d.] has proposed standards for residential soil-lead levels. The level of concern requiring some degree of risk reduction is 400 ppm (mg/kg), and the level requiring permanent abatement is 2,000 ppm (mg/kg). Again these levels are for residential settings, rather than for industrial operations.

- There is no quantitative guidance for surface cadmium concentrations. OSHA [40 CFR 745.65] states that surfaces shall be as free as practicable of accumulations of cadmium, all spills and sudden releases of cadmium material shall be cleaned as soon as possible, and that surfaces contaminated with cadmium shall be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne.

ATTACHMENTS

ATTACHMENT 1

AIR SAMPLING DATA TABLE
[General Factory Floor in/near Areas of E-waste Recycling]

Location: FCI Fort Dix, Building 5013
Sampling/Laboratory Methodology: NIOSH Method 7300
Samples collected by: F. Fitzpatrick, CIH (FOH) and J. Davis (DOJ-OIG)

Sample #	Date Collected	Building	Sample Information (Location; activities performed, etc.)	Air Volume Collected (L)	Sample Duration (min.)	Lead mg/m^3	Cadmium mg/m^3
AP1	1/17/08	UNICOR Electronics Recycling Building	Personal: [redacted] Activities – Breakdown table	589	269	ND	ND
AP2	1/17/08	UNICOR Electronics Recycling Building - Lower level	Area: Maintenance adjacent to tool room- on stand	951	315	ND	ND
AP3	1/17/08	UNICOR Electronics Recycling Building - Upper level	Area: Near office in breakdown Line #1 on sign above table	879	295	ND	ND
AP4	1/17/08	UNICOR Electronics Recycling Building - Lower level	Area: Quality assurance – desktop cleaning area – on exhaust	951	314	ND	ND
AP5	1/17/08	UNICOR Electronics Recycling Building	Personal: [redacted] Activities - Motherboards and cards area	582	258	0.0014	ND
BP1	1/17/08	UNICOR Electronics Recycling Building - Upper level	Area: Glass booth area next to boiler (compacter)	903	304	ND	ND
BP2	1/17/08	UNICOR Electronics Recycling Building	Personal: [redacted] Activities - Breakdown table	572	261	ND	ND

Sample #	Date Collected	Building	Sample Information (Location; activities performed, etc.)	Air Volume Collected (L)	Sample Duration (min.)	Lead mg/m^3	Cadmium mg/m^3
BP3	1/17/08	UNICOR Electronics Recycling Building - Lower level	Area: Scrap laptops and parts on stand	954	317	ND	ND
BP4	1/17/08	UNICOR Electronics Recycling Building	Personal: [redacted] Activities - Breakdown table	567	259	ND	ND
BP5	1/17/08	UNICOR Electronics Recycling Building	Personal: [redacted] Activities - Breakdown table	562	250	ND	ND
Blank 1	1/17/08	---	Field blank	--	--	ND	ND
Blank 2	1/17/08	---	Field blank	--	--	ND	ND

Notes:

1. Sampling was performed to characterize airborne lead and cadmium concentrations at various locations on the general factory floor in/near recycling operations (primarily de-manufacturing). The purpose of this sampling was to characterize general ambient air exposures presumably from the dust deposits found on various surfaces.
2. Detection limits: 'ND' denotes 'None detected' or <0.2 ug Pb/sample (equivalent to 0.0004mg/m3 based on 500 liters of air sampled) and <0.04ug/sample Cd (equivalent to 0.00008 mg/m3 based on 500 liters of air sampled).
3. In addition to the time-weighted average data shown above, an airborne dust survey was performed throughout the sampling day using a real-time, direct-reading instrument (HAZDUST-1100). The purpose of this testing was to identify whether any elevated concentrations or 'dust release' trends could be discerned. Special emphasis was placed on testing air immediately adjacent to the various de-manufacturing work activities being conducted in the building and during other activities which might generate contaminated dusts to which personal may be exposed. The instrument showed no detectible concentrations of any airborne particulates in any of the areas surveyed. The HD-1100 instrument identifies particulates on a semi quantitative basis ranging from 0.1 um to 50 um in size (detection limit: approximately 0.02 mg/m3).
4. NOTE: Other metals included in the lab data (besides lead and cadmium) have not been evaluated.

ATTACHMENT 2

DATA TABLE: Fort Dix Wipe/Bulk/Air Handler Filters (Samples Collected 1/17/08)

Sample #	Date Collected/ Collected By	Sample Type	Building Name	Surface /Item	Elevation	Description	Area Wiped	Area Wiped	Lead			Cadmium			Notes:
		W=Wipe, B=Bulk, H=Hand Wipe			(feet)		(Sq. In)	(Sq. Feet)	µg /wipe	µg /ft2	mg /kg	µg /wipe	µg /ft2	mg /kg	
B-1	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Pipe	13	Pipe (high) inside former glass breaking area	40	0.28			440			110	
B-2	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Metal truss	13	Metal truss by ceiling by small bay door	42	0.29			390			95	
B-3	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Window ledge	11	Window ledge of side wall	96	0.67			970			160	
B-4	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Metal Pipe	12	Metal pipe over main corridor	54	0.38			790			250	
B-5	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Metal Pipe	12	Top pipe surface in breakdown line #1 & 2 across from bay door	36	0.25			670			68	
B-6	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Metal Truss	12	Metal truss just outside office	48	0.33			330			67	
B-7	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Floor	0	Floor - corner of exterior wall next to second boiler	50	0.35			560			48	(Area listed is approximate)
F-1	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters	13	Dust shaken from the air handling unit filters					990			220	Six air filters were provided by [redacted] sealed together in a plastic bag. He indicated that they were from the air handling units in the breakdown area which are replaced on qualerly basis. These reportedly were removed on 1/2/08 and the bag was labeled as such. Received by F. Fitzpatrick. Sample collected by F. Fitzpatrick by shaking filter over clean paper for 10 seconds.
F-2	1/17/2008 FOH	B	Demanufacturing Building (#5713)	Air handling unit filters	13	Dust shaken from the air handling unit filters					690			170	See F-1
F-3	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters	13	Dust shaken from the air handling unit filters					1100			220	See F-1
F-4	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters	13	Dust shaken from the air handling unit filters					1200			220	See F-1
F-5	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters	13	Dust shaken from the air handling unit filters					1300			220	See F-1
F-6	1/17/2008 FOH	B	UNICOR Computer Demanufacturing Building (#5713)	Air handling unit filters	13	Dust shaken from the air handling unit filters					980			230	See F-1
G-1	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Gloves	0	Gloves used by worker in "breakdown area" wiped.			26	-		2.9	-		Collected using Lynx Products "Lead wipes". Wipe of fingers and palms of left and right work gloves [redacted] requested that we "test the gloves"
G-2	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Gloves	0	Blank wipe			ND	ND		ND	ND		Blank wipe - Lynx Products "lead wipes"
W-1	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Sheet metal ducting	8	Inside of round duct going through wall - outside glass breaking area	72	0.50	160	320		30	320		Collected from the exhaust
W-2	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Sheet metal ducting	-	Top of horizontal pipe right next to wall - outside glass breaking area	60	0.42	380	912		120	288		

ATTACHMENT 2 (Continued)

Sample #	Date Collected/ Collected By	Sample Type	Building Name	Surface /Item	Elevation	Description	Area Wiped	Area Wiped	Lead			Cadmium			Notes:
W-3	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Fluorescent light	13	Top of fluorescent light in the center of previous glass breaking area	54	0 38	480	1,280		120	320		
W-4	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Exhaust fan	3	Blade of exhaust fan leading outside - clerk area	24	0 17	130	780		20	120		
W-5	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Light fixture	14	Top of light fixture (incandescent) - across from utility closet	36	0 25	320	1,280		86	344		
W-6	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Metal pipe	12	Metal pipe over main corridor	48	0 33	720	2,160		310	930		
W-7	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Metal truss	13	Metal truss in front of exit door (Breakdown area #1)	48	0 33	600	1,800		220	660		
W-8	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Fan blade	10	Fan blade of exhaust fan over door	40	0 28	97	349		32	115		
W-9	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Floor	0	Floor - in corner of former glass breaking area	144	1 00	120	120		19	19		
W-10	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Wall	5	Wall in former glass breaking area in corner above floor sample (W-9)	144	1 00	49	49		12	12		
W-11	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Floor	0	Floor at corner directly under exhaust duct in glass breaking area	9	0 06	80	1,280		24	384		
W-12	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Metal support	-	Metal support (horizontal surface) of boiler next to exhaust fan	36	0 25	82	328		24	96		
W-13	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Metal conduit	2 5	Metal conduit on exterior wall next to scale - Outside battery recycling	12	0 08	79	948		11	132		Some visible dust apparent
W-14	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Conduit	7	Conduit over door near former glass breaking area	30	0 21	69	331		9 9	48		
W-15	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Ledge of mirror	6	On top ledge of mirror above slop sink	6	0 04	56	1,340		9 5	228		
W-16	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Window panel	-	Refurbish/testing area (downstairs) - top of bottom window panel	12	0 08	34	408		9 3	112		
W-17	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Floor	0	Floor corner exterior wall under window - middle of facility	24	0 17	100	600		29	174		
W-18	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	N/A	N/A	Blank wipe (ghost wipe)	n/a	n/a	ND	ND		ND	ND		"Ghost wipes" provided by NIOSH
W-19	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Cinder block ledge	6	Top of cinder block ledge behind electrical panel B	12	0 08	89	1,070		43	516		
W-20	1/17/2008 FOH	W	UNICOR Computer Demanufacturing Building (#5713)	Metal Pipes	6	Metal pipes (in between section bolts)	9	0 06	22	352		6	96		

ATTACHMENT 2 (Continued)

Conclusions-Wipe, Bulk and Particulates from Filters from Air Handling Units:

1. Detectable lead and cadmium contamination was found to exist on all surfaces tested and in the particulates shaken from the filters said to be taken from the air handling units.

2. Bulk samples of dust deposit collected from various surfaces throughout the electronics recycling facilities showed lead concentrations ranging from 330 to 970 mg/kg.

   These levels are not judged to be significant enough to warrant remediation, although steps should be implemented to limit exposures to personnel who may come in direct contact with this material (e.g., implementation of an operations and maintenance plan). Rationale for the conclusion that these levels in the settled dusts do not warrant remediation include the EPA criteria for lead contamination in soil. While not directly applicable, EPA has adopted 400 mg/kg lead in soil "where children may be exposed" as a level of concern that should trigger appropriate risk reduction activities and ≥ 2000 ppm as a trigger for permanent abatement of soil lead hazards. (http://www.cdc.gov/niosh/2001-113.html) Cadmium concentrations ranged from 48 to 250 mg/kg (about 5x lower than lead) and, as with lead, are not judged to be significant enough to warrant remediation.

3. Particulates shaken from air filters said to be taken from the air handling units in the electronics recycling building after 3 months of use all showed the presence of lead and cadmium.

   This is consistent with the other data gathered (i.e., for bulks and wipes) and indicates that lead and cadmium-containing dust exists in the area. It also indicates that lead and cadmium-containing dust is entering the air ducts or that the dust deposits have settled in the ductwork from previous operations (and are being released to the filters over time), or both.

4. Surface wipe samples ranged from 320 to 2160 ug/ft2 lead and 96 to 930 ug/ft2 cadmium.

   These levels are not judged to be a significant enough to warrant remediation, although steps should be implemented to limit exposures to personnel who may come in direct contact with this material (e.g., implementation of an operations and maintenance plan). Rationale for the conclusion that these levels do not warrant remediation includes the proposed Lange clean-up criteria for lead in commercial buildings and general lack of accessibility to the surfaces. [Lange]

5. Wipes of work gloves said to be used by an inmate in the electronics recycling factory showed very little lead and cadmium contamination.

6. Other metals: NOTE: Lab data for metals other than lead and cadmium have yet to be evaluated.

ATTACHMENT 3

SUMMARY REPORT
Analysis of Dust from Air Filters taken from Building 5713, Ft. Dix

By: F. Fitzpatrick, CIH; Federal Occupational Health
Date: 11/16/08

Six dusty air handling filters (size: 20"x20"x1") were provided to FOH on 1/17/08 by [redacted], UNICOR, FCI Ft. Dix. The filters were all wrapped in the same plastic bag which had the label "Changed 1/2/08; air handler filters". [redacted] indicated that the filters had been taken from the different ceiling air handling units serving the breakdown area of the e-waste breakdown area in Building 5713 on 1/2/08. He indicated that filters from the air handling units are replaced on quarterly basis.

Dust was collected from each of the six filters and analyzed for total lead and cadmium by BV Labs. Samples were collected by shaking each respective filter over clean paper and placing fallen deposits into a sampling container.

The dust samples showed concentrations of total lead ranging from 690 to 1300 mg/kg Total cadmium ranged from 170 to 230 mg/kg. [see "Data Table: Fort Dix Wipe/Bulk/ Air Handler Filters (Samples Collected 1/17/08)"]

In addition, sample was taken of dust obtained by shaking all the filters in the bag simultaneously. This composite sample was prepared (extracted) using EPA method 3011/3015 and analyzed for extractible seven metals, including lead and cadmium, via

EPA's TCLP method 6010B (preparation method) in order to determine whether these filters may need to be treated as hazardous waste.

Testing showed that the extractible lead concentration was 0.78 mg/l (EPA regulatory level is 5 mg/l) and the extractable cadmium concentration was1.8 mg/l (EPA regulatory level is 1 mg/m3). Traces of barium and chromium were also found in the leachate but at 10-100 times below the EPA limits.

TCLP Data-- Air Filter Dust (from DataChem Laboratories Report)

Analyte	Date Analyzed	PQL	Result	Comment	Qual.	Dilution	Regulatory Limit
Arsenic	10-NOV-08 14:48	0.3	ND		U	1	5.0
Barium	10-NOV-08 14:48	0.02	0.93			1	100.0
Cadmium	10-NOV-08 14:48	0.01	1.8			1	1.0
Chromium	10-NOV-08 14:48	0.02	0.17			1	5.0
Lead	10-NOV-08 14:48	0.1	0.78			1	5.0
Selenium	10-NOV-08 14:48	0.3	ND		U	1	1.0
Silver	10-NOV-08 14:48	0.02	ND		U	1	5.0

PQL= Practical Quantitation Limit; ND= "None Detected"; U= "Not detected above the minimum detection limit"

The presence of cadmium in the extracted leachate at a concentration which exceeds the EPA TCLP regulatory level

USP LEAVENWORTH

EVALUATION OF ENVIRONMENTAL, SAFETY, AND HEALTH INFORMATION RELATED TO UNICOR E-WASTE RECYCLING OPERATIONS AT USP LEAVENWORTH

PREPARED FOR THE UNITED STATES DEPARTMENT OF JUSTICE
OFFICE OF THE INSPECTOR GENERAL

Submitted to: [redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
U.S. Department of Justice

Submitted by: Mr. George Bearer, CIH
FOH Safety and Health Investigation Team
Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

November 5, 2009

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Appendix

1.0 INTRODUCTION

At the request of the U.S. Department of Justice (DOJ) Office of the Inspector General (OIG), the Federal Occupational Health Service (FOH) coordinated environmental, safety and health (ES&H) assessments of electronics equipment recycling operations at a number of Federal Bureau of Prisons (BOP) facilities around the country. The assessments were conducted as a result of whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium at electronics recycling operations overseen by Federal Prison Industries (UNICOR).[1] The allegations stated that these exposures were occurring from the breaking of cathode ray tubes (CRTs) and other activities associated with the handling, disassembly, recovery, and recycling of electronic components found in equipment such as computers and televisions (i.e., e-waste).[2] It was further alleged that appropriate corrective actions had not yet been taken by BOP and UNICOR officials and that significant risks to human health and the environment remained.

This FOH report discusses UNICOR's e-waste recycling operations at the United States Penitentiary, Leavenworth, Kansas (USP Leavenworth). The federal agencies that are assisting the OIG with its investigation (FOH, the National Institute for Occupational Safety and Health (NIOSH), and the Occupational Safety and Health Administration (OSHA)) did not conduct on-site assessments at USP Leavenworth. To prepare this report, FOH reviewed information assembled by the OIG, including UNICOR consultant industrial hygiene reports, other documents related to ES&H issues at USP Leavenworth, and an OIG interview with the Production Controller. FOH also interviewed the Production Controller. The primary objectives and purpose of this report are to characterize current UNICOR operations and working conditions at USP Leavenworth in light of the whistleblower allegations and to evaluate worker protection and environmental protection measures. This report characterizes current operations and working conditions at USP Leavenworth (i.e., from startup in 2007 to present) especially with respect to the potential for inmate and staff exposures[3] that may result from present day e-recycling activities.

USP Leavenworth is last of eight BOP institutions for which an assessment report has been prepared by FOH. On October 10, 2008, FOH issued a separate report entitled "*Evaluation of Environmental, Safety, and Health Information Related to Current UNICOR E-Waste Recycling Operations at FCI Elkton*" [FOH 2008] detailing current exposure conditions at FCI Elkton. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in e-waste

[1] FPI, (commonly referred to by its trade name UNICOR) is a wholly-owned, Government corporation that operates factories and employs inmates at federal correctional institutions.

[2] E-waste is defined as a waste type consisting of any broken or unwanted electrical or electronic device or component.

[3] In this report, the term "exposure" refers to the airborne concentration of a contaminant (e.g., lead or cadminm) that is measured in the breathing zone of a worker but outside of any respiratory protection devices used. Unless otherwise noted, "exposure" should not be confused with the ingestion, inhalation, absorption, or other bodily uptake of a contaminant since, in part, concentrations reported and discussed in this report are not adjusted based on respirator protection factors. However, when reported, it is indicated whether the exposure was within the protective capacity of the respirator.

electronics, pertinent regulatory requirements, and other information that provides additional context to this report for USP Leavenworth.

Currently, e-waste recycling operations at USP Leavenworth involve receipt of waste electronics from various locations around the country, disassembly and sorting activities ('demanufacturing'), and the associated material handling and facilities maintenance required to support these operations. Glass breaking operations (GBO) have never been performed at USP Leavenworth.

2.0 UNICOR E-WASTE RECYCLING FACILITIES AND OPERATIONS AT USP LEAVENWORTH

UNICOR e-waste recycling operations commenced at USP Leavenworth in mid-2007 at factory facilities located at a camp adjacent to the main prison. Incoming materials are received and unloaded at the factory loading dock and processed in the factory. Materials and equipment received for recycling include central processing units (CPUs), CRTs, televisions, printers, copiers, and fax machines. As with other UNICOR e-waste recycling operations, current recycling of electronic components at this facility involves receiving and sorting, disassembly, and packaging and shipping. Cleaning and maintenance in support of these processes are also conducted. Glass breaking and desoldering are not performed, although inmates clean-up CRT glass that is accidentally broken. After clipping cords, CRTs are shipped intact to FCC Tucson for removal of their housings and for shipping to a recycling factory in Mexico. The flow of materials and operations are described below.

The USP Leavenworth factory is a single building. Equipment for recycling is received at the factory's loading dock and then weighed, examined, unloaded, and categorized. CRTs are segregated and sent to a factory location where they are palletized and shipped intact to FCC Tucson. Parts and equipment to be refurbished and disassembled are segregated into Gaylord boxes by material type (e.g., plastics, metals, circuit boards, wires, etc.). These materials are then moved to various work stations in the factory for processing. Metal and plastic components are compacted using baling equipment. When processing is complete, materials are packaged for shipment. See FOH reports for USP Lewisburg and FCI Marianna for a more detailed description of disassembly and related activities that generally apply to USP Leavenworth. [FOH 2009a; FOH 2009b]

UNICOR has never performed glass breaking or plastic sanding at USP Leavenworth. When glass is accidentally broken, inmates clean up the glass according to a UNICOR written work instruction. A cleanup kit is on hand that includes protective equipment and cleanup equipment to be used for this operation. Inmates also perform daily and weekly cleaning activities to keep lead and cadmium contamination levels in check in the work areas. See Section 3.1 for further descriptions of work practices for CRT glass cleanup and work area cleaning activities.

3.0 BOP/UNICOR SAFETY AND HEALTH PROCEDURES AND PRACTICES AT USP LEAVENWORTH

Under 29 CFR 1960 each federal agency is obligated to develop a comprehensive and effective safety and health program. Such programs establish requirements and processes for controlling occupational hazards and meeting federal occupational safety and health regulations. The BOP has established an ES&H policy entitled Occupational Safety, Environmental Compliance, and Fire Protection (BOP Program Statement 1600.09). [BOP 2007] UNICOR's compliance with this policy will be evaluated in the OIG's final report.

Various OSHA standards require written programs or plans to address occupational hazards or implement hazard control measures. Examples applicable to UNICOR's e-waste recycling activities include:

- 29 CFR 1910.1025, Lead requires a written lead compliance plan;
- 29 CFR 1910.1027, Cadmium requires a written cadmium compliance plan;
- 29 CFR 1910.134, Respiratory protection requires a written respiratory protection program; and
- 29 CFR 1910.95, Occupational noise exposure requires a written hearing conservation program.

In addition to the specific OSHA standards listed above, heat exposure is another hazard that could be associated with USP Leavenworth recycling operations. Although OSHA does not have a specific standard for heat exposure, it can regulate this hazard under its "General Duty Clause" [OSHA 1970] that requires employers to furnish a workplace that is free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees.

In addition to written programs that address a specific hazard, a good practice approach warrants that a general safety and health plan should be in place to identify workplace hazards and specify appropriate hazard controls and safe work practices.

UNICOR's ES&H practices and programs associated with the e-waste recycling activities conducted at USP Leavenworth are discussed below.

3.1 Safety and Health Practices and Procedures to Control Toxic Metals Exposure

According to the USP Leavenworth Production Controller, recycling is conducted in accordance with UNICOR's standard operating procedures (SOPs), as well as two work instructions for housekeeping and cleanup of accidental glass breakage. These instructions and activities are discussed later in this section. The Production Controller reported that inmate workers receive familiarization training for the work environment. He stated that this training includes such information as hygiene practices (e.g., hand washing) and factory rules (e.g., no eating or drinking in the work area). UNICOR does not have written lead and cadmium compliance programs in place at USP Leavenworth; however, these programs are not required when worker exposures do not exceed the OSHA lead and cadmium PELs. UNICOR consultant reports discussed in Section 4.0 confirm that lead and cadmium action levels and PELs are not exceeded for current disassembly operations conducted at USP Leavenworth.

As with other factories, UNICOR does not have a written factory-specific safety and health document at USP Leavenworth to define existing workplace hazards and control measures. As a "good practice" approach, such a document should be developed and implemented to concisely define the safety and health practices and requirements specific to the factory. The document should address PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping and cleaning practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Non-routine or periodic work activities should also be addressed in the document, particularly those that potentially disturb dusts such as cleaning and handling/disposing of wastes from HEPA vacuums or containers. The approach to evaluate new or modified processes should be addressed as well. The document could also specify requirements for periodic site assessments, hazard analyses, inspections, monitoring, actions for new or changed processes, and regulatory compliance reviews.

The Production Controller stated that baseline biological monitoring for lead and cadmium was conducted for workers, and that this monitoring is to be provided on an annual basis. Because UNICOR consultant exposure monitoring has not shown exposures to be above the lead or cadmium action levels, the OSHA lead and cadmium standards do not require that biological monitoring be performed. However, as recommended by NIOSH in its reports for other UNICOR factories, UNICOR, if it so chooses, can continue this monitoring as an additional safeguard and as reassurance to staff and inmates.

According to the Production Controller, USP Leavenworth provides Northern Safety Model 7000 nuisance dust masks to workers for voluntary use. A UNICOR consultant recommended in May 2009 that only certain types of dust masks be used (e.g., equivalent to or better than an N-95 filtering facepiece respirator). The current USP Leavenworth dust mask does not meet this criterion. The consultant also recommended that workers be informed of Appendix D criteria of 29 CFR 1910.134, Respiratory protection, regarding voluntary use of respirators. UNICOR at USP Leavenworth has not yet implemented either of these recommendations, even though FOH has made this similar recommendation in previous reports for UNICOR factories. Because it is the position of UNICOR that respirators are only used voluntarily, UNICOR does not require a written respiratory protection program for disassembly operations at USP Leavenworth; however, UNICOR should ensure that disposable dust masks are properly stored, used, replaced, and disposed of. In addition, according to its written work instruction, USP Leavenworth requires the use of dust masks for cleanup of accidentally broken glass. A written respiratory protection program is, therefore, required for this operation (see the discussion of this work instruction and practice later in this section).

For general factory operations, the Production Controller stated that PPE consists of gloves, safety glasses, and safety shoes. Dust masks and hearing protection are provided for voluntary use but are not required.

The Production Controller provided a work instruction for housekeeping ("Line Housekeeping Work Instructions"). The Production Controller stated that cleaning is performed daily using HEPA vacuuming and wet methods. For bulk debris, the material is first wetted and then picked up. He confirmed that dry sweeping had been conducted, but based on the May 2009 UNICOR consultant recommendations, dry sweeping has been discontinued. The Production Controller also reported that a weekly cleanup is being initiated in addition to the daily practice. During the weekly cleanup, a cleaning agent formulated for lead dust cleanup is to be used to enhance cleaning effectiveness. FOH recommends that UNICOR revise the housekeeping work instruction to clearly prohibit dry sweeping and to include the weekly cleaning process.

The Production Controller also provided a work instruction for cleanup of broken CRT glass ("Accidental Cathode Ray Tube Glass Breakage Cleanup"). The Production Controller stated that inmates don Tyvek® coveralls, gloves, and dust masks. Broken glass is cleaned up using wet methods and HEPA vacuuming. Broken glass is placed in a Gaylord box and labeled as broken glass. The box is then sent to FCC Tucson where it is forwarded to a recycling plant in Mexico. Contaminated PPE is placed in a container and disposed of as hazardous waste. The work instruction is consistent with the methods reported by the Production Controller and is appropriate for the activity. The instruction lists use of a dust mask (type not specified) under the section titled "Mandatory Cleanup/Safety Equipment." Because respirator use is required, a written respiratory protection program is also required for this operation to include such elements as training, fit testing, and medical clearance, among others (see 29 CFR 1910.134, Respiratory protection). USP Leavenworth does not have a written respiratory protection program and has not implemented the elements required. Also, UNICOR should upgrade its dust masks for this operation to those recommended by the consultant (equivalent to or better than an N-95 filtering facepiece respirator), because the recommended masks offer protection against toxic metals dusts.

In summary, UNICOR safe work practices seem to be appropriate for the recycling operations performed, with the exception of dry sweeping. UNICOR should ensure that dry sweeping has been discontinued and revise work instructions to emphasize this restriction, as well as to add the weekly cleaning practices. UNICOR should also verify that dust masks meet the recommendation of N-95 filtering facepiece respirator or better that was made the UNICOR consultant, and it should implement a respiratory protection program for inmate workers involved in the cleanup of broken CRT glass. Finally as a good practice, UNICOR should implement a written safety and health program for USP Leavenworth and its other factories.

3.2 Safety and Health Practices and Procedures to Control Other Hazards

Certain disassembly operations at other UNICOR factories have been shown to produce noise exposures above the OSHA action level that triggers the requirement for a written hearing conservation program and implementation of such practices as hearing protection use, audiometric testing, training, and other requirements. A UNICOR consultant performed noise dosimetry in May 2009 and found that exposures did not exceed the OSHA action level of 85 dBA that triggers the requirement for a written hearing conservation program. The metal baler's exposure approached this level at 84 dBA (see Section 4.3 for additional information on noise). FOH recommended in its USP Atwater report that based on metal baler exposures being above the OSHA action level for noise at many factories, UNICOR should implement a hearing conservation program for inmates performing this operation at all UNICOR factories. [FOH 2009c]

UNICOR has prepared a document titled "Heat Stress Program" dated September 26, 2008. The Production Controller stated that USP Leavenworth does not have a heat stress program, but that he was aware of the heat stress issue found at FCI Marianna. He also stated that the USP Leavenworth factory was air conditioned and that there were no operations such as glass breaking where the type of work and the protective equipment could lead to a heat stress hazard. He also stated that even during unloading of trucks at the factory loading dock, workers are stationed within the air conditioned factory.

Regarding hazard analysis, the Production Controller stated that a walkthrough survey was conducted by the Institution Safety Specialist on a monthly basis. He also stated that UNICOR was planning a program review (in 2008), but that this review was not focused on safety and health. He also reported that a UNICOR consultant had conducted an industrial hygiene evaluation in 2008 and that such a survey was to be performed annually (another was conducted in May 2009). As part of an overall safety and health program, UNICOR should develop a thorough hazard analysis program. This program should include baseline hazard analysis for current operations and job (activity-specific) hazard analyses for routine activities, activities performed under an operations and maintenance (O&M) plan, non-routine activities, and new or modified activities. Such a program should include all potential hazards and not just lead and cadmium. This applies to all UNICOR recycling factories.

Regarding UNICOR information sharing from other UNICOR factory experiences and evaluations, the Production Controller appeared to be unaware of certain information regarding recycling hazards, exposures, and violations at other factories. For instance, he stated that he had heard of unspecified reports of problems at USP Atwater, but he also stated that it was his understanding that these reports were unsubstantiated. He was also aware of the FCI Marianna heat stress reports, but associated the heat issue only to glass breaking. He did not indicate any awareness concerning OSHA violations regarding dry sweeping in disassembly areas or potential for build-up of contaminants as a result of disassembly. Dry sweeping was performed until a UNICOR consultant recommended against it in May 2009. As discussed in FOH reports for other UNICOR factories, this is further indication that UNICOR does not have an effective system to share information between factories to ensure implementation of improved practices and to ensure that the same mistakes are not made among factories. The dry sweeping reported by the UNICOR consultant in 2009 is an example of an activity that should never have been performed given the OSHA violation issued to UNICOR at USP Lewisburg in 2007.

4.0 FIELD INVESTIGATIONS AND MONITORING RESULTS

UNICOR consultants conducted field evaluations of USP Leavenworth e-waste recycling operations in 2008 and 2009. These evaluations included personal exposure monitoring, surface sampling, and other testing and evaluation.

Metals of greatest interest for occupational exposures related to e-waste recycling include lead, cadmium, and barium. Beryllium can also be associated with e-waste materials and is also of interest because of its adverse health effects and low exposure limit. These metals were the focus of the field investigations. See the FCI Elkton report referenced in Section 1.0 for details regarding e-waste hazards.

Exposure monitoring results are compared to the legally enforceable permissible exposure limits (PELs) and action levels established by OSHA. In addition, non-mandatory ACGIH TLVs and NIOSH recommended exposure limits (RELs) are also provided for reference. Personal exposure limits are often based on 8-hour time weighted average (TWA) exposures and the TWAs are applicable to the exposures discussed in this report. Table 1 provides exposure limits for lead, cadmium, barium, and beryllium. PELs, action levels, and TLVs for other hazards can be found in OSHA standards (29 CFR 1910) and the 2009 ACGIH TLVs. [ACGIH 2009]

Federal standards or other definitive criteria or guidelines have not been developed for acceptable levels of lead or cadmium surface contamination or dust concentrations in industrial areas where activities are performed involving lead and/or cadmium bearing materials. However, several recommendations or guidelines, primarily for lead, provide points of reference to subjectively evaluate the significance of surface contamination. Some guidelines that are available are provided in the Appendix to this report.

Table 1
Occupational Exposure Limits[1]

	LEAD ($\mu g/m^3$)	CADMIUM ($\mu g/m^3$)	BARIUM ($\mu g/m^3$)	BERYLLIUM ($\mu g/m^3$)
OSHA PEL	50	5.0	500	2[5]
OSHA ACTION LEVEL[2]	30	2.5	N/A	N/A
ACGIH TLV (Total Exposure)	50	10.0	500	0.05[4]
ACGIH TLV (Respirable Fraction)	N/A	2.0	N/A	N/A
NIOSH REL	50	*Ca*[3]	500	0.5

Notes:

1. All limits are based on an 8-hour time weighted average (TWA) exposure. NIOSH RELs are based on TWA concentrations of up to a 10-hour workday during a 40-hour workweek.
2. The action level is an exposure level (often around half of the PEL) that triggers certain actions, such as controls, monitoring, and/or medical surveillance under various OSHA standards.
3. *Ca* (Potential Occupational Carcinogen). NIOSH RELs for carcinogens are based on lowest levels that can be feasibly achieved through the use of engineering controls and measured by analytical techniques. [NIOSH 2005]
4. ACGIH TLV 2009 adoption.
5. OSHA also has 5 $\mu g/m^3$ ceiling and 25 $\mu g/m^3$ peak exposure limits.

4.1 UNICOR Consultant Evaluation of 2008

A consulting firm conducted exposure monitoring and surface sampling in January 2008 for USP Leavenworth computer sorting, disassembly, and other operations. Results are summarized below.

- Three personal breathing zone samples were collected in what the consultant described as an area "outside" UNICOR. Two were for personnel performing sorting of computers and one was for disassembly (teardown). All three samples had non-detectable levels of lead and cadmium, well below the OSHA PELs and action levels. The consultant did not describe PPE used during the recycling operations monitored, except that steel-toed shoes were listed in the data sheets of an Appendix to the report. For instance, the use of gloves was not mentioned.

- One personal sample was apparently taken for a worker performing a nearby operation not related to e-waste recycling (sorting clothing and hangers). This personal exposure was also not detectable for lead and cadmium.

- Ten surface wipe samples were collected from work areas and equipment including work benches/tables, floors, a filter, gloves, a baler, a vacuum, and a canister. All of these samples were less than the OSHA lead guideline of 200 $\mu g/ft^2$ for clean areas (such as change rooms associated with lead work areas). The highest lead result (113 $\mu g/ft^2$) was from an unidentified filter #4 closest to a clerk's desk. The highest cadmium result (53 $\mu g/ft^2$) was from a HEPA vacuum handle used for broken CRT glass cleanup. The consultant offered no interpretation of the surface sample results.

- The surface samples as described in an Appendix of the consultant's report included such items and areas as: the inside surface of a canister used for disposal of PPE that is worn during clean-up of broken CRT glass; gloves used to handle broken CRT glass; HEPA vacuum used to clean-up broken CRT glass; and a cardboard box used to hold broken CRT glass. The consultant's report did not describe PPE used during the recycling operations including glass cleanup (except for steel-toed shoes listed in the sampling sheets), did not describe the extent of broken glass handling or the clean-up processes, and did not include exposure monitoring for broken glass handling or clean-up.

The UNICOR consultant presented exposure results compared to OSHA PELs and action levels, but did not provide much information regarding work activities, work practices, and hazard controls. No recommendations were provided. UNICOR should scope consultant activities in a manner that requires critical assessment of hazards, operations, and controls and that also ensures expert recommendations for continuing improvements.

4.2 UNICOR Consultant Evaluation of 2009

In May 2009 as part of UNICOR's recently implemented annual exposure monitoring program, a consultant conducted an industrial hygiene evaluation of USP Leavenworth's e-waste recycling operations. Personal exposure and surface wipe samples were collected during disassembly and related activities. Samples were analyzed for lead, cadmium, and beryllium. Results are presented below:

- Nine personal breathing zone samples were collected for lead analysis and four were collected for cadmium and beryllium analysis. The samples were collected for various disassembly and associated operations. All exposure results were reported as ND (less than the detection limit). The consultant did not quantify the detection limits in $\mu g/m^3$, but FOH calculations from the report indicate that the detection limits were appreciably below the PELs and action levels thus demonstrating adequate exposure control.

- The consultant collected 21 wipe samples for lead analysis. The consultant reported that 10 of 21 samples were above the OSHA 200 $\mu g/ft^2$ criterion, with the highest level at 849 $\mu g/ft^2$. [Note: FOH points out that this criterion applies to clean areas such as change rooms or lunch areas and not active work surfaces. See the Appendix to this report.] Of these 10, nine were from overhead mechanical systems (e.g., elevated surfaces) not subject to regular cleaning. Only one sample above the OSHA criterion was from a work surface where inmates operate. This sample had 330 $\mu g/ft^2$ lead.

- Of these 21 samples, six were also analyzed for cadmium and beryllium. All beryllium results were less than the limit of detection. The consultant reported that one cadmium result from an overhead beam was above the EPA guidance level for residential (non-workplace) cadmium (150 µg/ft^2 versus EPA guidance of 144 µg/ft^2). FOH emphasizes that this is a conservative level developed for residences and not work areas where cadmium-bearing materials are processed.

The consultant reported that site personnel were vigilant about cleaning up their workstations. However, the consultant observed dry sweeping during the evaluation, which is explicitly prohibited by the OSHA lead and cadmium standards. He recommended that dry sweeping be limited to the pick-up of larger parts, but also recommended that HEPA vacuuming and wet wiping be "continued" and that HEPA vacuuming be utilized "instead of" dry sweeping. [Note: In reports for other UNICOR factories, NIOSH recommended the use of misting and squeegees for clean-up of larger debris.] The consultant also noted that better cleaning practices are needed based on the one lead sample in the work area that was above the OSHA guideline for clean areas. In a discussion with FOH, the Production Controller stated that dry sweeping has since been discontinued and that a weekly cleaning process using a de-leading agent is being initiated to supplement daily cleaning practices.

The consultant also recommended that several types of disposable dust masks (N-95 filtering facepiece respirator or better) be available to workers based on their preference. This type of respirator is approved for toxic metals dusts. The consultant did not report whether the current dust masks in use meet his recommendation, but the Production Controller reported that Northern Safety Model 7000 nuisance dust masks are used, and these do not meet the consultant recommendation. The consultant also mentioned that some variability in respirator use existed ("variability" was not defined). The consultant also properly recommended that workers be informed of Appendix D criteria as required by 29 CFR 1910.134, Respiratory Protection, regarding voluntary use of respirators. The consultant did not report on other types of PPE used, but inferred that he did not find any issues with other PPE. The consultant also did not evaluate the cleanup of broken CRT glass for which various PPE including dust masks are required.

FOH concludes from the consultant report that inhalation exposures from general factory disassembly and related operations are well controlled below OSHA action levels and PELs. This finding is consistent with other UNICOR disassembly factories. The finding that elevated surfaces are higher in contamination levels than work areas is also consistent with other UNICOR factories. The elevated surfaces are not subject to regular clean-up activities, while work areas are regularly cleaned. Based on the suggested Lange lead criteria of 1,000 µg/ft^2 to 1,100 µg/ft^2 for surface contamination in commercial buildings [Lange 2001], these results are not excessive yet, but given that operations have only been underway for about 18 months, the results show that contamination can build up over time even when only disassembly is performed. UNICOR should implement an operations and maintenance (O&M) plan to keep contamination levels in check for these non-work areas (e.g., mechanical system surfaces) and prevent exposure during maintenance activities that access these areas (see Section 6.0, Recommendations). (See Appendix for information and guidance on surface contamination.)

4.3 Investigations for Noise Exposure

In May 2009, a UNICOR consultant conducted noise monitoring at the USP Leavenworth recycling factory. Five personal noise dosimetry samples were collected. Four of five samples were well below the OSHA action level of 85 dBA that triggers the requirement for a hearing conservation program. The metal baler operator had an exposure of 84 dBA which is just below the OSHA action level. The consultant did not report whether hearing protection was available and worn. According to the Production Controller, hearing protection is provided for voluntary use, but is not required for any operation.

FOH notes that the metal baler's exposure approaches the OSHA action level. UNICOR should verify that the action level is not exceeded through follow-up monitoring as part of its annual program. However, because metal baling at several other factories has been shown to exceed the OSHA action level, UNICOR should require a hearing conservation program for this operation at all of its factories, including USP Leavenworth, unless UNICOR clearly demonstrates that noise exposures are consistently maintained below the action level at a particular factory.

4.4 Environmental Issues

FOH conducted a review of available documents pertaining to environmental issues associated with the current e-waste recycling operations conducted by UNICOR at USP Leavenworth. UNICOR obtained a solid waste processing permit from the Kansas Department of Health and Environment (KDHE) in mid-2007 prior to startup of operations.

According to the Production Controller, recycling wastes that are disposed of as hazardous waste include disposable PPE (e.g., Tyvek® coveralls, gloves), HEPA vacuum filters and debris, and fluorescent light bulbs. The Production Controller stated that filters from the general ventilation system are tested by the Toxic Characteristic Leaching Procedure (TCLP) and have been found not to be hazardous waste. FOH reviewed a report for this TCLP testing and confirmed the results.

5.0 CONCLUSIONS

Conclusions concerning environmental, safety, and health aspects of UNICOR's e-waste recycling operations at USP Leavenworth are provided below under the following subsections:

- Heavy Metals Exposures;
- Noise Exposure and Other Hazards;
- Health and Safety Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

Various conclusions may be applicable to all UNICOR recycling factories with similar operations and activities. These conclusions are supported by the results, findings, and analyses presented and discussed in Sections 3.0 and 4.0 of this report, as well as the documents assembled by the OIG.

5.1 Heavy Metals Exposures

1. Based on UNICOR consultant monitoring results in 2008 and 2009, current routine e-waste recycling operations (disassembly and related activities) conducted in the general factory areas have minimal inhalation exposure potential to lead, cadmium, and other metals. Lead and cadmium exposures were well below OSHA action levels.

2. Based on consultant surface wipe samples, USP Leavenworth cleaning practices maintain cadmium and lead contamination in disassembly work areas at reasonable levels. Only one work area sample for lead was above the OSHA surface guideline for "clean areas." According to the Production Controller, cleaning enhancements are being initiated to include weekly cleaning with a de-leading agent in addition to the current daily cleaning process.

3. Based on consultant surface wipe samples, elevated surfaces such as mechanical systems have lead and cadmium contamination at higher levels than work areas. This indicates that disassembly operations result in build-up of contamination on surfaces not subject to regular cleaning. These levels are not excessive at this time, but disassembly at USP Leavenworth has been underway for only about 18 months. UNICOR should control contamination build-up and possible exposure from this contamination through implementation of an operations and maintenance plan.

4. In April 2009, the UNICOR consultant reported that vigilant cleaning practices were used, but also reported that dry sweeping of lead and cadmium-containing dusts was performed. FOH notes that this practice was used despite the prior OSHA violation for dry sweeping issued to the USP Lewisburg recycling factory in 2007. Dry sweeping is explicitly prohibited by the OSHA lead and cadmium standards. The Production Controller stated that this practice has since been discontinued.

5. FOH considers the performance of annual exposure monitoring starting in 2008 at USP Leavenworth to be important in establishing and ensuring effective hazard controls and continuing improvements. FOH encourages continuation of this practice and encourages monitoring of non-routine or periodic activities such as cleanup of broken CRT glass.

5.2 Noise Exposure and Other Hazards

6. In 2009, a UNICOR consultant found that noise exposure was less than the OSHA action level that triggers the requirement for a hearing conservation program. However, the metal baler's exposure was near the action level with an exposure of 84 dBA versus the 85 dBA action level. This operation has been found to exceed the OSHA action level for noise at other UNICOR factories, and daily variability factors (e.g., duration of baling) could cause higher exposures at USP Leavenworth.

7. According to the Production Controller, USP Leavenworth does not have a heat stress program, but he stated that the factory is air conditioned and protective clothing that can contribute to heat stress is not needed.

8. Although not specifically reviewed at USP Leavenworth, tasks that are potentially biomechanically taxing were observed by NIOSH at other UNICOR e-waste recycling factories. Similar tasks are performed at USP Leavenworth.

5.3 Health and Safety Programs, Plans, and Practices

9. The Production Controller stated that disassembly operations are conducted in accordance with UNICOR's standard operating procedures. Work instructions for housekeeping and cleanup of broken CRT glass are also in place.

10. USP Leavenworth currently provides Northern Safety Model 7100 nuisance dust masks for voluntary use. In May 2009, the UNICOR consultant recommended that N-95 filtering facepiece respirators or better be used, which are approved for toxic metals. UNICOR has not implemented this recommendation, nor has it implemented the consultant's recommendation to inform workers of Appendix D information of 29 CFR 1910.134, Respiratory protection. UNICOR requires the use of dust masks for clean-up of broken CRT glass according to the work instruction. UNICOR does not have a respiratory protection program for required respirator use during broken glass cleanup, and apparently uses nuisance dust masks not approved for toxic metals.

11. For disassembly, materials handling, and associated activities, a USP Leavenworth-specific safety and health document to define existing workplace hazards and control measures is not in place.

12. The Production Controller was unaware of various issues, exposures, and OSHA violations at other UNICOR factories. This is further indication that UNICOR does not have an effective system to share information and ensure corrective action and proper practices on a UNICOR-wide basis.

5.4 Health and Safety Regulatory Compliance

13. According to the Production Controller and as recently reported by a UNICOR consultant, dry sweeping was conducted at USP Leavenworth recycling operations through mid-2009. This practice is explicitly prohibited by OSHA lead and cadmium standards, and was performed despite the OSHA violation issued for dry sweeping to UNICOR at USP Lewisburg in 2007. This practice has since been discontinued, based on the UNICOR consultant's recommendation.

14. UNICOR is not in compliance with 29 CFR 1910.134, Respiratory protection at USP Leavenworth, in that it requires respirator use during cleanup of broken glass, but does not have a respiratory protection program (to include fit testing, medical clearance, and training in the use, storage, and maintenance of respirators, among other elements) and issues dust masks that are not approved for toxic metals dusts.

5.5 Environmental Compliance

15. UNICOR appropriately obtained a solid waste processing permit from the KDHE in 2007, prior to startup of recycling operations.

16. According to the Production Controller, contaminated disposable PPE and HEPA vacuum debris and filters are disposed of as hazardous waste. HVAC filters have been tested by TCLP and are not characterized as hazardous.

6.0 RECOMMENDATIONS

Recommendations concerning environmental, safety, and health aspects of UNICOR's e-waste recycling operations at USP Leavenworth are provided below under the following subdivisions:

- Heavy Metals Exposures;
- Noise Exposure and Other Hazards;
- Health and Safety Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

These recommendations relate to the conclusions presented above in Section 5.0. Various recommendations may apply to all UNICOR recycling factories where similar e-waste recycling activities are performed.

As a global recommendation, BOP and UNICOR should ensure that it has and allocates the appropriate level of staff, other personnel resources, and material resources to effectively implement these recommendations and to sustain an effective ES&H program over time.

6.1 Heavy Metals Exposures

1. UNICOR should continue its exposure monitoring program that has been conducted annually since USP Leavenworth factory startup. This monitoring will serve to document continued control of the lead and cadmium hazards. This recommendation, which goes beyond the requirements of the OSHA lead and cadmium standards, would provide important documentation to establish consistently low exposures and provide the basis for continuing improvements. UNICOR should ensure that as part of its monitoring program, any non-routine or periodic activities with potential for metals exposure are included in the monitoring plan. This should include monitoring during the cleanup of broken CRT glass, as well as daily and weekly cleaning practices. It should also ensure that consultants critically evaluate work practices and exposure controls and develop recommendations for continuing improvements.

2. In addition to personal exposure monitoring, the UNICOR exposure assessment program should continue to evaluate surface contamination levels. UNICOR should establish a surface contamination criteria that it intends to use to evaluate results and plan any clean-up or O&M actions. UNICOR should take preventive action to keep contamination of elevated surfaces (e.g., mechanical systems) from building up to problematic levels.

3. UNICOR should develop and implement an O&M plan to ensure that surface contamination is minimized and that existing contamination does not result in inhalation or ingestion exposures. Elements of this plan could include:

    - Identification of activities that could disturb contamination (e.g., HVAC maintenance, periodic or non-routine cleaning of elevated or other surfaces, access to areas where higher levels of surface contamination are present, and various building maintenance functions);

    - Processes to identify and control hazards for routine and non-routine activities (e.g., job hazard analysis process prior to conducting certain work with identification of mitigating actions);

    - Mitigating techniques and procedures during activities of concern (e.g., dust suppression and/or clean-up and capture, filter removal and bagging processes, and use of PPE and respiratory protection);

    - Training and hazard communication;

    - Disposal of contaminated materials based on testing data such as TCLP tests; and

- Periodic inspection, monitoring and evaluation of existing conditions, as appropriate. Exposure monitoring is particularly recommended for activities that can disturb surface dust. [Note: Follow-up surface sampling is important to ensure that surface contamination does not build up and to take preventive and corrective action, if it does.]

At UNICOR's discretion, the O&M plan could also include periodic clean-up of surfaces by inmate or other workers; that is, surfaces that are not subject to routine clean-up and housekeeping activities. If this element were adopted, however, UNICOR should ensure that practices to control exposures are included in the plan and implemented, such as appropriate worker training, PPE, respiratory protection, exposure monitoring, medical surveillance (if required based on hazard analysis and monitoring results), clean-up methods (e.g., HEPA vacuuming and wet methods), waste disposal, hygiene practices, and others deemed appropriate by UNICOR. Initial exposure monitoring should be conducted to determine whether exposure during clean-up is above the action levels for lead and cadmium. TCLP testing should also be conducted on waste materials generated to ensure proper disposal. Controls for future clean-up activities should then be based on exposure results. [Note: See FOH report for USP Lewisburg [FOH 2009a] that describes the preparation, hazard analysis, training, controls, work practices, and performance of a clean-up activity conducted for warehouse elevated surfaces. This is a noteworthy practice that could serve as a model for other activities conducted under an O&M plan.]

4. UNICOR should verify that dry sweeping has been discontinued at USP Leavenworth. The UNICOR consultant recommended that only bulk materials be cleaned by dry sweeping. The Production Controller stated that bulk materials and now wetted and then picked up. In other factory reports, NIOSH recommends the use of wet misting and a floor squeegee to carefully collect large pieces of debris that cannot be effectively HEPA vacuumed from the floor. Dusts should be cleaned by HEPA vacuum and wet methods.

6.2 Noise Exposure and Other Hazards

5. UNICOR should implement a hearing conservation program for inmates performing metal baling at all factories, including USP Leavenworth, unless repeated exposure monitoring clearly shows that it is not required at a particular factory. Although the metal baler's exposure was slightly less than the OSHA noise action level at USP Leavenworth, monitoring was only conducted on one day, and this operation has been shown to exceed the action level at other factories. UNICOR should also repeat noise monitoring as part of its annual program to confirm exposure levels and determine any variability in the metal baler's exposure.

6. Although the Production Controller stated that all operations are conducted in air conditioned areas, UNICOR should verify that heat exposure is not a factor at USP Leavenworth.

7. UNICOR should also ensure that other hazards are evaluated and controlled such as tasks that are potentially biomechanically taxing (e.g., lifting and repetitive stress).

6.3 Safety and Health Programs, Practices, and Plans

8. UNICOR should revise the USP Leavenworth work instruction for housekeeping to emphasize the restriction on dry sweeping and to add the process for weekly cleaning using a de-leading agent.

9. UNICOR should develop and implement a respiratory protection program in accordance with 29 CFR 1910.134, Respiratory protection, for the cleanup of broken CRT glass. UNICOR should also upgrade respiratory protection for this glass cleanup operation and all other operations (e.g., disassembly) consistent with the N-95 or better recommendation made by its consultant. For voluntary respirator use, UNICOR should implement the consultant's recommendation for informing workers of Appendix D information in the respiratory protection standard. These respiratory protection recommendations for cleanup of broken glass and for voluntary use during disassembly apply to all UNICOR factories.

10. As a "good practice" approach, UNICOR should prepare a concise written safety and health document specifically for its e-waste recycling operations at USP Leavenworth as well as for each of its other recycling factories that lack such a document. Such a document should be developed and implemented to define the safety and health requirements and practices for all the various recycling activities including general activities conducted on the factory floor (i.e., disassembly and materials handling). This document would serve to concisely define the safety and health practices and requirements specific to USP Leavenworth recycling, such as PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping and cleaning practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Non-routine or periodic work activities should also be addressed in the document, particularly those that potentially disturb dusts such as cleaning and handling/disposing of wastes from HEPA vacuums or containers. The document could also specify requirements for periodic site assessments, hazard analyses, actions for new or changed processes, inspections, and regulatory compliance reviews and help to ensure that practices are consistent with written requirements.

11. UNICOR should develop and implement a hazard analysis program that includes baseline hazard analysis for current operations and also job (activity-specific) hazard analysis (JHA) for both routine and non-routine activities. UNICOR and

USP Leavenworth should conduct JHAs for any new, modified, or non-routine work activity prior to the work being conducted. It should also conduct hazard analyses of existing processes that have not had such an analysis. The JHA process is intended to identify potential hazards and implement controls for the specific work activity prior to starting the work. For instance, the JHA process should be integral to an effective O&M plan, as described in Section 6.1.

12. UNICOR should share information among its factories to ensure proper work practices, correction of violations, and implementation of actions for effective worker protection. Specific to the findings of this FOH report for USP Leavenworth, UNICOR should inform all factories of the respiratory protection recommendations above regarding cleanup of broken glass and regarding voluntary use during disassembly. UNICOR should also emphasize the prohibition on dry sweeping.

6.4 Health and Safety Regulatory Compliance

13. UNICOR should verify that dry sweeping of lead and cadmium contaminated dusts has been discontinued, as well as dry sweeping of bulk materials that are co-located with dusts. As recommended by NIOSH, UNICOR should use wet misting and squeegees to pick up larger debris. Dusts should be cleaned using HEPA vacuums and wet methods.

14. UNICOR should verify that heat stress is not a hazard at USP Leavenworth as stated by the Factory Manager.

15. UNICOR should evaluate and appropriately control ergonomic hazards.

16. Also see the respiratory protection and hazard analysis recommendations in Section 6.3.

6.5 Environmental Compliance

No recommendations are made for this topic.

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APPENDIX

Criteria and Guidance for Evaluating Surface Samples

Federal standards or other definitive criteria or guidelines have not been developed for acceptable levels of lead or cadmium surface contamination or dust concentrations in industrial areas where activities are performed involving lead and/or cadmium bearing materials. However, several recommendations or guidelines, primarily for lead, provide points of reference to subjectively evaluate the significance of surface contamination. Some guidelines are available and are noted below (see the NIOSH/DART Elkton report for a more detailed discussion of guidelines):

- OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace (i.e., 29 CFR 1926.62) can be summarized and/or interpreted as follows: all surfaces shall be maintained as 'free as practicable' of accumulations of lead; the employer shall provide clean change areas for employees whose airborne exposure to lead is above the PEL; and the employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination. The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of the Department of Housing and Urban Development's (HUD) initially proposed decontamination criteria of 200 $\mu g/ft^2$ for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas. In situations where employees are in direct contact with lead-contaminated surfaces, such as working surfaces or floors in change rooms, storage facilities, and lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level.

- For other surfaces (e.g., work surfaces in areas where lead-containing materials are actively processed), OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of lead contamination meets the definition of "practicable." Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of lead dust does not become a source of employee lead exposures. OSHA [29 CFR, Part 1910.1025] has stated that any method that achieves this end is acceptable.

- Lange [2001] proposed a clearance level of 1,000 $\mu g/ft^2$ for floors of non-lead free commercial buildings and 1,100 $\mu g/ft^2$ for lead-free buildings. These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions.

- HUD [24 CFR 35] has established clearance levels for lead on surfaces after lead abatement. These levels range from 40 to 800 $\mu g/ft^2$, depending on the type of surface. The level of 200 $\mu g/ft^2$ is most commonly used. These levels, however, apply to occupied living areas where children reside, and are not intended for industrial operations.

- Regarding lead in bulk dust or soil samples, the U.S. EPA [EPA n.d.] has proposed standards for residential soil-lead levels. The level of concern requiring some degree of risk reduction is 400 ppm (mg/kg), and the level requiring permanent abatement is 2,000 ppm (mg/kg). Again these levels are residential criteria, rather than for industrial settings.

- There is no quantitative guidance for surface cadmium concentrations. OSHA [40 CFR 745.65]states that surfaces shall be as free as practicable of accumulations of cadmium, all spills and sudden releases of cadmium material shall be cleaned as soon as possible, and that surfaces contaminated with cadmium shall be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne.

U.S. Department of Justice
Office of the Inspector General

A Review of Federal Prison Industries' Electronic-Waste Recycling Program

Appendix – Volume II

Office of the Inspector General
Oversight and Review Division
October 2010

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USP LEWISBURG

DEPARTMENT OF HEALTH & HUMAN SERVICES

Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

EVALUATION OF ENVIRONMENTAL, SAFETY, AND HEALTH INFORMATION RELATED TO UNICOR E-WASTE RECYCLING OPERATIONS AT USP LEWISBURG

PREPARED FOR THE UNITED STATES DEPARTMENT OF JUSTICE
OFFICE OF THE INSPECTOR GENERAL

Submitted to: [redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
U.S. Department of Justice

Submitted by: Captain Joseph Terra, CIH
FOH Safety and Health Investigation Team
Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

June 02, 2009

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1.0 INTRODUCTION

At the request of the U.S. Department of Justice (DOJ) Office of the Inspector General (OIG), the Federal Occupational Health Service (FOH) coordinated environmental, safety and health (ES&H) assessments of electronics equipment recycling operations at a number of Federal Bureau of Prisons (BOP) facilities around the country. The assessments were conducted as a result of whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium at electronics recycling operations overseen by Federal Prison Industries (UNICOR).[1] The allegations stated that these exposures were occurring from the breaking of cathode ray tubes (CRTs) and other activities associated with the handling, disassembly, recovery, and recycling of electronic components found in equipment such as computers and televisions (i.e. e-waste).[2] It was further alleged that appropriate corrective actions had not yet been taken by BOP and UNICOR officials and that significant risks to human health and the environment remained.

This FOH report consolidates and presents the findings of technical assessments performed on UNICOR's e-waste recycling operations at the United States Penitentiary in Lewisburg, Pennsylvania (USP Lewisburg) by industrial hygienists and other environmental and safety and health specialists representing federal agencies including the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH) Division of Applied Research and Technology (DART); the Occupational Safety and Health Administration (OSHA); and FOH. Data and reports from these agencies are presented in the attachments to this report. The primary objectives of these assessments were to characterize current UNICOR operations and working conditions at USP Lewisburg in light of the whistleblower allegations and to identify where worker exposures, environmental contamination/degradation, and violations of governmental regulations and BOP policies may still exist so that corrective actions may be taken where appropriate. In addition, this FOH report also relies upon information from staff and inmate interviews, documents assembled by the OIG which were developed by various consultants, regulatory agencies, and BOP and UNICOR staff.

The overall purpose of this report is to characterize current operations and working conditions at USP Lewisburg (i.e., 2003 to present) with respect to the potential for inmate and staff exposures[3] that may result from present day e-recycling activities and from legacy contamination on building components from e-recycling operations which took place in the past. This report consolidates findings from those contributing to the

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[1] FPI, (commonly referred to by its trade name UNICOR) is a wholly-owned, Government corporation that operates factories and employs inmates at federal correctional institutions.

[2] E-waste is defined as a waste type consisting of any broken or unwanted electrical or electronic device or component.

[3] In this report, the term "exposure" refers to the airborne concentration of a contaminant (e.g., lead or cadmium) that is measured in the breathing zone of a worker but outside of any respiratory protection devices used. Unless otherwise noted, "exposure" should not be confused with the ingestion, inhalation, absorption, or other bodily uptake of a contaminant. Concentrations reported and discussed in this report are not adjusted based on respirator protection factors. However, when reported, it is indicated whether the exposure was within the protective capacity of the respirator.

OIG investigation, as well as serves to evaluate additional information assembled regarding BOP and UNICOR recycling operations. Conclusions and recommendations presented in this report are based on the entire body of available reports, data, documents, interviews, and other information.

USP Lewisburg is one of eight BOP institutions that have ongoing e-waste recycling operations for which an assessment report has been or will be prepared by FOH. On October 10, 2008, FOH issued a separate report entitled "*Evaluation of Environmental, Safety, and Health Information Related to Current UNICOR E-Waste Recycling Operations at FCI Elkton*" detailing current exposure conditions at Federal Correctional Institution (FCI) Elkton. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, pertinent regulatory requirements, and other information that provides additional context to this report on USP Lewisburg. FOH will be preparing assessment reports for the remaining BOP institutions that perform recycling upon completion of their respective environmental, safety, and health (ES&H) assessments.

Currently, e-waste recycling operations at USP Lewisburg involve receipt of waste electronics from various locations around the country, disassembly and sorting activities ('breakdown'), and the associated material handling and facilities maintenance required to support these operations. This report also addresses the glass breaking operation as it was conducted during the field activities performed by FOH and NIOSH/DART in January 2008. USP Lewisburg recycling facilities and operations are described below in Section 2.0 in greater detail.

2.0 UNICOR E-WASTE RECYCLING FACILITIES AND OPERATIONS AT USP LEWISBURG

UNICOR e-waste recycling operations commenced at USP Lewisburg in 2002. Beginning in 2003, glass breaking was performed in a plastic-curtained enclosure that was served by a local exhaust ventilation (LEV) system. The recycling factory was largely refurbished over a several month period in 2006 with completion in early 2007. The factory improvements included replacement of walls and ceilings and installation of new electrical and ventilation services, among other items. During this period, the original glass breaking enclosure was dismantled, a new glass breaking room was constructed with three solid and one plastic-curtained walls and better entry/exit areas were added. The same LEV system was re-installed for the new glass breaking room. Glass breaking was restarted in early 2007 in the improved glass breaking room that is currently located and used at the USP Lewisburg recycling factory.

As part of the OIG investigation, FOH and NIOSH/DART performed on-site evaluations of the recycling workplace in May 2007 and January 2008 to evaluate worker exposures to toxic metals and other workplace hazards. The January 2008 evaluation was more comprehensive than the May 2007 study. Glass breaking was performed throughout the January 2008 evaluation, but was not performed during the evaluation in May 2007. In its report (see Attachment 1), NIOSH/DART described USP Lewisburg's e-waste recycling facilities and operations. A summary of information from the NIOSH/DART report and other sources follows. See Attachment 1 for more detailed information on USP Lewisburg operations.

The recycling of electronic components at USP Lewisburg is performed in two buildings that are part of the prison camp outside of the main prison. One building, where many of the operations are performed, is composed of three sections: a receiving and warehousing area which also contains offices and areas where laptop refurbishing is done; a middle or center section where most of the disassembly is performed; and an area where some disassembly is done which also houses the glass breaking operation. Diagrams of these work areas are shown in Figures 1 and 2 with an enlargement of the glass breaking operation shown in Figures 3 and 4.

These figures provide a general visual description of the layout of the work process, although workers often moved throughout the various areas in the performance of their tasks. A second building, located behind the main disassembly area of the first building, houses e-waste baling operations.

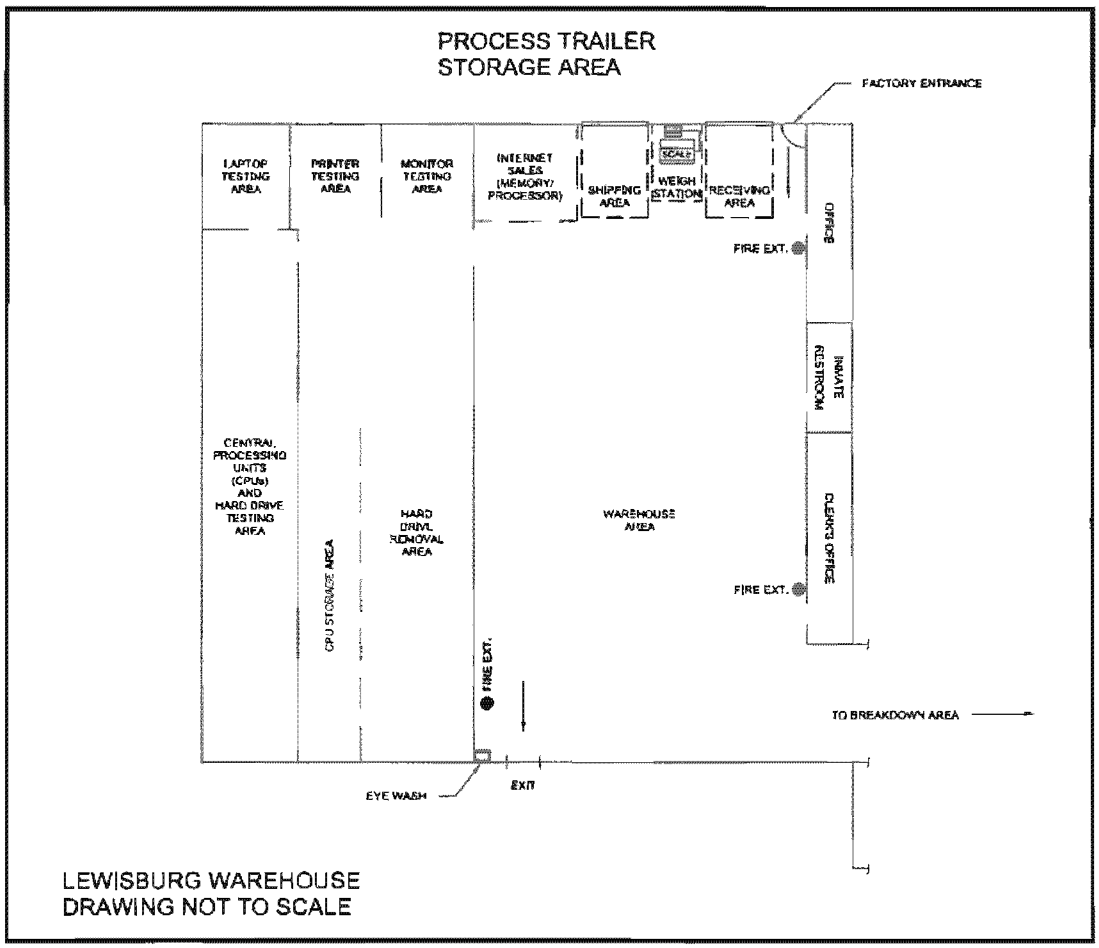

Figure 1: USP Lewisburg Warehouse [NIOSH 2009]

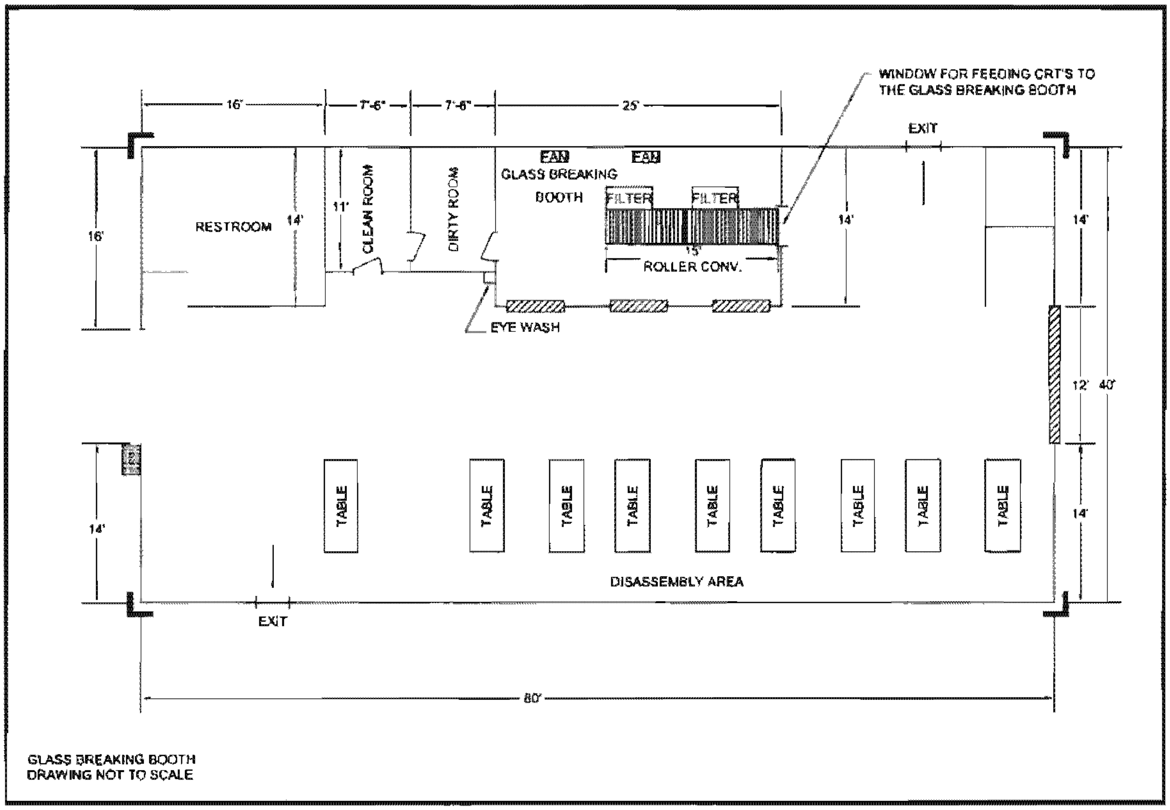

Figure 2: USP Lewisburg Recycling Factory Breakdown Area [NIOSH 2009]

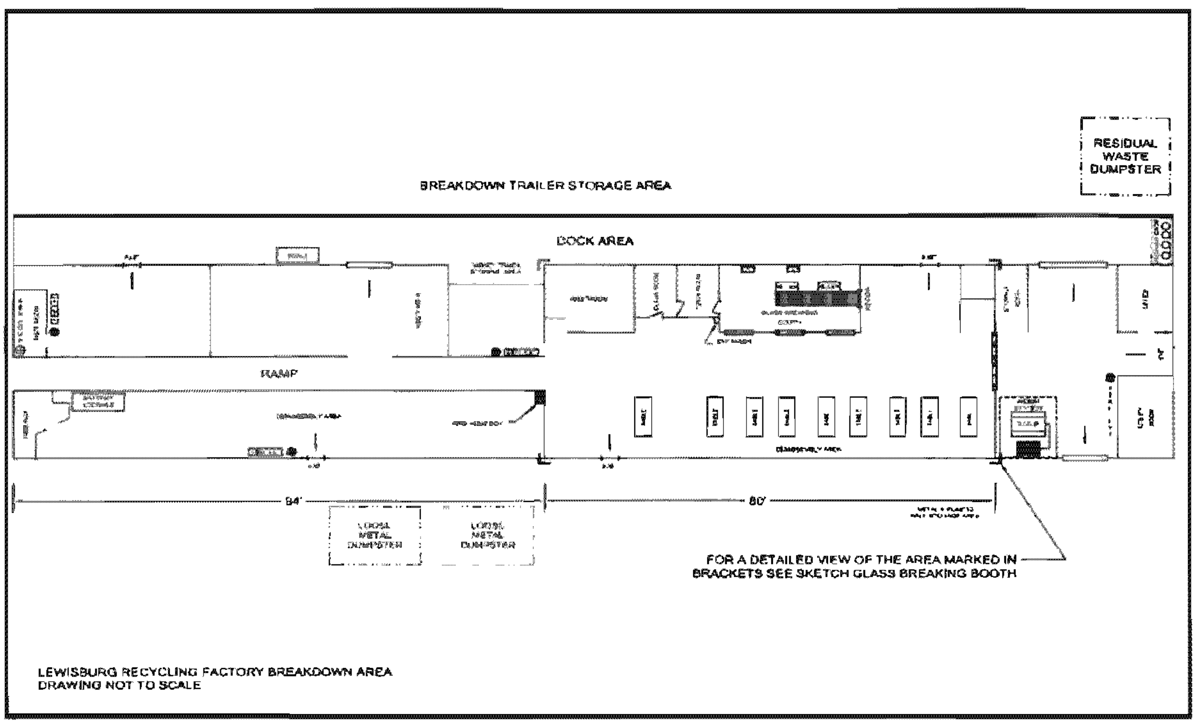

Figure 3: USP Lewisburg Glass Breaking and Disassembly Area [NIOSH 2009]

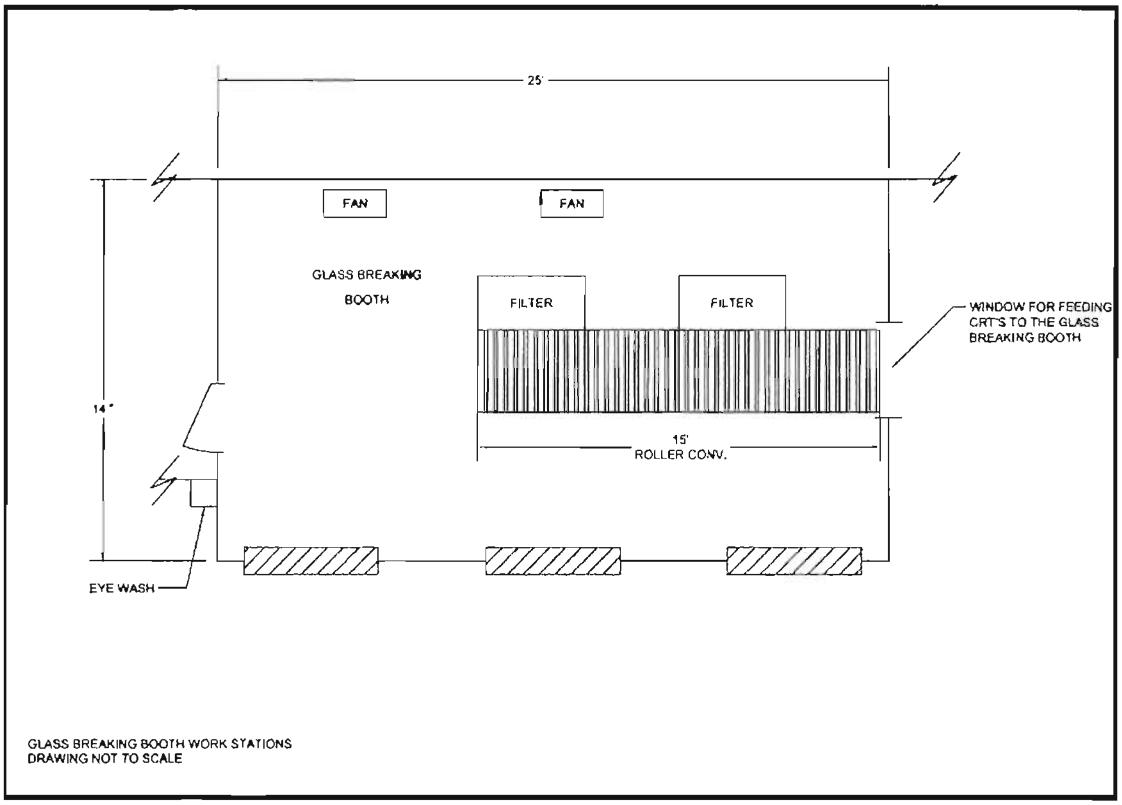

Figure 4: Glass Breaking Area [NIOSH 2009]

Image 1: Disassembly area

Image 2: Glass breaking booth

The electronics recycling operations can be organized into four production processes: receiving and sorting, disassembly, glass breaking operations, and packaging and shipping. Each of these operations is discussed in this section. Cleaning and maintenance is an associated activity that is also addressed below, and baling is conducted in an outer building located a short distance from the factory building.

Incoming materials to be recycled are received at the warehouse (Figure 1) where they are examined and sorted. During the FOH and NIOSH/DART on-site evaluations it appeared that the bulk of the materials received were computers, either desktop or notebooks, or related devices such as printers. Some items, notably notebook computers that can be upgraded and resold were sorted for that task. After electronic memory devices (e.g., hard drives and discs) were removed and degaussed or shredded, computer central processing units (CPUs), servers and similar devices were sent for disassembly. Monitors and other devices (e.g., televisions) that contain CRTs were separated and sent for disassembly and removal of the CRT. Printers, copy machines and any device that could potentially contain toner, ink, or other expendables were segregated. Inks and toners were removed prior to being sent to the disassembly area. In the disassembly process (see Figures 2 and 3; Image 1), external cabinets, usually of plastic construction, were removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing were removed and sorted by grade for further treatment, if necessary.

Components such as circuit boards or chips that may have value or may contain precious metals such as gold or silver were removed and sorted. With few exceptions, each of the approximately 85 workers in the main factory performed all tasks associated with the disassembly of a piece of equipment into its components, using powered and non-powered hand tools (primarily screwdrivers and wrenches). A few workers collected the various parts and placed them into the proper collection bin. Work tasks included removing screws and other fasteners from cabinets, unplugging or clipping electrical cables, removing circuit boards, and using whatever other necessary methods to break these devices into their component parts. Essentially all components are sold for some type of recycling.

The third production process evaluated was the glass breaking operation where CRTs from computer monitors and televisions were sent for processing. This was an area of primary interest in this evaluation because it represents a higher potential of exposure to toxic metals. This was the only process where local exhaust ventilation (LEV) was utilized and where respiratory protection was in universal use (see Sections 3.0 and 4.0 for additional PPE, respiratory protection, and LEV information). Glass breaking was done in an enclosed booth (see Figure 4) located as shown in Figure 2 (also see Image 2).

CRTs that had been removed from their cases were transported to the glass breaking area in large boxes and were fed into the glass-breaking booth through a side opening where they were placed on a metal grid for breaking (see Figure 4). As the CRT moved from right to left in the booth, the electron gun was removed by tapping with a hammer to break it free from the tube. A series of hammer blows were then used to break the funnel glass and allow it to fall through the metal grid into large Gaylord boxes (cardboard boxes approximately three feet tall designed to fit on a standard pallet) positioned below the grid. This was done at the first (right) station in Figure 4. The CRT was then moved to the second (left) station where any internal metal framing or lattice was removed before the panel glass was broken with a hammer and also allowed to fall into a Gaylord box. During the two days of NIOSH/DART sampling in January 2008, 293 and 258 CRTs were broken. No count was made by the survey team regarding the number of color versus monochrome monitors broken. According to the USP Lewisburg Factory

Manager, the CRT processing rate has risen and is currently between 450 and 600 CRTs broken per production day, which occurs on average twice per week (i.e., every 2.5 days).

The final production process, packing and shipping, involved moving the various materials segregated during the disassembly and glass breaking processes to the loading dock to be sent to contracted purchasers of the individual materials. To facilitate shipment, some bulky components such as plastic cabinets or metal frames were placed in a hydraulic baler located in a second outer building to be compacted for easier shipping. Other materials were boxed and removed for subsequent sale to a commercial recycling operation.

In addition to the routine daily activities in the four production processes, a LEV filter maintenance activity is conducted at approximately monthly intervals during which the two sets of filters in this ventilation system are removed and replaced. This activity was of particular interest because of potential elevated exposures documented in similar operations at other UNICOR e-waste facilities. At USP Lewisburg, two workers remove both sets of filters, clean the system, and replace the filters. They are assisted by two additional workers outside the glass breaking enclosure. During the filter change activity, the LEV system is shut down and all filters are removed and replaced. Initially the exhaust system components, including the accessible surfaces of the filters, are vacuumed with a HEPA vacuum. The filters are then removed and bagged for disposal, and the area inside the filter housing is vacuumed. New filters are inserted, the LEV system is reassembled, and any residual dust is removed with a HEPA vacuum.

The NIOSH/DART report (Attachment 1) presents details on personal protective equipment (PPE), respiratory protection, engineering controls, and work practices used during glass breaking, filter maintenance, and other recycling activities. These controls are summarized in Sections 3.0 and 4.0 of this report.

3.0 BOP/UNICOR SAFETY AND HEALTH PROCEDURES AND PRACTICES AT USP LEWISBURG

Under 29 CFR 1960 each federal agency is obligated to develop a comprehensive and effective safety and health program. Such programs establish requirements and processes for controlling occupational hazards and meeting federal occupational safety and health regulations. The BOP has established an ES&H policy entitled Occupational Safety, Environmental Compliance, and Fire Protection (BOP Program Statement 1600.09). UNICOR's compliance with this policy will be evaluated in the OIG's final report.

Various OSHA standards require written programs or plans to address occupational hazards or implement hazard control measures. Examples applicable to UNICOR's e-waste recycling activities performed at USP Lewisburg, particularly for glass breaking include:

- 29 CFR 1910.1025: Lead requires a written lead compliance plan;

- 29 CFR 1910.1027: Cadmium requires a written cadmium compliance plan;
- 29 CFR 1910.134: Respiratory Protection requires a written respiratory protection program; and
- 29 CFR 1910.95: Occupational Noise Exposure requires a written hearing conservation program.

In addition to the specific OSHA standards listed above, another hazard associated with UNICOR recycling operations at other facilities is heat exposure, particularly when conducting glass breaking and associated non-routine operations while wearing PPE and using respiratory protection. Although OSHA does not have a specific standard for heat exposure, OSHA can regulate this hazard under its "General Duty Clause" [OSHA, 1970] that requires employers to furnish a workplace that is free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees.

Even when hazards do not meet the exposure threshold for a written safety and health plan/program as required by a specific OSHA standard, a good practice approach warrants that a general safety and health plan should be in place to identify workplace hazards and specify appropriate hazard controls and safe work practices for both routine and non-routine activities.

UNICOR's ES&H practices and programs associated with the e-waste recycling activities conducted at USP Lewisburg are discussed below.

3.1 Safety and Health Practices and Procedures to Control Toxic Metals Exposure

UNICOR has a written Inmate Pre-Industrial Manual dated May 2005 that is applicable to its e-waste recycling factories, including USP Lewisburg. This manual serves as a training and job orientation document for staff and inmate workers. The document contains general rules of the factory that include some general requirements for safety equipment (e.g., safety shoes and safety glasses), smoking, eating and drinking restrictions, and work performance expectations. Personal protective equipment (PPE), hazards associated with recycling, and hazard communication topics are addressed in a general manner. Other topics addressed include lockout/tagout to control hazardous energy sources, flammable and combustible liquids, fire safety issues, and machine guarding. Safety issues are also addressed for operation of certain equipment such as jack operations, baler operations, and forklift operations, Glass breaking procedures are provided that list mandatory safety equipment (e.g., PPE and respiratory protection), personal hygiene and clean-up, and end-of-shift activities that include end-of-shift clean-up procedures. This manual provides a reasonable outline for inmate worker training. One deficiency is that the respirators identified for use during glass breaking are not those that are employed. This deficiency has been found at other UNICOR recycling facilities, as well.

In addition to the Pre-Industrial Manual, USP Lewisburg has developed various documents under its International Organization for Standardization (ISO) 9000 program.

As provided by the Production Controller, these documents include Production/QA Procedure Training Instructions for Glass Breaking; Production/QA Procedure Work Instructions for Glass Breaking; Production/QA Procedure Training Instructions for Respirator Cleaning, Inspection, and Storage; Production/QA Procedure Training Instructions for Nuisance Dust Mask and Ear Plugs; and instructions for operating equipment such as the baler and air compressor.

UNICOR has implemented requirements for lead and cadmium compliance for its current glass breaking operations. These requirements include engineering controls such as the glass booth containment and LEV system, work practices to minimize exposures, respiratory protection and personal protective equipment, and housekeeping and hygiene practices. The UNICOR Pre-Industrial Manual briefly addresses some of the hazard controls in place, and USP Lewisburg's ISO 9000 documents provide training procedures and work/safety procedures that address lead and cadmium hazards and controls. These documents provide much of the information required for a lead and cadmium compliance plan under the OSHA lead and cadmium standards. UNICOR should improve these lead and cadmium compliance documents at USP Lewisburg by (a) making the Pre-Industrial Manual and the ISO 9000 documents fully consistent, such as for PPE, respiratory protection, equipment operation, (b) adding a procedure/instruction to describe the engineering controls (e.g., LEV and containment), including operating parameters and maintenance requirements; and (c) specifically specifying the type of protective clothing and respiratory protection to be used. In its reports of 2006 and 2007, UNICOR's consultant also recommended that UNICOR verify and document current glass breaking work practices, procedures, and control measures (see Section 4.1.2). UNICOR and USP Lewisburg documents should address inspection and verification processes.

NIOSH/DART reported on the types of PPE and respiratory protection that were worn by breakers and feeders during glass breaking operations. The PPE was generally consistent with the requirements of the UNICOR Pre-Industrial Manual and ISO 9000 documents; however, both the Pre-Industrial Manual and ISO 9000 documents are vague in some ways. For instance, the Pre-Industrial Manual specifies use of jumpsuits for glass breaking but does not define a jumpsuit, and the ISO 9000 glass breaking training instruction and procedure specifies use of disposable protective jump-suits but does not define the type. The Production Controller stated that glass breaking is now performed using "breathable," disposable protection clothing, and that other factory work is conducted using launderable coveralls provided by a supplier. These specifics should be reflected in UNICOR and USP Lewisburg documents and procedures. Also, the respiratory protection used by breakers consisted of hooded powered air purifying respirators (PAPRs), which is different from the full face-piece air purifying respirators (APRs) specified in the Pre-Industrial Manual. Although protection factors are similar for these respirators, cleaning and inspection of respirators in the Pre-Industrial Manual apply to APRs and are not relevant to PAPRs. ISO 9000 documents indicate different respiratory protection and associated procedures. UNICOR should ensure that its written requirements and current practices are consistent.

Since UNICOR at USP Lewisburg requires use of respiratory protection during glass breaking, non-routine maintenance of LEV HEPA filters, non-routine cleaning activities, and other cleaning activities, a written respiratory protection program is required by OSHA under the respiratory protection standard (29 CFR 1910.134) and the lead and cadmium standards (29 CFR 1910.1025 and 1027, respectively). A Respiratory Protection Program dated April 2008 is in place for USP Lewisburg that applies to all operations conducted at the penitentiary. This is a general program that does not specifically address UNICOR recycling, but provides the overall requirements for using respirators. UNICOR has supplemented this overall program with its recycling-specific ISO 9000 procedures regarding respirator use, inspection, and storage. Documentation is also available for inmate worker medical clearance to wear respiratory protection, and for voluntary use of disposable dust masks per Appendix D of the OSHA respiratory protection standard, 29 CFR 1910.134. The latter has been found to be deficient at some other UNICOR factories. UNICOR should share the USP Lewisburg approach to meet Appendix D requirements with its other facilities.

UNICOR has not conducted a complete noise survey at USP Lewisburg, although one has been recommended by a UNICOR consultant (see Section 4.1.2). USP Lewisburg does not have a written hearing conservation program for its recycling activities. The USP Lewisburg Production Controller provided FOH with a limited noise survey conducted by the USP Lewisburg Safety Department for baling operations. This study found that noise levels were below the levels that would require a hearing conservation program under the OSHA noise standard (see Section 4.5 for a discussion of this noise study). However, based on more comprehensive NIOSH/DART noise dosimetry (see Section 4.5 and Attachment 1), some recycling activities at USP Lewisburg (e.g., glass breaking and baling) have noise exposures at levels that require a hearing conservation program in accordance with the OSHA noise standard. UNICOR should conduct a complete noise survey for its recycling operations at USP Lewisburg and implement a hearing conservation program, accordingly.

Safety practices and procedures are applied at the USP Lewisburg recycling factory. Written safety and health documents to define these practices include the Pre-Industrial Manual and the ISO 9000 documents. USP Lewisburg also developed specific written practices for non-routine cleaning of elevated surfaces conducted in 2009 (see Section 4.4 for further information). In addition to the recommended improvements that were discussed above for lead and cadmium control, this documentation could be further improved by specifying requirements for periodic site assessments, hazard analyses, inspections and verifications as recommended by UNICOR's consultant, and regulatory compliance reviews. UNICOR should review the USP Lewisburg ISO 9000 documents and supplement this information, as appropriate, with a written, site-specific safety and health document for the general factory operations, including both routine and non-routine activities. Additionally, consolidation of various safety and health practices into an overall site-specific safety and health document would benefit understanding, implementation, and verification of requirements. See Section 6.0, Recommendations, for opportunities to improve safety and health documentation.

3.2 Other UNICOR Programs and Procedures

UNICOR has developed a heat stress program. This program will be evaluated and discussed in the final OIG report. According to UNICOR Factory Managers, UNICOR has drafted a set of standard operating procedures (SOPs) that will serve to define practices and measures for lead, cadmium, and other hazard controls. These SOPs have not been reviewed by FOH to date. This set of SOPs will be reviewed and discussed prior to the completion of the OIG investigation. Environmental issues are discussed in Section 4.7.

4.0 FIELD INVESTIGATIONS AND MONITORING RESULTS

Several field investigations of USP Lewisburg e-waste recycling operations have been conducted since 2003. These investigations are listed below:

- A UNICOR consulting firm performed personal and area air monitoring and surface sampling in July/August 2003 for routine recycling activities. This sampling was very basic. Other than sample data tables, no discussion or information regarding the meaning of the results or recommendations were provided.

- OSHA notified USP Lewisburg of safety-related allegations that OSHA received in 2005 and required a response regarding these allegations. In April 2007, OSHA conducted an inspection of UNICOR e-waste recycling operations at USP Lewisburg (see Attachment 3).

- Two other consultants performed more comprehensive industrial hygiene (IH) evaluations of the recycling operations in April 2005, April 2006, March 2007, and March 2008. These evaluations included personal and area exposure monitoring, surface sampling, and a review of operations. Findings and results were presented and discussed and recommendations were provided.

- As part of the DOJ OIG investigation, NIOSH/DART and FOH conducted an initial field investigation in May 2007 and a more detailed field investigation in January 2008 to determine personal exposures to toxic metals, noise, and heat, as well as existing toxic metal surface contamination on various building components. NIOSH/DART prepared a report of its study to assess worker exposures to metals and other occupational hazards (see Attachment 1). FOH sampling results and observations are provided in this report and Attachment 2.

- A UNICOR consultant also performed two studies of targeted scope in September 2008; one involving mercury vapor screening and another involving a protective coverall performance evaluation during glass breaking operations.

- Finally in March 2009, a UNICOR consultant provided services including worker training, hazard control development, and exposure monitoring in support of a non-routine activity to decontaminate elevated surfaces of dusts containing toxic metals.

Results of the OSHA, UNICOR consultant studies, NIOSH/DART, and FOH studies are discussed in this section[4], in the following order:

- Section 4.1 addresses OSHA, UNICOR consultant, and NIOSH/DART and FOH investigations to evaluate exposure to toxic metals from recycling operations;

- Section 4.2 addresses surface contamination and bulk dust sampling results and the implications for potential worker exposure;

- Section 4.3 addresses FOH observations for two specific activities that have potential for toxic metals exposures (i.e., the dumping of metal masking and banding into roll-off containers, and accessing the area above the factory ceiling where surface contamination is present;

- Section 4.4 addresses a non-routine UNICOR and USP Lewisburg activity that was conducted to decontaminate elevated surfaces in the warehouse;

- Section 4.5 addresses noise exposures;

- Section 4.6 addresses other exposure hazards such as heat and ergonomic issues; and

- Section 4.7 addresses environmental issues resulting from the investigations.

Toxic metals of greatest interest for e-waste recycling include lead, cadmium, and barium. Beryllium can also be associated with e-waste materials and is also of interest because of its high toxicity, adverse health effects, and low exposure limit. These metals were the focus of the field investigations. See the FCI Elkton report referenced in Section 1.0 for additional details regarding e-waste hazards.

Exposure monitoring results are compared to permissible exposure limits (PELs) and action levels (ALs) established by OSHA. In addition, non-mandatory ACGIH TLVs and NIOSH recommended exposure limits (RELs) are also available for reference. Personal exposure limits are often based on 8-hour time weighted average (TWA) exposures and the TWAs are applicable to the exposures discussed in this report.

Table 1 provides exposure limits for lead, cadmium, barium, and beryllium. PELs and TLVs, as well as action levels, for other hazards can be found in OSHA standards (29 CFR 1910) and the 2009 ACGIH TLVs. [ACGIH 2009]

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[4] Given the many variables that may impact air sampling and exposure monitoring, testing data and findings can vary from one period to the next. Also, the findings, interpretations, conclusions and recommendations in this report may in part be based on representations by others which have not been independently verified by FOH.

Table 1
Occupational Exposure Limits[1]

	LEAD ($\mu g/m^3$)	CADMIUM ($\mu g/m^3$)	BARIUM ($\mu g/m^3$)	BERYLLIUM ($\mu g/m^3$)
OSHA PEL	50	5.0	500	2
OSHA ACTION LEVEL[2]	30	2.5	N/A	N/A
ACGIH TLV (Total Exposure)	50	10.0	500	0.05[4]
ACGIH TLV (Respirable Fraction)	N/A	2.0	N/A	N/A
NIOSH REL	50	*Ca*[3]	500	0.5

NOTES:

1. All limits are based on an 8-hour time weighted average (TWA) exposure. NIOSH RELs are based on TWA concentrations of up to a 10-hour workday during a 40-hour workweek.
2. The action level is an exposure level (often around half of the PEL) that triggers certain actions, such as controls, monitoring, and/or medical surveillance under various OSHA standards.
3. *Ca* (Potential Occupational Carcinogen). NIOSH RELs for carcinogens are based on lowest levels that can be feasibly achieved through the use of engineering controls and measured by analytical techniques. [NIOSH 2005]
4. ACGIH TLV 2009 adoption.

Exposure standards for noise are discussed in the section below where results are presented.

4.1 Investigations for Exposure to Toxic Metals

Given the various materials and components in e-waste, recycling activities have the potential to result in worker exposure to toxic metals including, in particular, lead and cadmium. The magnitude and potential health consequences of exposures are dependant on a number of factors such as workplace ventilation and other engineering controls, work practices, protective equipment utilized (e.g., respirators, protective clothing, gloves, etc.), duration of exposures, and others. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, their relative toxicities, pertinent regulatory requirements, and other information.

A series of investigations that included evaluation of toxic metals exposure during USP Lewisburg's e-waste recycling operations have been conducted since 2003. These investigations are discussed below.

4.1.1 UNICOR Consultant Monitoring and Sampling of October 2003

A UNICOR consulting firm conducted a limited amount of sampling for routine operations at USP Lewisburg e-waste recycling facilities on July 31 and August 1, 2003. This sampling included personal and area exposure monitoring and surface wipe sampling. Samples were analyzed for lead, cadmium, barium, and beryllium. Results are summarized below.

- On July 31, 2003, a personal air sample collected in the glass breaking booth, an exhaust sample from the glass breaking booth's LEV, and an area sample outside the glass breaking booth were all below the limit of detection (LOD) for the four metals analyzed. The detection limits were appropriately well below the OSHA PELs and action levels.

- Also on July 31, two samples were taken of PPE; that is, one glove/sleeve and one Tyvek collar. The results are reported in mg/kg units which suggests that these are not wipe samples from the clothing, but rather a total amount of contamination that was digested from a bulk patch or piece of clothing. Only lead was detected at 2.80 mg/kg and 4.71 mg/kg. The significance of these results was not discussed in the report.

- On August 1, 2003, three surface wipe samples were collected and analyzed. A wall inside the glass breaking enclosure had low levels of contamination. For instance, surface lead was not detectable and cadmium was 1.91 $\mu g/ft^2$. A conveyer face inside the enclosure had lead at 591 $\mu g/ft^2$ and cadmium at 139 $\mu g/ft^2$. A wall outside the enclosure had lead at 19.8 $\mu g/ft^2$ which is less than the OSHA criteria for clean areas. Cadmium was at 2.55 $\mu g/ft^2$. See Section 4.2 for a discussion of surface contamination criteria and other surface monitoring results.

This report was very basic and simply provided sample locations, sample types, and results. No evaluation of the significance of the results was provided. No information or observations were provided regarding the work practices or hazard controls, and no conclusions or recommendations were provided. The only description of work activities was that about 170 "tubes" were processed on each day of sampling.

4.1.2 OSHA Inquiry and Inspection

On April 19, 2005, OSHA received a report of alleged hazardous working conditions at UNICOR's USP Lewisburg e-waste recycling facility from a source that requested to remain anonymous. Seven specific issues were alleged that involved such items as inadequate eating areas, consumption of food and beverages in contaminated areas; processing of food in a manner that does not protect against contamination; use of compressed air to clean contaminated surfaces and clothing; skin and eye irritation from exposure to toxic metals dusts; and lack of effective hazard communication information and training.

On April 20, 2005, OSHA informed the Safety Manager at USP Lewisburg of these allegations in writing. OSHA decided not to conduct an inspection at that time, but required a written response to the allegations within 30 days. The USP Lewisburg Warden responded to OSHA on April 26, 2005. The Warden rebutted each of the seven allegations as inaccurate or not applicable and summarized USP Lewisburg's practices for each item. He also summarized some additional practices that were to be implemented regarding hazard communication (see Attachment 3 for the OSHA letter to USP Lewisburg and the USP Lewisburg response to OSHA).

On October 10, 2006, OSHA generated a "Referral Report" following meetings with the DOJ OIG that identified a hazard involving employee exposure to "heavy metals, including lead, cadmium, and beryllium from the breaking and/or recycling of cathode ray tubes (CRTs)." This report stated that engineering controls, PPE, housekeeping, and medical programs may be deficient, and that maintenance workers may also be potentially exposed to heavy metals. This Referral Report was followed by OSHA inspections conducted by the local area office that were initiated on October 18, 2006 and completed with an inspection on April 10, 2007. The lapse of time between the Referral Report and the April 10, 2007 inspection was the result of the recycling factory being refurbished starting in mid-2006 with completion in early 2007.

A Referral Narrative Report was prepared by OSHA for this inspection (#310227467), and this report was followed by a report of violation on July 20, 2007. Results of the inspection are summarized below, and the OSHA reports and documentation for the referral and inspection are provided in Attachment 3:

- In the report of violation, OSHA cited one "serious" violation under the lead standard, 29 CFR 1910.1025 (h)(1), that requires that "all surfaces shall be maintained as free as practicable of accumulations of lead." Personal exposure monitoring performed by OSHA found inhalation exposures to lead on the general factory floor that, although below the PEL and action level, were produced by inappropriate actions such as dry broom cleaning, high volume pedestal fans, and tracking of dust from the glass breaking booth to the general disassembly area.

- Also in the report of violation, OSHA provided abatement notes (i.e., abatement actions) that are to be implemented to correct the violation. These actions included (a) prohibiting dry sweeping and instead performing cleaning using HEPA vacuums and wet methods with suitable liquid agents; (b) removing pedestal fans while allowing slow speed ceiling fans, if desired; and (c) using tack floor mats at the open edge of the CRT breaking booth and other areas to prevent tracking of dust from the glass breaking booth.

- OSHA conducted personal exposure monitoring of a CRT breaker while conducting glass breaking in the first part of the shift and then while conducting general factory (e.g., disassembly) operations in the second part of the shift. Interestingly, OSHA found that the entirety of the detectable inhalation exposure occurred during the disassembly operations, not glass breaking; however, the exposures were still well below the PELs and action levels. The lead exposure in the disassembly area was 6.19 $\mu g/m^3$, and the cadmium exposure in the disassembly area was 0.68 $\mu g/m^3$. Lead and cadmium exposures were below the limit of detection during glass breaking. [Note: This finding was somewhat different from UNICOR consultants and NIOSH/DART results which showed lead and cadmium exposures for disassembly area activities to be lower or not detectable, while glass breaking exposures were higher, but still below the PELs and actions levels. See Sections 4.1.2, 4.1.3, and 4.1.5 for results.]

- In its narrative, OSHA reported that noticeable dust was observed during general disassembly when CRTs were removed from their cabinetry. This observation supports the disassembly exposure results discussed above. The report provided additional information on the broom cleaning, tracking of dust from the glass breaking booth, and the use of pedestal fans that OSHA discussed in its report to support the violation issued.

- The narrative also discussed improving the ventilation system in the glass breaking booth, specifically by creating a "negative pressure" condition in the glass breaking booth and by achieving air exchanges and cooling through the introduction of an HVAC system. The report expressed concern for a heat stress hazard under the conditions that existed at the time of the inspection.

- In a separate correspondence of August 3, 2007, OSHA further informed the USP Lewisburg Safety Manager of the potential heat stress hazard in the glass breaking booth (see Attachment 3). OSHA chose not to issue a citation under Section 5(a)(1), the general duty clause of the Occupational Safety and Health Act, but suggested that UNICOR add a ventilation system to the glass breaking booth to provide air conditioning and achieve a negative pressure relative to the general factory. Other general suggestions for this system are discussed by OSHA in the report provided in Attachment 3.

- Another subject raised by the OSHA inspection was that an unapproved replacement part was used for a PAPR that voided its certification (i.e., PAPR effectiveness can not be assured). A citation was not issued, but OSHA noted that only original manufacturer parts should be used to maintain respirator equipment. The Production Controller stated that only proper parts are now used. He also stated that current PAPRs are no longer made and that new PAPRs will have to be purchased and used when replacement parts can no longer be obtained.

The OSHA report of violation required that UNICOR or USP Lewisburg provide "abatement certification and documentation" to OSHA that demonstrates corrective action for the violation. In response to the OSHA reports and violation, UNICOR and USP Lewisburg implemented corrective actions, and the USP Lewisburg Warden issued a written correspondence to OSHA documenting the abatement actions (see Attachment

3). The following actions were taken to address the OSHA violation as stated in the correspondence to OSHA and as described by the Production Controller:

- Dry sweeping is prohibited and signage is in place to communicate this restriction. Misting is required before any sweeping of bulk materials such as pieces of wire or other bulk debris. Training is provided in hygiene, housekeeping, and cleaning practices and workers sign a document to acknowledge receipt of training.

- Pedestal fans have been removed from the disassembly area. The area is now air conditioned.

- Tack mats have been placed at the entrance/exit of the glass breaking room. Cleaning practices are implemented for equipment that is taken from the glass breaking room.

UNICOR and USP Lewisburg have also taken some action to address the ventilation of the glass breaking room and potential heat stress issue. According to the Production Controller, air conditioning is now provided to the general factory area within which the glass breaking room is housed. Direct ventilation is not provided to the room, but some migration of tempered factory air could occur through the plastic curtain wall. According to the Production Controller, USP Lewisburg also submitted a proposal to UNICOR Headquarters to create a negative pressure condition within the glass breaking room, but UNICOR did not accept this proposed action to create the negative pressure condition, even though this improvement has been suggested by its consultant, OSHA, and NIOSH/DART. [Note: In January 2008, NIOSH/DART found that the booth is not operated at negative pressure. See Section 4.1.5 for further information.] Finally, the Production Controller stated that "breathable," disposable protective coveralls are now used in the glass breaking room which serve to reduce heat exposure.

The condition regarding broom, brush, or other dry cleaning at USP Lewisburg that was in part responsible for the OSHA violation was also found at FCI Tucson, which used dry cleaning methods into 2009, two years after the USP Lewisburg OSHA violation. This indicates that UNICOR is not effectively communicating, alerting, and directing its recycling factories as a whole to correct OSHA violations or other deficiencies that are found at the individual facilities. UNICOR should ensure that all of its recycling factories are aware of deficiencies and violations, and ensure that corrective actions are made at all applicable factories. UNICOR should ensure that it has proper staffing levels and management systems to achieve improvements in information sharing and corrective action tracking, among other management and ES&H functions.

A "lessons learned" issue that UNICOR should understand from the citation and share with all of its factories is that many OSHA standards require more than controlling exposures to levels below the PEL. Many standards, including lead and cadmium standards, require various specific actions to limit exposure (e.g., use of engineering and work practice controls over respiratory protection to control exposure, prohibiting dry sweeping, implementing housekeeping and hygiene practices, and worker training, among others).

4.1.3 Annual UNICOR Consultant Evaluations of 2005, 2006, 2007, and 2008

Beginning in 2005 and continuing to the present time, two other consultants conducted more thorough annual industrial hygiene evaluations of USP Lewisburg e-waste recycling operations in April 2005, April 2006, March 2007, and March 2008. Since 2006, all studies were conducted by the same consultant. In addition to personal exposure monitoring, area air monitoring and surface wipe sampling, these studies also evaluated work processes and hazard controls. As opposed to the 2003 study, findings were presented and discussed and recommendations were provided.

4.1.3.1 Consultant Evaluation of 2005

In April 2005, only one personal sample for a glass breaker was taken, along with three area air samples. Six wipe samples were also collected from some work surfaces and worker PPE and hands. Results are as follows.

- Air sample results showed the glass breaker's lead exposure at 18 $\mu g/m^3$ and cadmium exposure at 0.5 $\mu g/m^3$. The consultant reported that if a maximum shift of five hours was worked with this exposure, then the lead result would calculate to 22% of the PEL and 38% of the action level as an 8-hour TWA.

- Outside the enclosure, an area air sample showed all metals results to be below the limit of detection (LOD). Inside the enclosure, an area sample near the left wall also showed all results to be below the LOD. A sample behind the right HEPA unit was reported to be 14% of the PEL for lead and 6% of the PEL for cadmium as an 8-hour TWA.

- Three surface wipe samples were collected from an enclosure wall, pallet jack, and floor outside the enclosure. The highest surface level found was on the floor outside the enclosure and had 316 $\mu g/ft^2$ lead and 123 $\mu g/ft^2$ cadmium. The consultant did not make a definitive conclusion regarding these levels. See Section 4.2 for additional information on surface contamination levels.

- Wipe samples of workers' hands found cadmium contamination, but no lead. The consultant stated that these samples were of most concern.

- Smoke tests and face velocity measurements of the LEV system showed that the system was adequate for the capture of light dust.

[Note: There were some data inaccuracies in Table 1 of the consultant's report regarding presentation of an 8-hour TWA for lead and transposing another lead result from the laboratory report. However, the consultant's interpretation of the results is accurate and the errors do not detract from the accuracy of the findings.]

The consultant concluded that all air samples were below applicable limits and no changes were needed in operations. Recommendations included maintaining the air handling system, maintaining regular housekeeping, continuing use of respiratory protection, training of workers in the lead and cadmium hazards as required by the OSHA lead and cadmium standards, re-enforcing personal hygiene practices (hand cleaning), improving contamination control when exiting the glass breaking area, improving floor cleaning, and performing additional exposure monitoring.

4.1.3.2 Consultant Evaluation of 2006

In April 2006, another IH professional conducted a similar industrial hygiene evaluation. The personal exposure monitoring and surface wipe sampling was more intensive in this study. Results are summarized below.

- Five personal exposure monitoring samples were collected, two breakers inside the glass breaking booth, one "runner" outside the booth (i.e., presumably a feeder), and two inmate workers performing "teardown" (i.e., disassembly) activities on the factory floor. As would be expected, the breakers had the highest exposures, but all exposures were only small fractions of the PELs. For instance, the highest lead exposure was 8.2% of the PEL for the duration sampled, and 3.3% as an 8-hour TWA. The highest cadmium exposure was 16% of the PEL for the duration sampled and 6.4% as an 8-hour TWA. The feeder/runner cadmium exposure was less than 8% of the PEL (less than the LOD) and the lead exposure was 1.4% of the PEL as an 8-hour TWA. Inmate worker exposures conducting disassembly activities outside the booth were less than 4% of the cadmium PEL (less than the LOD), and the highest lead exposure was 1.9% of the PEL as an 8-hour TWA.

- Area samples inside and outside the glass breaking booth were lower than the corresponding personal exposures; that is, small fractions of the PEL, if detectable.

- Fifteen surface wipe samples were collected from surfaces inside the glass breaking booth, outside the booth in disassembly areas, from hands and PPE, and in change room and PPE storage areas. The consultant compared these results to different criteria than those cited in FOH and NIOSH/DART reports to date (except for beryllium). The criteria used by the consultant for lead are more restrictive (see Section 4.2 for a discussion of consultant and NIOSH/DART and FOH cited criteria), but the consultant noted that an assessment is needed to determine if more suitable surface contamination criteria should be used. The consultant found that various surface samples inside and outside the glass breaking booth that were analyzed for lead and cadmium exceeded the criteria that he applied. The consultant noted that some other metals exceeded or may potentially have exceeded the criteria used. Beryllium was found in some samples in detectable levels, but these levels were less than the Department of

Energy's (DOE) standard found in its Chronic Beryllium Disease Prevention Program (CBDPP). [DOE 1999] See Section 4.2 for additional discussion of surface contamination levels and criteria cited by the consultant, NIOSH/DART and FOH.

The consultant recommended general actions relative to the OSHA lead and cadmium standards, including employee information and training, PPE selection and laundering, use of HEPA vacuums, separate change rooms and PPE storage areas, LEV and HEPA maintenance and cleaning functions, periodic inspection of hygiene facilities and practices, and management of worker clothing contamination. Specific recommendations included worker notification of monitoring results; verification of training for cadmium, lead, respirator use, and hazard communication; verification of work practices, clean-up procedures, and handling procedures; PPE implementation improvements; verification and documentation of various work practices, procedures, and control measures; continuation and documentation of various inspections; and performance of various monitoring activities. Additional monitoring recommended included screening to determine if other metals or radiation should be monitored, further evaluation of beryllium surface contamination, performance of noise dosimetry, development of a surface testing plan for future and periodic testing, and re-monitoring for toxic metals exposures.

4.1.3.3 Consultant Evaluation of 2007

In March 2007, the same IH professional performed a third industrial hygiene evaluation that was similar to the evaluation in 2006. The consultant reported that CRT demolition (breaking) and related processing had not changed since 2006, but that the factory area had been re-constructed and re-finished to improve decontamination control. The Production Controller confirmed that the recycling factory was fully refurbished starting approximately in mid-2006 with completion in early 2007. Results are summarized below.

- Eight personal samples were collected for glass breakers, feeders, and inmate workers performing equipment disassembly on the factory floor. Exposure results were similar to those found in 2006 and discussed above. Breakers had the highest exposures, but well below the PELs. The highest lead exposure was 9.8% of the PEL and the highest cadmium exposure was 5% of the PEL, both as 8-hour TWAs. The feeder/runner had lead exposure at 2.6% of the PEL, and cadmium exposure at less than 1% of the PEL, both as 8-hour TWAs. The highest disassembly worker exposure was 1% of the PEL for lead and less than 1% of the PEL for cadmium, both as 8-hour TWAs.

- Area air samples collected inside and outside the glass breaking booth were comparable to or much lower than personal samples taken in similar work areas. At the entry to the glass breaking booth, lead was found at 0.86 $\mu g/m^3$ and cadmium was below the LOD.

- Over 20 surface wipe samples were collected. Where the consultant made side-by-side comparisons between 2006 and 2007 results, the lead contamination levels varied, with some higher, some lower, and some in the same range. Samples from the disassembly area in the factory seemed to be generally higher in lead levels in 2007 than 2006, although a direct comparison between these surfaces may not be appropriate because of varied sample locations and was not made by the consultant. The consultant found that cadmium and beryllium levels were generally lower in 2007 than in 2006. The consultant reported that many of the lead levels, and potentially some other metals, exceeded the criteria that he cited (generally more restrictive than those cited by NIOSH/DART and FOH; see Section 4.2 for a discussion) and recommended further sampling and more standardized work procedures and clean-up practices. [Note: In his recommendations, the consultant stated that more suitable industrial contamination guidelines should be identified that are more applicable to UNICOR recycling. See Section 4.2 for additional discussion of surface contamination levels and suggested criteria.]

The consultant again recommended general actions relative to the OSHA lead and cadmium standards, including employee information and training, PPE selection and laundering, use of HEPA vacuums, separate change rooms and PPE storage areas, LEV and HEPA maintenance and cleaning functions, and others. Specific recommendations included employee notification of air monitoring results, verification and documentation of various work procedures and control practices and facilities, improvements in clean room facilities and PPE practices, improvements in the cleaning regimen, improvements in contamination control, and additional monitoring. The additional monitoring recommendations included development of a surface testing plan, screening to determine whether other metal contaminants or radiation should be monitored, performing noise dosimetry, and conducting periodic re-monitoring for metals.

4.1.3.4 Consultant Evaluation of 2008

In March 2008, the same consultant performed another industrial hygiene evaluation that involved an assessment of the overall factory operations similar to those in 2006 and 2007. Results are summarized as follows:

- Fourteen personal exposure monitoring samples were taken from workers, including breakers, feeders, a forklift operator, disassembly personnel, and warehouse personnel. Results were generally comparable to or somewhat less than results of the prior two years. Lead exposures were highest for breakers/feeders but were less than 10% of the PEL as an 8-hour TWA, while cadmium exposures were all below the LOD. Exposures for warehouse and factory workers were 2% or less of the lead PEL as an 8-hour TWA and less than the LOD for cadmium.

- Four area samples collected in the glass breaking room, "clean room," and recycling office were also low. The only detectable lead sample was from the glass breaking room and was 1.8 $\mu g/m^3$, and the only detectable cadmium sample was from the recycling office and was 0.17 $\mu g/m^3$.

- Surface dust lead concentrations within the glass breaking room were found in similar concentrations as the consultant's prior surveys, and these dusts are contained within the enclosure. A composite sample from "teardown" (disassembly) benches showed "an extremely high concentration of lead (90,000 $\mu g/m^2$)" which is about 9,000 $\mu g/ft^2$. This sample included dust collected from within angle iron corners of monitoring room benches. The consultant noted that these findings indicate the need for "vigilant HEPA vacuuming practices within each and all work areas, before the end-of-shift, as well as periodic inspection." Surface lead concentrations within the warehouse exceeded the surface criteria used by the consultant, but were less than the OSHA criteria of 200 $\mu g/ft^2$ that is appropriate for "clean" areas associated with lead work (see Section 4.2 for further discussion of surface contamination criteria).

- Cadmium surface contamination was found at less than the surface criteria used by the consultant, except for a teardown bench composite sample. Beryllium was not detected in most samples, and was 10.5% and 23% of the DOE Chronic Beryllium Disease Prevention Program (CBDPP) release criteria in two samples with detectable beryllium.

The consultant provided many useful conclusions and recommendations. He cited several actions taken since 2007 related to compliance with the OSHA lead and cadmium standards and suggested that these actions be maintained. Examples of compliance actions included worker lead and cadmium information and training, improved PPE with disposable and launderable protective clothing, improved cleaning practices, and improved PPE storage and PPE procedures. Example recommendations included improvements of the glass breaking ventilation system to include establishing a negative pressure condition as suggested by OSHA, replacing existing glass breaking room ceiling mounted ventilators with properly designed HEPA-filtration system (see Section 4.1.5 for similar NIOSH/DART findings on this issue), eliminating "uncontrolled" dumping of Gaylord bins and establish Gaylord bin cleaning practices and other control measures (see Section 4.3 for FOH observations of a similar issue), sealing of various surfaces to enhance cleaning efficiency, continued enhancements to cleaning practices, additional and on-going testing and monitoring practices including worker notification of results, various facility improvements, and various documentation and verification practices, among others. He continued to provide and re-emphasize recommendations from prior surveys.

4.1.3.5 Summary of Annual Consultant Evaluations-2005 through 2008

In summary, the annual UNICOR consultant industrial hygiene evaluations conducted in 2005, 2006, 2007, and 2008, were thorough and provided useful and practical information and recommendations to evaluate and control hazards associated with UNICOR's e-waste recycling operations at USP Lewisburg. Inhalation exposures were consistently well below OSHA PELs for all toxic metals monitored, but improvements in work practices, hazard controls, verification and documentation of procedures and practices, and additional monitoring were among items recommended to further enhance work practices and hazard control measures. Each annual evaluation built upon past findings to focus continuing studies, evaluate existing and improved work practices and hazard controls, and contribute to continued improvements.

FOH considers this type of annual or periodic industrial hygiene evaluation to be a noteworthy practice that UNICOR should implement at all of its recycling facilities, whether or not glass breaking is conducted. This type of annual or periodic evaluation would meet several of the FOH and NIOSH/DART recommendations made in reports for other UNICOR recycling facilities to ensure continued control of hazards, verify effective work practices and hazard controls, and achieve continued improvements over time. To properly implement such a monitoring program, even if performed by contractors, UNICOR should ensure it has the proper staff and management systems to promptly evaluate and convey results and implement any corrective action required.

According to the Production Controller, the next annual industrial hygiene evaluation of the overall factory operations is scheduled for June 2009. Since the last evaluation in March 2008, glass breaking production has been increased to between 450 and 600 CRTs per day and is conducted on average every 2.5 days. The June 2009 monitoring will be the first monitoring since production has increased. Under the lead and cadmium standards, OSHA requires that additional monitoring be conducted when production or other changes occur that could result in increased exposure. The June 2009 monitoring will serve this purpose, but should have been scheduled more promptly after production was ramped up.

FOH emphasizes that to make such evaluations effective, UNICOR should ensure that it follows through with implementation of recommendations (see Section 6.0, Recommendations, for information to ensure closure of recommendations made by consultants, participants in the OIG investigation, OSHA, and other organizations). For instance, it is apparent that UNICOR at USP Lewisburg has made continued improvements in health and safety aspects of recycling operations over time, but the extent of implementation of the consultant's recommendations is not completely clear. The consultant's reports indicate implementation of some improvements, but many of the same recommendations are repeated each year. When asked which consultant recommendations were implemented, the USP Lewisburg Production Controller stated that several recommendations were implemented but that some others were not because they were not deemed feasible. The Production Controller stated that recommendations implemented included improved cleaning practices, use of HEPA vacuum systems, use of a service company to provide coveralls to all factory workers and to provide a laundering service for the coveralls, facility modifications to reduce dust accumulation and enhance effectiveness of cleaning, and follow up monitoring. These improvements demonstrate a good faith and on-going effort to provide for continuing improvements in worker protection.

An example of a recommendation that has not been implemented includes the improvements in the glass breaking room ventilation system, such as the introduction of fresh air, establishment of a negative pressure, and improvement of ceiling vents. Dating from 2007 forward, OSHA, NIOSH/DART, and the UNICOR consultant have presented similar findings and recommendations in this regard. The Production Controller stated that a proposal was provided for upgrading the ventilation system to UNICOR Headquarters, but that the proposal was not accepted.

Closure of recommendations with documentation of those which were accepted and details of their implementation, along with those not accepted or pending (and why) is important to demonstrate and track improvement actions. BOP and UNICOR should implement a corrective action system to track, accept, not accept, prioritize, and document corrective actions taken from various evaluations and investigations, including those of its consultants and those of the OIG investigation. If recommendations are not accepted, UNICOR should document the reason and document any alternate actions taken to achieve similar results. See Section 6.0, Recommendations, for further information on tracking and closing deficiencies, compliance issues, and recommendations.

4.1.4 UNICOR Consultant Targeted Studies of September 2008

In addition to the annual industrial hygiene evaluations conducted since 2005, a UNICOR consultant has performed additional targeted studies to address specific issues. These included two studies conducted in September 2008. One study provided mercury vapor screening in the recycling factory, and another provided performance testing for two types of coveralls used during glass breaking. Results are discussed below.

Mercury vapor screening found that mercury vapor was not widely detected in appreciable concentrations within the factory and that no survey results throughout the factory were found with detectable mercury vapor exceeding the ACGIH TLV of 25 $\mu g/m^3$. The report concluded, however, that "survey results indicate that mercury may be distributed within the factory environment." Areas of accumulation could include difficult to clean areas, metal balers and crushers, metal lockers, and metal receptacles. Various recommendations were made that included staff and worker training, follow-up monitoring, contingency clean-up preparedness, and repeat screening, among others.

The study to compare relative performance of two types of coveralls under field-use conditions was made to determine the relative capability of alternate, breathable coveralls to hold out particulate contamination (e.g., toxic metals dusts) with the goal of reducing overall heat stress to workers. The report stated that the "results of this study are not conclusive." Recommendations were made to repeat coverall testing using a modified test approach, among others. The Production Controller stated that USP Lewisburg is currently using "breathable" disposable coveralls which have benefit for heat reduction to workers; therefore, presumably USP Lewisburg has finalized coverall selection.

These types of targeted studies indicate an on-going effort by UNICOR and USP Lewisburg to continue hazard evaluations and hazard control improvements. UNICOR should determine whether recommendations from these studies are of sufficient priority and benefit to worker protection. The type of tracking system described in Section 4.1.3.5, above and in Section 6.0, Recommendations, would provide for acceptance, non-acceptance, and prioritization of recommendations and corrective actions.

[Note: A third targeted consultant study for non-routine cleaning activities of elevated surfaces is discussed in Section 4.4 after the presentation of surface contamination results in Section 4.2 and after a discussion of FOH observations on a related topic in Section 4.3.]

4.1.5 NIOSH/DART Monitoring for Toxic Metals

NIOSH/DART and FOH conducted a field investigation of the USP Lewisburg electronic equipment recycling facilities to assess worker exposure to toxic metals (see Attachment 1). The investigation included exposure monitoring and other assessments and was conducted in January 2008 after an initial study was performed in May 2007. Personal exposure monitoring was conducted for 31 metals. During the two days of sampling, 293 and 258 CRTs were broken. Lead and cadmium were found to be the more significant exposures, but were maintained below the PELs of the OSHA lead and cadmium standards for both routine and non-routine activities. Exposure results for other metals were well below the applicable exposure limits. Exposure monitoring results from the NIOSH/DART study are summarized below:

- Lead and cadmium exposure monitoring results (not including glass breaking) were well below the action levels and PELs for lead and cadmium. The highest lead exposure on the factory floor was 1.13 $\mu g/m^3$ over roughly a six hour period which equates to about 0.85 $\mu g/m^3$ as an 8-hour TWA exposure. This compares to a lead PEL of 50 $\mu g/m^3$ and an action level of 30 $\mu g/m^3$. The highest cadmium result was 0.08 $\mu g/m^3$ for the duration sampled which is well below the PEL of 5.0 $\mu g/m^3$ and action level of 2.5 $\mu g/m^3$. These exposures were for disassembly activities. Exposures for the other 29 metals were also well below the PELs.

- Lead and cadmium exposures during glass breaking were also well below the OSHA action levels and PELs. Lead exposures during routine glass breaking ranged up to 4.4 $\mu g/m^3$ for the duration sampled (i.e., 320 minutes), or about 2.9 $\mu g/m^3$ as an 8-hour TWA. Cadmium exposures during routine glass breaking ranged up to 0.12 $\mu g/m^3$ for the duration sampled, which is about 0.08 $\mu g/m^3$ as an 8-hour TWA. These highest exposures are small fractions of the PELs.

- The non-routine filter cleaning and change-out activity, conducted approximately monthly, was the task of greatest potential exposure concern. This activity involves changing the LEV HEPA filter, cleaning the system housing the filter, and cleaning the general area afterwards. Cadmium exposure during the filter change-out activity was 2.94 $\mu g/m^3$ which calculates as 0.6 $\mu g/m^3$ as an 8-hour

TWA. The 8-hour TWA result is below the cadmium action level and PEL as an 8-hour TWA exposure. Lead exposure was 10.3 $\mu g/m^3$ which calculates as 2 $\mu g/m^3$ as an 8-hour TWA. The 8-hour TWA result is also below the lead action level and PEL. All other metal exposures were well below the PELs. Inmate workers wear PAPRs during this operation with a protection factor of 25; therefore, lead and cadmium exposures (via inhalation) are well controlled.

NIOSH/DART detailed the PPE and respiratory protection used during recycling activities. Respiratory protection and PPE worn by breakers performing glass breaking inside the glass breaking room included hooded powered air purifying respirators (PAPRs), Tyvek coveralls, gloves, hand and arm protection against broken glass, and work boots. During the filter change-out activity, Tyvek coveralls, gloves, and PAPRs were worn. The PPE and respiratory protection is appropriate for breakers and the inmate workers performing filter change-outs. The respiratory protection provides a protection factor of 25, which means that respirators would be effective in controlling exposures up to 25 times greater than the PELs. As noted above, all metals exposures were less than the PELs.

In addition to the PPE and respiratory protection evaluation, NIOSH/DART also conducted an evaluation of the local exhaust ventilation (LEV) system that serves the glass breaking room. The LEV system consists of two reverse flow horizontal filter modules (HFMs) located inside the glass breaking area. They have a bank of pre-filters and a HEPA filter with a 1,200 cubic feet per minute (cfm) fan and one-half horsepower motor. The control panel has a pressure gauge and variable speed control. Air enters through the pre-filters in the front of the unit and passes through the HEPA filter. After filtration, all air is recirculated back into the glass breaking room through a grille at the back of the unit. Plastic strip curtains provide a partial physical barrier between the workers and an angle iron grate where breaking occurs. The HFMs are in an area enclosed by building walls on three sides and a plastic strip curtain on the fourth side.

NIOSH/DART conducted a visual inspection, qualitative testing using smoke, and quantitative testing for face velocity. Summary results are as follows:

- NIOSH/DART found that the average face velocity measurement of HFM-1 (unit to the right when facing from the front) was 160 feet per minute (fpm), with a range of 150 – 170 fpm. For HFM -2, NIOSH/DART found that the average face velocity was 140 fpm, with a range of 130 – 150 fpm. These values are sufficient for the capture of fine dust emissions.

- Smoke tests performed at the plastic strip curtain wall (the boundary between the glass breaking area and the general workplace) showed little air flow into the enclosed area from the general work area. Two exhaust fans are placed in the ceiling of the enclosed area in an attempt to achieve a negative pressure condition with respect to the adjacent general workplace. However, the smoke tests showed that exhaust fans designed to achieve a negative pressure differential are not sufficient. [Note: In 2008, UNICOR's consultant also recommended that this system be redesigned and replaced.]

- NIOSH/DART found that because the HFMs discharge into the GBO enclosure (rather than to the outside of the building, for example) and re-circulate the filtered air, the enclosure is not under negative pressure with regard to the rest of the glass breaking booth. Recirculation of air from industrial exhaust systems into workroom air can result in hazardous air contaminant concentrations in the facility if not designed properly [AIHA/ANSI 2007]. NIOSH/DART's exposure monitoring indicates that the recirculation causes no elevated exposures to workers in the glass breaking booth. [Note: The exposure conditions are based on the LEV being effectively maintained and operated and suffering no malfunctions.] If UNICOR were to redesign the system to exhaust to the outside, the system must be redesigned to meet applicable fire, safety, or environmental codes that apply to this facility and operations.

NIOSH/DART noted in its FCI Marianna report [NIOSH 2008b] that ANSI and AIHA [2007] recommend that "under no circumstances shall workroom air consist of 100% re-circulated air." The USP Lewisburg glass breaking LEV system is similar to the FCI Marianna system, except that the glass breaking area at USP Lewisburg is located within a tempered air factory environment and, as noted above, exhaust fans are located in the booth ceiling in an attempt to introduce general workplace air that contains a component of fresh air. [Note: Since the NIOSH/DART investigation, air conditioning has been added to the FCI Marianna's glass breaking area.] However, NIOSH/DART smoke tests did not show significant air movement from the general workplace into the glass breaking room. FOH also notes that the OSHA lead and cadmium standards require monitoring of LEV exhaust air streams when it is re-circulated to the work environment. [Note: OSHA and the UNICOR consultant also recommended actions to improve ventilation to the glass breaking room, achieve a negative pressure condition, and/or monitor re-circulated air.]

UNICOR should further evaluate the glass breaking booth LEV and ventilation system to ensure adequate fresh air ventilation while maintaining a slight negative pressure within the booth. Possible methods to improve the LEV system could include re-engineering the system, with appropriate engineering support, to provide fresh air while maintaining a negative pressure relative to the general factory area, and improving the monitoring of re-circulated air from the exhaust streams of the HFMs back to the glass breaking room. See Section 6.0, Recommendations, for additional information.

The following provides a summary of the NIOSH/DART evaluation for toxic metals exposure at USP Lewisburg:

- Inhalation exposures to lead, cadmium, and other metals are minimal for routine activities conducted on the general factory floor, as well as for associated recycling activities.

- Inhalation exposure to metals during glass breaking were also controlled at levels well below the OSHA PELs and action levels, plus the use of PAPRs reduce these exposures even further.

- Inhalation exposure to metals during the non-routine filter change-out activity were the highest found for the duration sampled; however, these exposures were also controlled at levels below the OSHA PELs and actions levels as 8-hour TWAs. Worker use of PAPRs reduce these exposures even further.

- As operating during the time of sampling, the LEV system is effective in controlling toxic metals exposures in the glass breaking room; however, opportunities exist for improving the system and bringing the system into compliance with OSHA and ANSI standards. For instance, the OSHA lead standard (29 CFR 1910.1025) requires monitoring of LEV exhaust air streams that are re-circulated to the work area (see Section 6.0, Recommendations).

Based on the exposure characterizations and observations described above, USP Lewisburg glass breaking operations, disassembly operations, and associated activities are conducted in a manner that maintains exposures at levels less than OSHA PELs and action levels.

4.2 Surface Wipe and Bulk Dust Sample Results

As part of the OIG investigation, NIOSH/DART and FOH conducted bulk dust and surface wipe sampling at USP Lewisburg in e-waste recycling areas during the site evaluations in May 2007 and January 2008. Samples were analyzed for total lead, cadmium, and other toxic metals. In addition, several bulk dust samples were collected and analyzed for total toxic metal content or for extractable metals using the Toxic Characteristic Leaching Procedure (TCLP) to determine whether contamination should be treated as hazardous waste. Results for these samples are presented in Section 4.2.1 and 4.2.2 below.

Federal standards or other definitive criteria or guidelines have not been developed for acceptable levels of lead or cadmium surface contamination or dust concentrations in industrial areas where activities are performed involving lead and/or cadmium bearing materials. However, several recommendations or guidelines, primarily for lead, provide points of reference to subjectively evaluate the significance of surface contamination. Some guidelines are available and are noted below (see the NIOSH/DART FCI Elkton report for a more detailed discussion of guidelines):

- OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace (i.e., 29 CFR 1926.62) can be summarized and/or interpreted as follows: all surfaces shall be maintained as 'free as practicable' of accumulations of lead; the employer shall provide clean change areas for employees whose airborne exposure to lead is above the PEL; and the employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination. The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of the Department of Housing and Urban Development's (HUD) initially proposed decontamination criteria of 200 $\mu g/ft^2$ for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas. In situations where employees are in direct contact with lead-contaminated surfaces, such as working surfaces or floors in change rooms, storage facilities, and lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level.

- For other surfaces (e.g., work surfaces in areas where lead-containing materials are actively processed), OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of lead contamination meets the definition of "practicable." Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of lead dust does not become a source of employee lead exposures. OSHA has stated that any method that achieves this end is acceptable. [29 CFR, Part 1910.1025]

- Lange [2001] proposed a clearance level of 1,000 $\mu g/ft^2$ for floors of non-lead free commercial buildings and 1,100 $\mu g/ft^2$ for lead-free buildings. These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions.

- HUD has established clearance levels for lead on surfaces after lead abatement. [24 CFR 35] These levels range from 40 to 800 $\mu g/ft^2$, depending on the type of surface. The level of 200 $\mu g/ft^2$ is most commonly used. These levels, however, apply to occupied living areas where children reside, and are not intended for industrial operations.

- Regarding lead in bulk dust or soil samples, the U.S. EPA has proposed standards for residential soil-lead levels. [EPA n.d.] The level of concern requiring some degree of risk reduction is 400 ppm (mg/kg), and the level requiring permanent abatement is 2,000 ppm (mg/kg). Again these levels are residential criteria, rather than for industrial settings.

- There is no quantitative guidance for surface cadmium concentrations. OSHA states that surfaces shall be as free as practicable of accumulations of cadmium, all spills and sudden releases of cadmium material shall be cleaned as soon as possible, and that surfaces contaminated with cadmium shall be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne. [40 CFR 745.65]

The discussion regarding surface wipe and bulk dust sample results is presented below in context of these available recommendations and guidelines.

[Note: UNICOR's consultant applied other, more conservative criteria in his analysis of surface wipe samples. Some of these criteria are from the U.S. EPA World Trade Center (WTC) working group surface guide (health-based benchmark) that apply to the general population with a 24-hour exposure. [COPC 2003] The consultant acknowledged that these criteria are not directly related to the industrial setting and recommended that a more suitable surface contamination guideline be developed by UNICOR for its recycling operations. FOH agrees with these statements. Potential surface contamination guidelines will be further discussed in the OIG final report.]

4.2.1 Surface Wipe and Bulk Dust Results at Current Recycling Facilities

During its January 2008 field investigation, NIOSH/DART collected a limited number of surface wipe samples from work surfaces in the USP Lewisburg general factory areas. In addition, surface samples were collected from various component parts of e-waste equipment. Samples were analyzed for lead and cadmium and other toxic metals. Summary results for these samples are presented below (see Attachment 1 for complete results):

- Three surface wipe samples were collected from work surfaces (benches or bench mats) outside the glass breaking area. Only one of the three was above the 200 $\mu g/ft^2$ OSHA criteria for lead that applies to clean or non-work areas, and it was 279 $\mu g/ft^2$. The cadmium level for this sample was 8 $\mu g/ft^2$.

- Eight surface samples were collected from component parts of e-waste equipment. Two of these samples from blades of fans removed from CPUs were found to be contaminated with lead at 512 $\mu g/ft^2$ and 7,068 $\mu g/ft^2$. Cadmium was present at 14 $\mu g/ft^2$ for these samples. These levels of contamination were likely present at the time of UNICOR's receipt of this equipment. Disassembly or other activities could free this dust and result in surface contamination in the facility over time and also create potential for worker inhalation and ingestion exposures. The FOH investigator reported that glove use was inconsistent during general factory operations.

- The remaining six samples from e-waste equipment components ranged up to 36 $\mu g/ft^2$ for lead and 1 $\mu g/ft^2$ for cadmium.

- All beryllium results for the eight surface samples were less than the analytical limit of detection (LOD).

The higher surface contamination levels on some of the electronic equipment component parts indicate that if loose dust on the equipment is dislodged during handling and disassembly it can contribute to facility and working surface contamination. In addition, this can contribute to the potential for inhalation or ingestion exposure during routine disassembly, although inhalation exposures have been consistently low during this activity. This finding highlights the importance for control and management of incoming materials, effective PPE, rigorous housekeeping and hygiene practices, routine clean-up practices, and an operations and maintenance (O&M) plan.

In addition to the above-referenced samples, FOH performed more extensive wipe sampling of various surfaces in the recycling factory and warehouse (see Figures 1-3) both inside and outside the glass breaking booth, in the general factory area, and associated areas. These samples were collected during the initial investigation in May 2007 and in the follow-up investigation in January 2008. Attachment 2 provides tables with additional details about sample locations and the analytical results. A summary of results is provided below for samples collected in May 2007:

- Samples in the glass breaking room and feeder area ranged up to 1,300 $\mu g/ft^2$ lead and 880 $\mu g/ft^2$ cadmium. As expected, these samples were the highest levels found, but are contained within the enclosure and isolated from the factory floor.

- Samples collected from the "clean" and "dirty" rooms that provide for transition from the glass breaking area and allow for PPE donning, doffing, and storage were well below the 200 $\mu g/ft^2$ OSHA criteria for lead that applies to clean areas. Cadmium was at 8 $\mu g/ft^2$ or lower.

- Of 14 samples collected from surfaces in the general factory, warehouse, and associated office areas, all but one were below the 200 $\mu g/ft^2$ OSHA criterion for lead in clean areas. The one sample above this criterion, at 450 $\mu g/ft^2$ lead was on a shelf above a workbench outside the glass breaking area. As found at other UNICOR recycling facilities, elevated surfaces are often found to have higher surface contamination than work bench areas, likely because elevated surfaces are not subject to as much regular cleaning as working surfaces.

- For the most part, cadmium levels were significantly lower than lead levels for these 14 samples. However, two samples, a (circuit) board separation area table mat and disassembly area 7A rubber mat, showed cadmium to be present at higher levels than lead. These levels were 300 $\mu g/ft^2$ and 110 $\mu g/ft^2$, respectively.

- A sample inside a Gaylord box had a lead concentration of 1,200 $\mu g/ft^2$. Cadmium was at 38 $\mu g/ft^2$. These boxes are used to hold e-waste, including CRT glass, therefore, higher concentrations of lead are not unexpected but point to the need for periodic cleaning of the boxes using HEPA vacuums.

- Beryllium was below the analytical limit of detection (LOD) for all wipe samples.

In January 2008, FOH also collected surface wipe and bulk dust samples for total lead and cadmium analysis, as well as bulk and mop water samples for TCLP analysis. The bulk dust and TCLP results are discussed in Section 4.2.2. Results from six surface wipe samples are discussed below:

- Surface samples from vacuum hoses/dust pans and plastic curtains inside the glass breaking room were found to have relatively high levels of lead at 4,000 $\mu g/ft^2$ and 8,400 $\mu g/ft^2$, respectively. Cadmium was found at levels of 44 $\mu g/ft^2$ and 63 $\mu g/ft^2$. These surface dusts are contained inside the enclosed booth where workers are protected by PPE and respiratory protection and, therefore, do not represent a hazard to the workers on the general factory floor.

- One sample collected from a glass breaker's gloves and another collected from a breaker's plastic sleeves were found to have 160 $\mu g/ft^2$ and 170 $\mu g/ft^2$ lead, respectively. These results affirm the importance of using PPE during glass breaking and using proper PPE doffing practices to avoid contamination of skin and inner clothing during the removal process.

- Two composite samples were collected from window sills in the middle section of the recycling factory. Lead was found at 1,100 $\mu g/ft^2$ and 390 $\mu g/ft^2$, with cadmium at 27 $\mu g/ft^2$ and 22 $\mu g/ft^2$. These results were higher than the levels that NIOSH/DART found on working surfaces of the factory area and were in the range of levels found on a higher shelf and within a Gaylord box. These non-working areas such as elevated surfaces, window sills, and others should be periodically cleaned as part of an O&M plan (see Section 6.0, Recommendations for further information).

In comparing 2007 and 2008 NIOSH/DART and FOH data with 2006 and 2007 UNICOR consultant data, the surface wipe results are generally in a similar range, although direct comparisons of data are difficult because of differences in sampling locations, for instance. In reviewing lead data, most surface levels in the general factory areas (e.g., disassembly) were below the OSHA criterion that applies to clean areas (e.g., lunchrooms, change rooms), with an occasional level above this criterion. Glass breaking surfaces were higher but these areas are confined within the containment room. Lead levels in Gaylord boxes were also higher, around or above 1,000 $\mu g/ft^2$. Non-working surfaces that are not subject to regular cleaning were at higher levels than working surfaces. As discussed earlier in this report, when evaluating data, the UNICOR consultant applied more conservative levels than the OSHA criterion or other guidance discussed in Section 4.0 of this report, but suggested that more applicable guidance be determined and applied to the recycling work at UNICOR facilities. FOH agrees that surface contamination criteria for areas where lead materials are processed should be evaluated and developed.

Regarding beryllium, the consultant found detectable levels of beryllium in various surface samples, but all were below the DOE CBDPP standard for surface contamination. The consultant reported that beryllium levels in 2007 were generally lower than in 2006.

NIOSH/DART and FOH found no detectable beryllium levels in surface wipe samples collected in 2007 and 2008. One bulk sample showed a trace concentration of beryllium (see Section 4.2.2, below).

Based on existing surface contamination levels relative to surface contamination guidance, UNICOR and USP Lewisburg should implement an operations and maintenance (O&M) plan to limit contact with existing lead and cadmium contamination, limit its accumulation, prevent and/or control any releases of the contamination to the air, and generally prevent potential for inhalation and ingestion (i.e., hand-to-mouth contact) exposure. The O&M plan should address contamination on elevated surfaces and other factory surfaces (e.g., window sills) that are not regularly cleaned. It should also address the cleaning of Gaylord boxes at appropriate intervals and also other surfaces highlighted by the UNICOR consultant. The O&M plan should include appropriate actions to keep elevated surface contamination in check, such as the February 2009 activity conducted at USP Lewisburg to clean elevated surfaces in the warehouse (see Section 4.4). With proper controls established, the O&M plan could include periodic clean-up of surfaces by inmate or other workers, such as in the February 2009 clean-up of elevated surfaces performed by inmate workers (see Section 4.4). Elements of an O&M plan are discussed in Section 6.0, Recommendations.

[Note: In February 2009, USP Lewisburg initiated activities, with proper controls, to clean-up elevated warehouse surfaces using inmate workers. This activity is the type of activity that is conducted as part of an O&M plan. See Section 4.4 for additional details on this activity.]

Further surface testing should be periodically conducted to ensure that surface contamination levels do not increase over time, and/or to take preventive and corrective action should levels start to build up. Surface testing in areas of legacy contamination such as above the more recently installed factory ceiling (discussed below) should also be performed. Future surface testing should also include elevated surfaces that are not subject to routine cleaning (see Section 4.2.2, below for additional data from elevated surfaces).

4.2.2 TCLP and Bulk Dust Results

In addition to the surface wipe samples, in May 2007 and January 2008, FOH collected bulk samples for analysis of total lead and cadmium and waste water samples for TCLP analysis for extractable metals to determine their status relative to hazardous waste criteria. Table 2 provides TCLP criteria and FOH data are presented in Attachment 2. Results are as follows.

- TCLP results for the two mop water samples collected in May 2007 showed that extractable metals were at levels less than the criteria for hazardous waste. Three mop water samples collected in January 2008 showed similar results. [EPA n.d.]

- One bulk sample taken in May 2007 above the ceiling in the 7B disassembly area (above the former glass breaking operation) showed lead to be at 19,000 mg/kg, which is 1.9%. This sample is high in lead and could be legacy contamination from past glass breaking operations. Cadmium was found at only 62 mg/kg. Beryllium was detected in this bulk sample, but at a level that was below the analytical limit of quantitation (LOQ; a level below which the concentration can not be reliably determined; a trace amount).

- Two bulk samples taken in January 2008 from ceiling access panels on the north and south side of the factory room contained lead at 18,000 mg/kg and 5,800 mg/kg, respectively. These levels are comparable to the one sample collected above the ceiling in May 2007 (see above and Attachment 2).

- Two additional bulk dust samples were collected in January 2008. Debris from the floor where LEV filters were changed showed lead at 8,000 mg/kg which enforces the need for thorough cleaning of this area during and after filter changes. A sample from a canister vacuum cleaner in the glass breaking area was at 330 mg/kg lead.

Table 2
Maximum Concentration of Selected Contaminants
for the Toxicity Characteristic[1]

Contaminant	TCLP Regulatory Level
Arsenic	5.0 mg/L
Barium	100.0 mg/L
Cadmium	1.0 mg/L
Chromium	5.0 mg/L
Lead	5.0 mg/L
Mercury	0.2 mg/L

[1][40 CFR 261.24].

Mop water results were less than the Resource Conservation and Recovery Act RCRA [EPA n.d.] criteria for hazardous waste; however, UNICOR should conduct periodic TCLP analyses to verify that this non-hazardous waste status consistently prevails. The bulk dust samples with up to 1.9% lead taken from elevated surfaces emphasizes the need for additional surface sampling of elevated or other surfaces that are not subject to routine cleaning, as well as the implementation of an O&M plan to control this contamination and clean-up specific areas with higher contamination levels.

In 2006 UNICOR submitted a sample from filters for laboratory analysis by the TCLP procedure. The sample was identified as "Outside #2 Filters". This sample was found to be below hazardous waste levels for all metals tested. In 2009, UNICOR submitted two furnace filter samples for analysis by the TCLP procedure. These samples were also below the regulatory limit for hazardous waste, indicating that these filters do not need to be disposed of as hazardous waste.

4.3 FOH Observations Regarding Potential Exposure Sources

During its investigations in May 2007 and January 2008, FOH investigators noted two activities with observed potential for worker exposure to toxic metals, as well as potential for environmental contamination. Although monitoring of these activities was not performed, the following observations were made that indicate potential for exposure that should be further evaluated and appropriately controlled by UNICOR.

The first activity involved the transport of metal components removed from CRTs (i.e., metal masking and banding) to a roll-off container in the rear of the building. During this activity, inmate workers move boxes containing these metal components from the glass breaking area to an area at the rear of the factory. This activity is conducted by workers using hand trucks.

A forklift operator picks up the boxes using a forklift truck and moves the box outside of the factory to a raised position over a roll-off (i.e., approximately two to three feet above the roll-off, see Image 3) The forklift is used to invert the box and shake the contents into the roll-off. At times, one or two workers assist in this activity by picking up any debris that falls to the ground and placing the debris into the roll-off. As observed by FOH and noted in Figure 3, workers did not wear respiratory protection and did not wear protective clothing for this activity during the FOH investigations. [Note: The USP Lewisburg Production Controller stated that currently all factory workers wear protective coveralls provided by a uniform supplier and that disposable dust masks are available to these workers.]

Image 3. Forklift emptying Gaylord boxes containing computer scrap metal (ribbing, etc.) into roll-off container behind Camp building.

In observing this activity, FOH investigators noted the release of visible dust and phosphors. These emissions potentially expose the forklift operator, especially when the wind is in the direction of the operator, as well as the assistants. As found by UNICOR consultants and by NIOSH/DART and FOH, Gaylord boxes contain lead and cadmium dust contamination which indicates that this activity can release contaminated dusts. Also an FOH bulk sample from the interior of the roll-off was found to exceed the RCRA extractable lead criteria for hazardous waste (see Section 4.7, Environmental Issues, for further discussion of this finding, and see Image 4).

Image 4. Debris in scrap metal roll-off container (similar to debris constituting the sample exhibiting TCLP lead levels above RCRA hazardous waste limit).

UNICOR should further evaluate this activity for exposure to toxic metals and implement improvements in work practices and any appropriate levels of personal protective equipment and respiratory protection, if required. Environmental controls could also be warranted as discussed in Section 4.7. Work practices should be modified to control the release of dust to the air. See Section 6.0, Recommendations for further information. [Note: In March 2008 UNICOR's consultant recommended that "uncontrolled" dumping of Gaylord bins should be discontinued and that cleaning practices for Gaylord boxes be implemented.]

A second non-routine activity with potential for personal exposure to toxic metals is any access made above the factory ceiling that was installed in the disassembly factory during its refurbishment between mid-2006 and early 2007 (or other elevated surfaces). This area was shown by FOH bulk and surface sampling to be contaminated with higher levels of lead and cadmium dust, which could be related to the legacy glass breaking operations formerly performed in the area (see Section 4.2 for a discussion FOH sampling results in this area). Activities above the ceiling area could disturb this dust and result in worker exposure if proper control measures are not taken. UNICOR should implement an O&M plan to prevent this exposure (see Section 6.0, Recommendations, for further information). [Note: See Section 4.4, below for a clean-up approach that could also apply to this area, depending on the degree and extent of contamination, as well as worker training, capabilities, and qualifications. Also see Section 6.0, Recommendations]

It is possible that workers who installed the current factory ceiling and conducted other refurbishment, such as electrical or HVAC work, in the general factory area were exposed to this deposited dust (and other contaminated surfaces) if they disturbed these surfaces. The Production Controller stated that he and five inmate workers performed the factory refurbishment and that some controls such as dust masks were available. However, a thorough hazard analysis was not conducted prior to this work, exposure monitoring was not conducted during the refurbishment process, and the same degree of safety and health preparation and work performance measures as discussed in Section 4.4 were not applied. Therefore, the degree of potential exposure is uncertain, and the effectiveness of control measures can not be assured.

4.4 Clean-up Activity for Elevated Surfaces -- 2009

In February 2009, UNICOR conducted a non-routine activity to clean-up dust contamination from elevated surfaces in the USP Lewisburg recycling warehouse. This activity was conducted internally by inmate workers. Prior to and during this work activity, UNICOR implemented measures to prepare workers to safely and effectively conduct the work, control potential exposure to toxic metals, evaluate exposures, and evaluate clean-up effectiveness. These measures included the following.

- A specific worker training program was developed for the activity and was presented to workers by an industrial hygiene professional (UNICOR consultant) over parts of two days immediately prior to the activity.

- Work practices, standardized work procedures, and worker protection measures were developed and implemented including such items as cleaning methods (HEPA vacuuming and wet methods), and use of PPE including respiratory protection. The training program addressed the measures to be implemented during the activity.

- Exposure monitoring was conducted by the UNICOR consultant during the activity to determine exposure levels and verify the appropriateness of work practices and hazard controls.

- Toxic metal clearance sampling (post-activity surface wipe sampling) was also conducted after cleaning to verify and document the effectiveness of the cleaning activity.

These measures demonstrated effective preparation by UNICOR and USP Lewisburg and a commitment to worker protection during the cleaning process.

Personal exposure monitoring conducted by the UNICOR consultant showed all exposures to be below the LOD, which is well below the OSHA PELs and action levels for all metals analyzed (i.e., arsenic, antimony, cadmium, and lead). Area sampling results were also less than the toxic metal LODs. These results verified the effectiveness of work practices and hazard control measures in keeping exposures low. Surface clearance sampling showed that cleaning methods were effective in reducing surface contamination to below the LOD and/or well below the surface contamination criteria applied by the consultant, including the OSHA lead criteria of 200 $\mu g/ft^2$ for "clean" areas.

FOH considers the process and measures taken during preparation for and implementation of this clean-up activity to be a noteworthy practice. UNICOR should standardize these types of processes and practices within O&M plans for all of its recycling facilities. FOH also emphasizes that waste materials generated from these clean-up processes should be tested using the TCLP procedure to ensure proper disposal in accordance with U.S. EPA RCRA regulations.

4.5 Investigations for Noise Exposure

As part of its investigation, NIOSH/DART conducted noise dosimetry for various recycling activities and operations conducted at USP Lewisburg. Dosimetry was performed to determine personal noise exposures as well exposures in areas of potential noise hazard where personnel work. Sixteen dosimetry measurements were taken.

NIOSH/DART found that none of the samples collected exceeded the OSHA PEL for noise of 90 dBA, although several samples exceeded the OSHA action level for noise of 85 dBA. The highest 8-hour TWA noise measurements were in the range of 86 to 89 dBA for several area samples taken on top of the glass, funnel, and panel breaking booth. These area samples were taken to estimate breaker exposures. Personal samples were not taken for breakers because the dosimeters could interfere with work, but these area samples were representative of personal exposure. The highest personal exposures for general factory operations (other than glass breaking) were for balers conducting activities in the outer building. These exposures were 84.1 and 85.3 dBA as 8-hour TWAs. The higher exposures for disassembly workers were 81.7 and 82.5 dBA as 8-hour TWAs.

Noise exposure at or above the OSHA action level of 85 dBA requires the implementation of a hearing conservation program that involves worker training, audiometric testing, hearing protection, monitoring, and other requirements. UNICOR at USP Lewisburg makes hearing protection available, but has not formally implemented a hearing conservation program, as would be required based on NIOSH/DART noise dosimetry results for glass breaking and baling. Based on the recent production increase in daily CRT breaking, it is possible that current noise levels are higher than those measured by NIOSH/DART.

In 2006, at the request of the Production Controller, the USP Lewisburg Safety Department performed noise dosimetry for an inmate performing plastic baling. The noise exposure was low at 78.1 dBA as a TWA. This result was not consistent with NIOSH/DART findings. UNICOR has not conducted a thorough noise exposure study at USP Lewisburg as required by OSHA.

The NIOSH/DART data indicate the need for UNICOR to conduct a complete noise survey and implement controls accordingly, including a hearing conservation program. UNICOR should not presume that NIOSH/DART captured the full range of noise producing activities and should not rely on NIOSH/DART data to satisfy its monitoring requirements. See the NIOSH/DART report (Attachment 1)

4.6 Other Occupational Hazards

NIOSH/DART observed that certain tasks are conducted in a manner that appeared to be physically awkward. NIOSH/DART suggested that UNICOR evaluate tasks to determine potential for repetitive stress and determine if modifications in procedures or equipment would benefit worker protection.

NIOSH/DART also suggested that heat exposure be periodically evaluated during hot weather, followed by implementation of any hazard or work practice controls, as appropriate. OSHA also expressed heat stress concerns based on its April 2007 inspection. UNICOR has developed a Heat Stress Program that calls for such evaluations. With the installation of factory air conditioning at USP Lewisburg and the use of "breathable" protective clothing, any heat stress hazard during glass breaking could already be remediated; however, this determination should be evaluated and documented. The UNICOR heat stress program will be further reviewed and discussed in the final OIG report.

4.7 Environmental Issues

FOH conducted a limited review of available documents pertaining to environmental issues associated with the e-waste operations at USP Lewisburg. FOH also tested for legacy contamination on various building surfaces in proximity to current and former CRT glass breaking operations and analyzed several samples of waste (e.g., mop water, debris in roll-off container) using the Toxic Characteristic Leaching Procedure (TCLP).

No information was reviewed that indicated that USP Lewisburg's e-waste operations are now or have ever been conducted under any special environmental permits associated with air emissions or wastewater discharges. Some wastes associated with the e-waste recycling operations (e.g., contaminated disposable coveralls used by glass breakers, contaminated local exhaust air filters from the glass breaking room, etc.) are currently managed under hazardous waste management regulations of the Resource Conservation and Recovery Act (RCRA) and Rules adopted under the State of Pennsylvania Department of Environmental Protection's (DEP) hazardous waste program. According to the current UNICOR Production Controller, the DEP is aware of the e-waste recycling activities that take place at USP Lewisburg and representatives are on-site on a regular basis providing informational 'tours' to staff and interested parties.

As shown in Attachment 2 tables, mop rinse water samples were collected during the mopping of floors both inside and outside the glass breaking room and analyzed via TCLP methodology for lead and cadmium. Results showed that these wastes would not be considered hazardous based on regulatory levels for these metals established by the RCRA. [EPA n.d.]

TCLP analyses were also performed on a sample collected from the debris in one of two uncovered, outdoor steel roll-off containers used to accumulate scrap metal e-wastes prior to transport to a local scrap metal recycler. Analysis showed an extractible lead concentration of 8.8 mg/l which is above the RCRA limit for lead of 5 mg/l (see Attachment 2). The materials collected in the roll-off containers consist primarily of metal bands and ribbing from CRTs and CPUs and a small amount of adhering dusts and glass particles. These materials are brought to the roll-offs in Gaylord boxes via forklift. The forklift then turns the box upside down emptying the contents into the roll-off. (see Image 3) This process was observed by FOH to result in some dust and phosphors being released into the air. Based on a very limited sampling (i.e., only one sample), the materials in the roll-off container would be considered hazardous waste if not subject to applicable conditional exemptions. At a minimum, precautions should be taken to ensure that the scrap metal wastes deposited in the roll-offs are protected from the elements (covered), that dusts and runoff from the containers are not released into the environment, and that any other provisions of the DEP conditional exemptions for e-wastes are being met. Also, UNICOR should conduct additional testing to better characterize this waste and the results shared with the scrap metal vendor and the DEP.

5.0 CONCLUSIONS

Conclusions concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at USP Lewisburg are provided below under the following subsections:

- Heavy Metals Exposures;
- Noise and Other Hazard Exposures;
- Safety and Health Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

These conclusions are supported by the results, findings, and analyses presented and discussed in Sections 3.0 and 4.0 of this report, as well as the documents assembled by the OIG. These conclusions, in part, are consolidated from the various federal agency reports, and are also supplemented by FOH based on the entire body of information assembled and reviewed. See Attachment 1 for additional conclusions from NIOSH/DART.

5.1 Heavy Metals Exposures

1. Based on NIOSH/DART's and a UNICOR consultant's monitoring results in 2005, 2006, 2007, and 2008, current routine e-waste recycling operations conducted in the USP Lewisburg recycling factory (not including glass breaking), have minimal inhalation exposure potential to lead, cadmium, and other toxic metals. Lead, cadmium, and other metals exposures were consistently low.

2. During glass breaking, exposure monitoring performed by NIOSH/DART and a UNICOR consultant in 2005, 2006, 2007, and 2008 showed that all lead, cadmium, and other metals exposures were well below the OSHA PELs and action levels when calculated as 8-hour TWA exposures.

3. An OSHA inspection conducted in April 2007 noted inappropriate practices on the general factory floor, including dry sweeping and use of pedestal fans that can increase airborne concentrations of dusts containing toxic metals. OSHA issued a violation of the lead standard to USP Lewisburg. Although OSHA found lead exposure to be less than the PEL and action level, the practices cited were prohibited by OSHA and could produce exposures that were higher than otherwise would prevail. OSHA also found that lead dusts were tracked from the glass breaking area into the general factory area. Abatement actions were suggested by OSHA. USP Lewisburg implemented corrective actions at the recycling factory and informed OSHA of its corrective actions, which included prohibiting dry cleaning, removing fans, and placing tack mats at the entry/exit of the glass breaking room. These corrective actions were appropriate at USP Lewisburg, but apparently UNICOR did not share this violation and ensure corrective action for its other factories, because, for instance, dry sweeping continued at FCI Tucson into 2009.

4. During the non-routine filter change-out activity, exposure monitoring performed by NIOSH/DART in January 2008 showed that exposures were higher than other activities, but still below the OSHA PELs and action levels for lead, cadmium and other toxic metals as 8-hour TWAs. In addition, inmate workers are appropriately protected by the use of PAPRs with a protection factor of 25 and appropriate PPE.

5. Current lead and cadmium surface contamination in the factory can be controlled through existing and/or improved housekeeping practices and implementation of an operations and maintenance (O&M) plan to control potential exposure from existing contamination and prevent excessive build up over time. An element of the O&M plan could include periodic clean-up of surfaces by inmate or other workers: however, this would have to be performed using proper hazard controls. Periodic surface sampling is also an important element to monitor contamination levels and direct O&M activities. See the following conclusion for details for a non-routine cleaning activity performed by USP Lewisburg in early 2009.

6. USP Lewisburg conducted a non-routine cleaning activity performed by inmate workers for elevated surfaces in the recycling warehouse in early 2009. Appropriate work practices and hazard controls were developed and implemented, training was provided prior to the work activity, the work was conducted effectively and safely, surface level contamination was largely reduced or eliminated, and personal exposures were controlled at non-detectable levels of toxic metals. FOH considers this activity as prepared for and conducted to be a noteworthy practice that UNICOR should implement at all of its facilities within the overall context of an O&M plan.

7. Based on FOH data, dust collected from elevated surfaces above the factory ceiling and at access panels had high total lead concentrations. Cadmium was also present. Workers who engaged in refurbishing the factory and installing the current ceiling and other building systems (e.g., electrical service) in this area could have been exposed to this contamination. In addition, other surfaces that were demolished or disturbed in the refurbishment could have had lead and cadmium surface contamination. According to the Production Controller, refurbishment was conducted between mid-2006 and early 2007 by five inmate workers and the Production Controller. Some hazard controls were available, such as dust masks, but a hazard analysis did not precede the work and monitoring was not conducted during the work. Therefore, the degree of potential exposure is uncertain and the effectiveness of hazard controls can not be assured. Future access above the factory ceiling should be made under an O&M plan using appropriate control measures based on a hazard analysis. In addition, future activities that demolish, refurbish, or significantly disturb contaminated surfaces at any UNICOR recycling factory should be preceded by a thorough hazard analysis and should then be planned and conducted with proper preparation, testing, and control measures (see Section 6.0, Recommendations).

8. Surface contamination found on certain component parts of electronic equipment was elevated. This confirms that loose dust can potentially be dislodged from equipment during handling and disassembly, contributing to facility surface contamination and personal exposure.

9. The glass breaking LEV system is effective in capturing toxic metals dusts and maintaining exposures below the OSHA PELs and action levels; however, system improvements are warranted. Since 2007, ventilation and LEV improvements have been recommended by OSHA, NIOSH/DART, FOH and the UNICOR consultant to introduce fresh air to the glass breaking room, achieve a negative pressure condition in the room relative to the general factory, improve the ceiling vents in the glass breaking room, and monitor LEV re-circulated air streams. UNICOR has not acted upon these recommendations.

10. UNICOR's annual monitoring program conducted by its consultants in 2005, 2006, 2007, and 2008 (and planned for June 2009) is of the frequency and quality to be considered a noteworthy practice that UNICOR should continue and should

apply to all of its recycling facilities. Despite this noteworthy annual program, UNICOR is not always promptly performing monitoring when changes are made that could increase exposure (also see Conclusion 11, below).

11. UNICOR increased glass breaking production at USP Lewisburg after the 2008 consultant monitoring to between 450 and 600 CRTs per day of operation (production was less than 300 per day during the NIOSH/DART investigation in January 2008). UNICOR did not promptly conduct exposure monitoring for this change that could potentially increase lead and cadmium exposure, as required by the OSHA lead and cadmium standards. The planned June 2009 monitoring will serve to document exposures for this production increase, assuming that production rates are at the higher levels at the time of sampling; however, exposure monitoring for this change should have been conducted more promptly after the production increase as required by OSHA lead and cadmium standards.

12. As observed by FOH, the activity that transfers metal masking and banding removed from CRTs to the roll-off containers has potential for worker exposure to toxic metals dusts. UNICOR should evaluate this activity for personal exposure and improvement in work practices and safety and health practices. UNICOR's consultant recommended that "uncontrolled" dumping of Gaylord boxes be discontinued and that cleaning of Gaylord boxes be conducted. This type of dumping occurred in the FOH activity observed.

13. UNICOR at USP Lewisburg has implemented a number of important improvement actions to control exposure to toxic metals. Examples of improvement actions include factory refurbishments, improved glass breaking room with change room transition area, use of protective clothing supplier with laundering service, improved cleaning and housekeeping practices, safe and effective clean-up of elevated warehouse surfaces, and an on-going monitoring program. These improvements indicate a commitment to enhance worker protection measures and control exposure to toxic metals. However, some other recommendations have not been implemented such as the recommendations to improve the LEV and ventilation system for the glass breaking room, which were recommended by OSHA, NIOSH/DART, FOH, and UNICOR's consultant (see Conclusion 9).

5.2 Noise and Other Hazard Exposures

14. NIOSH/DART found that workers performing glass breaking and some performing baling had noise exposures that were above the OSHA action level that requires implementation of a hearing conservation program including monitoring, audiometric testing, and hearing protection, among other control actions. Except for limited sampling by the USP Lewisburg Safety Department, UNICOR has not evaluated noise exposures at USP Lewisburg and has not implemented a hearing conservation program.

15. NIOSH/DART found that certain activities such as lifting have the potential to be a repetitive stress hazard, and that heat exposure during hot weather periods could occur. These hazards should be evaluated by UNICOR.

5.3 Safety and Health Programs, Plans, and Practices

16. UNICOR and USP Lewisburg have implemented lead and cadmium controls and have various documents that define controls. These documents and procedures can be improved by revising the documents to be consistent with current practices and by precisely specifying the PPE and respiratory protection that is used for glass breaking, factory and warehouse activities, and non-routine activities. Engineering controls, including their testing, maintenance, and verification procedures should also be specified.

17. UNICOR and USP Lewisburg documents such as the ISO 9000 training and operational procedures and the Pre-Industrial Manual define various work practices and safety and health practices. See Section 6.0 for recommended improvements and/or supplements to these documents.

18. UNICOR has not implemented a hearing conservation program at USP Lewisburg. NIOSH/DART found exposures above the OSHA level that triggers this requirement.

5.4 Health and Safety Regulatory Compliance

19. UNICOR is effectively controlling inmate worker inhalation exposure to toxic metals at USP Lewisburg. All operations and activities monitored have inhalation exposures at levels that are below OSHA PELs and action levels. This includes disassembly operations on the factory floor, CRT glass breaking, non-routine filter change-out activity, and non-routine clean-up activities for elevated surfaces. Data are available in the years 2003, 2005, 2006, 2007, 2008, and 2009 from UNICOR consultants and NIOSH/DART.

20. Current USP Lewisburg e-waste recycling activities are in compliance with the OSHA lead and cadmium standards regarding control of employee inhalation exposure below the PELs.

21. UNICOR, at USP Lewisburg, does not monitor exhaust/re-circulated air stream from the glass breaking room LEV and does not supply ventilation to the glass breaking room as stated in ANSI and AIHA standards and as recommended by OSHA, NIOSH/DART, and UNICOR's consultant.

22. UNICOR has not conducted a noise evaluation at USP Lewisburg as recommended by the UNICOR consultant in 2007 and as required to ensure compliance with 29 CFR 1910.95, Noise. NIOSH/DART monitoring indicated

the need for a hearing conservation program; however, UNICOR has not implemented such a program at USP Lewisburg.

23. UNICOR has not evaluated exposures to heat and repetitive stress at USP Lewisburg.

24. UNICOR did not conduct exposure monitoring promptly after the rate of CRT breaking increased. UNICOR also did not conduct exposure monitoring during the factory refurbishment. These activities represent additional, increased, or new exposures that must be monitored for exposure per the OSHA lead and cadmium standards.

25. Also see Conclusion 3 regarding a past OSHA violation, which is now corrected.

5.5 Environmental Compliance

26. TCLP results from mop water samples in the USP Lewisburg recycling facilities showed that this material is not a hazardous waste according to U.S. EPA RCRA regulations.

27. Waste scrap metal (metal bands and ribbing from CRTs and CPUs and adhering dusts and glass particles) is placed in uncovered, outdoor steel roll-off containers prior to transport to a local scrap metal recycler. Debris from the roll-off container was found to be hazardous waste and contained extractable lead at concentrations above 5 mg/l RCRA regulatory limit.

6.0 RECOMMENDATIONS

Recommendations concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at USP Lewisburg are provided below under the following subdivisions:

- Heavy Metals Exposures;
- Noise and Other Hazards Exposure;
- Safety and Health Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

These recommendations relate to the conclusions presented in Section 5.0, above. Some recommendations are taken from supporting documents such as the NIOSH/DART report (Attachment 1). See the NIOSH/DART report for additional recommendations, as well. Other recommendations provided below are developed by FOH from the body of data and documents reviewed to prepare this report. Various recommendations may apply to all UNICOR recycling factories where similar e-waste recycling activities are performed.

As a global recommendation, BOP and UNICOR should ensure that it has and allocates the appropriate level of staff, other personnel resources, and material resources to effectively implement these recommendations and to sustain an effective ES&H program over time.

6.1 Heavy Metals Exposures

1. As recommended by NIOSH/DART and UNICOR consultants, UNICOR should continue use of PAPRs for glass breakers and for workers performing glass breaking room cleaning, and filter change-out (see Attachment 1).

2. UNICOR's annual monitoring in 2005, 2006, 2007, and 2008 is a noteworthy practice that should be continued. UNICOR should continue to periodically conduct at least a limited amount of personal exposure monitoring that characterizes exposures resulting from current work activities conducted during glass breaking, LEV filter change-out, general factory activities, and associated activities, such as cleaning, HEPA vacuum filter change-out, and disposal of contaminated debris. This monitoring will serve to document continued control of the lead and cadmium hazards. Continuation of the annual monitoring program conducted since 2005 would be appropriate, but should also include non-routine activities. This recommendation goes beyond the requirements of the OSHA lead and cadmium standards, but would provide important documentation to verify consistently low exposures.

3. UNICOR should promptly conduct monitoring of any new activities (e.g., non-routine or certain O&M activities) and future changes in work operations, production rates, work processes/practices, personal protection, and other practices. Exposure monitoring is an OSHA requirement when any change is made that could result in a new or additional lead or cadmium exposure. An example of a production change that should have been monitored more promptly is the increase in CRT breakage to between 450 – 600 CRTs per day of processing. Monitoring is scheduled for this increased production in June 2009, but should have been performed shortly after ramp up. The factory refurbishment conducted between mid-2006 and early 2007 should have also been monitored. Conversely, the monitoring performed for the new non-routine activity involving clean-up of elevated warehouse surfaces in 2009 is an excellent example of the proper way that initial/additional monitoring should be conducted for a new/additional exposure.

4. As part of its monitoring program, UNICOR should periodically conduct exposure monitoring for the non-routine LEV filter change-out activity that is associated with glass breaking. NIOSH/DART found that this activity produced the highest lead and cadmium exposures for the duration of the activity, but these levels were still below the action levels and PELs as 8-hour TWAs. UNICOR consultants have not performed exposure monitoring for this activity at USP

Lewisburg. Through periodic monitoring (perhaps part of the annual monitoring program), UNICOR should verify continued effective control of toxic metals for this activity. This recommendation applies to all factories where this activity is performed.

5. UNICOR should perform a hazard analysis of the activity that involves transfer of metal masking and banding from Gaylord boxes or other containers to roll-offs. This analysis should include several episodes of exposure monitoring to ensure results represent various levels of production and weather/wind conditions. The hazard analysis should also involve thorough evaluation of the work activity to determine improved work practices to limit personal and environmental exposures. The UNICOR consultant recommended that "uncontrolled" dumping of Gaylord boxes be discontinued and FOH agrees. Protective measures should be implemented based on the hazard analysis. (Also see Section 6.5 for recommendations on environmental considerations.)

6. As part of its monitoring program, UNICOR should continue to implement the consultant's recommendation of 2006, 2007, and 2008 to evaluate surface contamination levels to ensure that lead and cadmium contamination is not increasing over time and to verify that clean-up, housekeeping, and operations and maintenance (O&M) practices are effective. This monitoring should be part of the annual monitoring program and the O&M program discussed below. The surface sampling should include elevated surfaces that are not routinely cleaned to ensure that contamination is not building up over time. Such monitoring results should also be used to focus activities conducted under the O&M plan.

7. UNICOR should specifically conduct additional surface testing of elevated surfaces above the factory ceiling. FOH found that bulk dust samples in this area had high levels of toxic metals contamination. Depending on the degree and extent of surface contamination, UNICOR should determine appropriate methods to control the hazard: that is, through O&M activities when access to the area is required, surface clean-up by inmate workers similar to that conducted for warehouse elevated surfaces, or remediation by a professional contractor (also see Recommendations 8 and 9, below).

8. UNICOR should develop and implement an operations and maintenance (O&M) plan to ensure that surface contamination is minimized and that existing contamination is not released that could result in inhalation or ingestion exposures. This plan should be developed to standardize the type of approach that USP Lewisburg implemented for cleaning elevated surfaces of the warehouse. Elements of this plan could include:

   - Identification of activities that could disturb contamination (e.g., HVAC maintenance, periodic or non-routine cleaning of elevated surfaces, access above the factory ceiling where higher levels of surface contamination were found, and various building maintenance functions);

- Processes to identify and control hazards for routine and non-routine activities (e.g., job hazard analysis process prior to conducting certain work with identification of mitigating actions, such as that implemented for the warehouse elevated surface cleaning);

- Mitigating techniques and procedures during activities of concern (e.g., dust suppression and/or clean-up and capture, filter removal and bagging processes, and use of PPE and respiratory protection);

- Training and hazard communication;

- Disposal of contaminated materials based on testing data such as TCLP tests; and

- Periodic inspection, monitoring and evaluation of existing conditions, as appropriate. Exposure monitoring is particularly recommended for activities that can disturb surface dust above the factory drop ceiling. [Note: Follow-up surface sampling is important to ensure that surface contamination does not build up and to take preventive and corrective action, if it does.]

At UNICOR's discretion, the O&M plan could also include periodic clean-up of surfaces by inmate or other workers; that is, surfaces that are not subject to routine clean-up and housekeeping activities. If this element were adopted, however, UNICOR should ensure that practices to control exposures are included in the plan and implemented, such as appropriate PPE, respiratory protection, exposure monitoring, clean-up methods (e.g., HEPA vacuuming and wet methods), waste disposal, hygiene practices, and others deemed appropriate by UNICOR. Initial exposure monitoring should be conducted to determine whether exposure during clean-up is above the action levels for lead and cadmium. TCLP testing should also be conducted on waste materials generated to ensure proper disposal. Controls for future clean-up activities should then be based on exposure results. Implementation of an O&M plan applies to all UNICOR recycling factories.

9. The USP Lewisburg activity for cleaning elevated surfaces in the warehouse can serve as a model process for standardizing clean-up activities for elevated or other surfaces conducted under an O&M plan for all UNICOR facilities. Noteworthy approaches included advance preparation and training, development of task-specific safety and health and work practices including worker protection measures, safety and health oversight by an industrial hygiene professional, exposure monitoring, and clearance testing. Should UNICOR conduct future non-routine clean-up activities by inmate workers at USP Lewisburg and/or its other factories, as a prerequisite to authorizing the work, UNICOR should ensure that the level of worker training, capabilities, and qualifications are appropriate for the

scope of the activity (e.g., degree and extent of contamination, location of contamination, degree of difficulty, and presence of other safety hazards, etc.).

10. UNICOR should ensure that any recycling factory refurbishment, remodeling, demolition, or similar activity that could disturb contaminated surfaces is conducted in a manner that controls worker exposure and environmental release. Preparation processes for the activity should include hazard analysis with surface testing, work planning, procedure development, worker training, and selection and implementation of hazard controls and measures to prevent worker exposures and environmental releases. Appropriate ES&H oversight, exposure monitoring, TCLP waste testing, and other ES&H support should be provided during the activity. The February 2009 clean-up of elevated surfaces in the USP Lewisburg warehouse is an example of a smaller activity that incorporated such preparation, oversight, and control measures. The same type of process should be applied to other activities that could disturb contaminated surfaces and create potential for worker or environmental exposures.

11. As recommended by OSHA, NIOSH/DART, FOH, and UNICOR's consultant, UNICOR should improve the glass breaking room LEV and ventilation system. Improvements should include providing ventilation with both outside (fresh) and re-circulated air while maintaining a negative pressure in the glass breaking room, improving (redesigning/replacing) the exhaust vents in the ceiling of the room to include proper HEPA filtration and air changes, and providing monitoring of the exhaust/re-circulated air streams to ensure effective capture of toxic metals. Any modifications of the LEV and ventilation system should be made in consultation with a qualified industrial ventilation engineer. In addition, UNICOR should investigate the use of an alternative method, such as static pressure drop, to determine the frequency of filter changes for the LEV system.

12. UNICOR should evaluate the feasibility of controlling potential contamination from component parts during handling and disassembly. This could include control of incoming materials, HEPA vacuuming of parts prone to dust deposits during disassembly, and other measures.

6.2 Noise and Other Hazards

13. UNICOR should conduct a complete noise evaluation for its recycling operations at USP Lewisburg. A hearing conservation program should be implemented based on test results. NIOSH/DART noise monitoring results found a hearing conservation program is required for glass breakers and baler operators.

14. UNICOR has prepared a draft Heat Stress Program dated 09/26/08, which will be evaluated prior to the completion of the OIG investigation. UNICOR should implement the heat hazard analysis elements of this program for USP Lewisburg and its other facilities and implement any required controls actions that are warranted based on heat exposure results. UNICOR has implemented heat

controls at USP Lewisburg, including installation of air conditioning in the recycling factory and has implementing use of "breathable" PPE to reduce heat exposure during glass breaking. However, through appropriate hazard analysis, UNICOR should confirm and document that these measures are adequate to control the heat hazard.

15. UNICOR should evaluate operations and activities that could be biomechanically taxing such as lifting of loads and repetitive motion associated with disassembly. Appropriate controls should be implemented based upon the results of the evaluation.

6.3 Safety and Health Programs, Practices, and Plans

16. UNICOR should implement a formal hearing conservation program based on a complete noise evaluation at USP Lewisburg.

17. UNICOR should improve its documents representing lead and cadmium compliance plans by defining glass breaking engineering controls (e.g., containment and LEV system) and revising documents to ensure both consistency and more specific details for PPE and respiratory protection. These documents include the Pre-Industrial Manual and applicable ISO 9000 procedures. (Also see Recommendations 18 and 19, below.)

18. As a "good practice" approach, UNICOR should prepare a concise written safety and health document specifically for its recycling operations at USP Lewisburg as well as for each of its other recycling factories that lack such a document. Such a document should be developed and implemented and would serve to supplement and consolidate ISO 9000 documents that contain safety and health practices and other documents with safety and health content. The existing documents are vague in some ways and contain some conflicting information that is not consistent with actual practices (see Section 3.0 for details). A written safety and health document would ensure that practices are consistent with written requirements and would benefit verification processes. Additionally, the document should prescribe inspection, verification, assessment, and hazard analysis processes. This document should address both routine and non-routine activities.

19. UNICOR should clarify to its factories the intended purpose of its ISO 9000 processes and documentation as they relate to occupational safety and health and environmental compliance practices. For instance, it is not cleat whether the ISO 9000 documents are intended to satisfy the requirements for written safety and health programs and plans. Different UNICOR factories have taken different approaches regarding the safety and health content of ISO 9000 documentation.

20. UNICOR should evaluate USP Lewisburg work activities for hazards related to lifting and repetitive stress, and implement any appropriate procedures, training, or equipment to address the hazards.

21. BOP and UNICOR should implement a system to list, track, and document closure of any identified deficiencies or recommendations, regardless of the source. Closure of deficiencies and recommendations with documentation of those accepted and implementation details, along with those not accepted or pending (and why) is important to document improvement actions. This recommendation applies to all UNICOR recycling factories. This topic will be discussed in further detail in the final OIG report.

22. UNICOR should ensure that all of its recycling facilities are informed of violations and other deficiencies, along with corrective actions, that are found at any individual facility. Effective practices demonstrated at one factory should also be shared with others. UNICOR should develop and implement a system to achieve this communication and information sharing, which could possibly be part of the tracking system recommended above.

23. BOP and UNICOR should ensure that they have proper personnel resources, consulting resources, and material resources to effectively implement the management systems, such as corrective action tracking, information disbursement, and assessment processes to ensure effective ES&H and work processes. The need for sufficient resources also applies to the evaluation of and response to assessment, investigation, inspection, and monitoring findings and data to ensure prompt corrective action and information distribution.

24. BOP, UNICOR and FCI Lewisburg should ensure that staff and consultants conducting ES&H assessments, evaluations, inspections, and monitoring activities are qualified for their assigned tasks and led by certified or highly qualified professionals. One benchmark for vetting individuals leading industrial hygiene activities is to ensure certification in the practice of industrial hygiene (CIH) by the American Board of Industrial Hygienists (AIHA).

6.4 Health and Safety Regulatory Compliance

25. USP Lewisburg should conduct activity-based job hazard analysis (JHA) for any new, modified, or non-routine work activity prior to the work being conducted. The JHA process is intended to identify potential hazards and implement controls for the specific work activity prior to starting the work. For instance, the JHA process should be integral to an effective O&M plan, as described in Section 6.1.

26. Also see above recommendations regarding noise and a hearing conservation program, glass breaking room LEV/ventilation improvements, and prompt

monitoring of changes in processes that could create a new or increased lead or cadmium exposure.

6.5 Environmental Compliance

27. In implementing clean-up methods and the O&M plan, UNICOR should periodically evaluate the wastes from HEPA vacuums, mop rinse water, and other potentially contaminated debris to determine acceptable disposal methods per U.S. EPA regulations.

28. UNICOR should ensure that the scrap metal wastes deposited in the outside roll-offs are covered, that dusts and runoff from the containers are not released into the environment, and that any other provisions of the DEP conditional exemptions for e-wastes are being met. Also, UNICOR should perform additional testing to better characterize this waste and share the results with the scrap metal vendor and the DEP. Modify work practices and environmental controls based on testing.

29. UNICOR should develop a list of waste materials and/or wastes generated from specific activities that should be periodically and/or routinely TCLP tested to determine proper disposal methods per U.S. EPA RCRA regulations. This would include wastes generated from clean-up of elevated surfaces and other O&M activities, as well as other wastes from routine and non-routine activities. This recommendation applies to all UNICOR recycling factories.

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Attachment 1

CONTROL TECHNOLOGY AND EXPOSURE ASSESSMENT FOR
ELECTRONIC RECYCLING OPERATIONS
UNITED STATES PENITENTIARY, LEWISBURG, PA

REPORT DATE:
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FILE NO.:
EPHB 326-17a

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SITES SURVEYED:	UNICOR Recycling Operations Federal Correctional Institution Lewisburg, PA
NAICS:	562920
SURVEY DATE:	January 28 – 31, 2008
SURVEY CONDUCTED BY:	Dan Almaguer, MS Ed Burroughs, Ph.D., CIH, CSP Dave Marlow

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"The findings and conclusions in this report have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy."

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Tables, Appendices and Figures

EXECUTIVE SUMMARY

Researchers from the National Institute for Occupational Safety and Health (NIOSH) conducted a study of the recycling of electronic components at the Federal Prison Industries facilities (aka, UNICOR) in Lewisburg, PA in January 2008 to assess workers' exposures to metals and other occupational hazards, including noise, associated with these operations.

The electronics recycling operations at Lewisburg can be organized into four production processes: a) receiving and sorting, b) disassembly, c) glass breaking operations, and d) packaging and shipping. A fifth operation, cleaning and maintenance, was also addressed but is not considered a production process per se. It is known that lead (Pb), cadmium (Cd), and other metals are used in the manufacturing of electronic components and pose a risk to workers involved in recycling of electronic components if the processes are not adequately controlled or the workers are not properly trained and provided appropriate personal protective clothing and equipment.

Methods used to assess worker exposures to metals during this evaluation included: personal breathing zone sampling for airborne metals and particulate, and surface wipe sampling to assess surface contamination. Samples were analyzed for 31 metals with five selected elements (barium, beryllium, cadmium, lead and nickel) given emphasis. Noise exposures were determined using sound pressure level monitors.

The results of air sampling conducted during this visit indicated no overexposures of workers to metals above the most stringent occupational exposure limits. Exposures to airborne metals during the filter change-out maintenance operation (the task of primary concern in this evaluation) were also well below the most stringent occupational exposure limits.

Although beryllium is used in consumer electronics and computer components, such as disk drive arms (beryllium-aluminum), electrical contacts, switches, and connector plugs (copper-beryllium) and printed wiring boards [Willis and Florig 2002, Schmidt 2002], most beryllium "in consumer products is used in ways that are not likely to create beryllium exposures during use and maintenance" [Willis and Florig 2002]. This may account for the fact that beryllium in this study was not detected at levels above the detection limit of the analytical method. The removal and sorting of components seen here is typical of a maintenance activity (components are removed from the cases and sorted, rather than removed and replaced). Other e-recycling activities that include further processing, such as shredding of the components, may produce higher exposures to beryllium but shredding (except as a means to destroy memory devices) does not occur at this facility.

Samples collected during routine daily disassembly operations and glass breaking operations were less than 10% of the OSHA PELs for both Cd and Pb. Unless specified, results of samples presented are for the duration of the sample and not calculated on an 8 hour time weighted average basis.

Lead was detected on surface wipe samples in excess of recommended levels, although in 2 of 3 instances it was concluded that this was existing contamination on materials coming into the workplace. Cadmium and other heavy metals were detected in the surface wipe and bulk dust samples. There are few established standards available for wipe samples with which to compare these data although the samples collected were below recommended maximum levels which do exist. The wipe sample results generally cannot be used to determine the source of the contamination. They only estimate the surface contamination present at the time the sample was collected.

Eight-hour time weighted average measurements of noise in this workplace identified several instances where exposure was greater than the REL and TLV of 85 dBA, although none which exceeded the PEL of 90 dBA.

Recommendations resulting from this study include:

- The implementation of a site-specific health and safety program at Lewisburg that includes a noise reduction program.
- The respiratory protection program for this facility should be evaluated to ensure that it complies with OSHA regulations.
- Attention should be focused on practices to prevent accidental ingestion of lead and other metals.
- Management should evaluate the feasibility of providing and laundering work clothing for all workers in the recycling facility.
- Change rooms should be equipped with separate storage facilities for work clothing and for street clothes to prevent cross-contamination.
- All UNICOR operations should be evaluated from the perspective of health, safety and the environment in the near future.

A comprehensive program is needed within the Bureau of Prisons to assure both staff and inmates a safe and healthy workplace.

I. INTRODUCTION

Researchers from the National Institute for Occupational Safety and Health (NIOSH) conducted a study of exposures to metals and other occupational hazards associated with the recycling of electronic components at the Federal Prison Industries (aka, UNICOR) in Lewisburg, PA.* The principal objectives of this study were:

1. To measure full-shift, personal breathing zone exposures to metals including barium (Ba), beryllium (Be), cadmium (Cd), lead (Pb) and nickel (Ni);
2. To evaluate contamination of surfaces in the work areas that could permit skin contact or allow re-suspension of metals into the air;
3. To identify and describe the control technology and work practices in use in operations associated with occupational exposures to metals, as well as to determine additional controls, work practices, substitute materials, or technology that can further reduce occupational exposures;
4. To evaluate the use of personal protective equipment (PPE) in operations involved in the recycling of electronic components; and,
5. To determine the size distribution of airborne particles for purposes of toxicity and control.

Other objectives such as a preliminary evaluation of noise exposures and visual observations of undocumented hazards, were secondary to those listed above but are discussed as appropriate in this document.

An initial walk-through evaluation was conducted in May 2007 to observe operations at Lewisburg in order to facilitate subsequent testing. In January 2008 an in-depth evaluation was conducted during which two full shifts of environmental monitoring were conducted for the duration of normal plant operations, and monitoring also was conducted during cleaning and maintenance as described in Section II (Process Description) and Section III (Sampling and Analytical Methods).

Computers and their components contain a number of hazardous substances. Among these are "platinum in circuit boards, copper in transformers, Ni and cobalt in disk drives, barium and cadmium coatings on computer glass, and lead solder on circuit boards and video screens" [Chepesiuk 1999]. The Environmental Protection Agency (EPA) notes that "In addition to lead, electronics can contain chromium, cadmium, mercury, beryllium, nickel, zinc, and brominated flame retardants" [EPA 2008]. Schmidt [2002] linked these and other substances to their use and location in the "typical" computer: lead used to join metals (solder) and for radiation protection, is present in the cathode ray tube (CRT) and printed wiring board (PWB). Aluminum, used in structural components and for its conductivity, is present in the housing, CRT, PWB, and connectors. Gallium is used in semiconductors; it is present in the PWB. Ni is used in structural

* This report documents the study conducted at Lewisburg, Pennsylvania. Other NIOSH field studies were conducted at Federal correctional facilities in Elkton, Ohio and Marianna, Florida

components and for its magneticity; it is found in steel housing, CRT and PWB. Vanadium functions as a red-phosphor emitter; it is used in the CRT. Be, used for its thermal conductivity, is found in the PWB and in connectors. Chromium, which has decorative and hardening properties, may be a component of steel used in the housing. Cd, used in Ni-Cad batteries and as a blue-green phosphor emitter, may be found in the housing, PWB and CRT. Cui and Forssberg [2003] note that Cd is present in components like SMD chip resistors, semiconductors, and infrared detectors. Mercury may be present in batteries and switches, thermostats, sensors and relays [Schmidt 2002, Cui and Forssberg 2003], found in the housing and PWB. Arsenic, which is used in doping agents in transistors, may be found in the PWB [Schmidt 2002].

Lee et al. [2004] divided the personal computer into three components, the main machine, monitor, and keyboard. They further divided the CRT of a color monitor into the "(1) panel glass (faceplate), (2) shadow mask (aperture), (3) electronic gun (mount), (4) funnel glass and (5) deflection yoke. Lee et al. [2004] note that panel glass has a high Ba concentration (up to 13%) for radiation protection and a low concentration of Pb oxide. The funnel glass has a higher amount of Pb oxide (up to 20%) and a lower Ba concentration. They analyzed a 14-in Philips color monitor by electron dispersive spectroscopy and reported that the panel contained silicon, oxygen, potassium, Ba and aluminum in concentrations greater than 5% by weight, and titanium, sodium, cerium, Pb, zinc, yttrium, and sulfur in amounts less than 5% by weight. Analysis of the funnel glass revealed greater than 5% silicon, oxygen, iron and Pb by weight, and less than 5% by weight potassium, sodium, Ba, cerium, and carbon. Finally, Lee et al. [2004] noted that the four coating layers are applied to the inside of the panel glass, including a layer of three fluorescent colors (red, blue and green phosphors) that contain various metals, and a layer of aluminum film to enhance brightness.

German investigators [BIA 2001, Berges 2008a] broke 72 cathode-ray tubes using three techniques (pinching off the pump port, pitching the anode with a sharp item, and knocking off the cathode) in three experiments performed on a test bench designed to measure emissions from the process. Neither Pb nor Cd was detected in the total dust, with one exception, where Pb was detected at a concentration of 0.05 mg/cathode ray tube during one experiment wherein the researchers released the vacuum out of 23 TVs by pinching off the pump port [BIA 2001, Berges 2008b]. They described this result as "sufficiently low that a violation of the German atmospheric limit value of 0.1 mg/m^3 need not generally be anticipated" [BIA 2001]. The researchers noted that "the working conditions must be organized such that skin contact with and oral intake of the dust are excluded" [BIA 2001].

However, there are few articles documenting occupational exposures among electronics recycling workers. Sjödin et al. [2001] and Pettersson-Julander et al. [2004] have reported potential exposures of electronics recycling workers to flame retardants while they dismantled electronic products, although no retardants were used in this facility. Recycling operations in the Lewisburg facility are limited to disassembly and sorting tasks, with the exception of breaking CRTs and stripping insulation from copper wiring. Disassembly and sorting probably pose less of a potential hazard from retardants as well as metals for workers than tasks that disrupt the integrity of the components, such as shredding or de-soldering PWBs.

The process of greatest concern was the glass breaking operation (described below) that releases visible emissions into the workroom atmosphere. Material safety data sheets and other information on components of CRTs broken in this operation listed several metals, including Pb, Cd, Be and Ni. In addition, FOH investigators expressed a particular interest in Ba.

II. PROCESS DESCRIPTION

The recycling of electronic components at the United States Penitentiary (USP) Lewisburg is done in one extended building that is part of the prison camp outside of the main prison. That building is composed of three sections: 1) a receiving and warehousing area which also contains offices and areas where laptop refurbishing is done; 2) a middle or center section where most of the disassembly is performed; and 3) a third area where some disassembly is done which also houses the glass breaking operation. Diagrams of these work areas are shown in Figures I and II with an enlargement of the glass breaking operation in Figure III. These figures provide a general visual description of the layout of the work process, although workers often moved throughout the various areas in the performance of their tasks.

The electronics recycling operations can be organized into four production processes: a) receiving and sorting, b) disassembly, c) (glass breaking operation), and d) packaging and shipping. A fifth operation, cleaning and maintenance will also be addressed but is not considered a production process per se.

Incoming materials to be recycled are received at the warehouse (Figure I) where they are examined and sorted. During this evaluation it appeared that the bulk of the materials received were computers, either desktop or notebooks, or related devices such as printers. Some items, notably notebook computers, could be upgraded and resold, and these items were sorted out for that task.

After electronic memory devices (e.g., hard drives, discs, etc.) were removed and degaussed or destroyed, computer central processing units (CPUs), servers and similar devices were sent for disassembly; monitors and other devices (e.g., televisions) that contain CRTs were separated and sent for disassembly and removal of the CRT. Printers, copy machines and any device that could potentially contain toner, ink, or other expendables were segregated and inks and toners were removed in the warehouse prior to being sent to the disassembly area.

In the disassembly process (see Figures II and III), external cabinets, usually plastic, were removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing were removed and sorted by grade for further treatment if necessary. Components such as circuit boards or chips that may have value or may contain precious metals such as gold or silver were removed and sorted. With few exceptions each of the approximately 85 workers in the main factory will perform all tasks associated with the disassembly of a piece of equipment into the mentioned components with the use of powered and non-powered hand tools (primarily screwdrivers and wrenches), with a few workers collecting the various parts and placing them into the proper collection bin. Work tasks included removing screws and other fasteners from cabinets, unplugging or clipping electrical cables, removing circuit boards, and using whatever other methods necessary to break these devices into their component parts.

Essentially all of these component parts are sorted and separated, then repackaged and sold for some type of recycling.

Personal protective equipment in these first two operations consisted of safety glasses and gloves where needed. Control of dust and surface contamination was accomplished primarily by good housekeeping procedures which included brushing dust from work tables and sweeping floors up to twice a day. Protective clothing and housekeeping were more stringent in the third operation and are described below.

The third production process to be evaluated was the glass breaking operation where CRTs from computer monitors and TVs were sent for processing. This was an area of primary interest in this evaluation due to concern from staff, review of process operations and materials involved, and observations during an initial walk-through. This was the only process where local exhaust ventilation was utilized or where respiratory protection was in universal use. Workers in other locations would wear eye protection and occasionally would voluntarily wear a disposable respirator. Additional PPE in the glass breaking operation included Tyvek™ coveralls, hand and arm protection for broken glass, and powered air-purifying respirators (PAPRs). Glass breaking was done in an enclosed booth (see Figure III), approximately 25 ft by 14 feet, located as shown in Figure II. The local exhaust ventilation system, contained in that booth, consisted of 2 reverse flow horizontal filter modules (model HFM24-ST/RD/SP, Atmos-Tech Industries, Ocean, NJ), for funnel glass and for panel glass. These units were 16 ga. galvanized steel with filter faces approximately 26 inches high and 51 inches wide. The units were 36 inches deep. Filtration was achieved with three 16 inch x 24 inch x 1 inch pleated pre-filters preceding a single 24" x 48" x 6" high efficiency particulate air (HEPA) filter. Air was exhausted through the HEPA filter back into the glass breaking booth. Exhaust fans and air filters were placed on top of the glass breaking booth to produce air movement between the booth and the general work area.

Workers in the glass breaking operation wore PAPRs, (MB14-72 PAPR w/ Super Top Hood, Woodsboro, MD, Global Secure Safety), work boots, gloves and coveralls. Of the UNICOR recycling facilities evaluated to date, Lewisburg has the most adequate arrangement for donning and doffing personal protective clothing and equipment. A typical work area that requires the use of protective clothing includes: a) an outer change area where workers can remove and store their street clothing and don their work clothing and personal protective equipment before entering the work area; b) upon completion of their work, workers exit the work area through a "decon" area (e.g., where they vacuum the outer surface of their clothes); c) they then enter a separate, "dirty" locker area, where their soiled work clothes are removed and placed in receptacles for cleaning or disposal. The workers then pass through a shower area, and then enter the outer change area, where they change into their street clothes again. In some cases (e.g., asbestos removal), respirators are worn into the shower and not removed until the exterior surfaces are rinsed.

CRTs that had been removed from their cases were trucked to this process area in large boxes and were fed into the glass-breaking booth through an opening on the side and placed on a metal grid for breaking (see Figure IV). As the CRT moved from right to left in the booth the electron gun was removed by tapping with a hammer to break it free from the tube, then a series of hammer blows was used to break the funnel glass and allow it to fall through the metal grid into large Gaylord boxes (cardboard boxes approximately 3 feet tall designed to fit on a standard pallet) positioned below the grid. This was done at the first (right) station in Figure IV. The CRT was moved to the second (left) station where any internal metal framing or lattice was removed before the panel glass was broken with a hammer and also allowed to fall into a Gaylord box. During the two days of sampling 551 CRTs were broken (293 on day 1 and 258 on day 2). No count was made by the survey team regarding the number of color vs monochrome monitors broken.

The final production process, packing and shipping, moved the various materials segregated during the disassembly and glass breaking processes to the loading dock to be sent to contracted purchasers of those individual materials. To facilitate shipment some bulky components such as plastic cabinets or metal frames were placed in a hydraulic bailer to be compacted for easier shipping. Other materials were boxed and removed for subsequent sale to a recycling operation.

In addition to monitoring routine daily activities in the four production processes described above, environmental monitoring was conducted to evaluate exposures during the replacement of filters in the local exhaust ventilation system used for the glass breaking operation. This is a maintenance operation that occurs at approximately monthly intervals during which the two sets of filters in this ventilation system are removed and replaced. This operation was of particular interest because of concern expressed by management and workers, and also because of elevated exposures documented in similar operations. Two workers in Tyvek™ coveralls, gloves and PAPRs remove both sets of filters, clean the system, and replace the filters. They are assisted by two additional workers who wear Tyvek™ coveralls and gloves while working outside the glass breaking enclosure. The filter change is a maintenance operation that occurs at approximately monthly intervals during which the ventilation system is shut down and all filters are removed and replaced. Initially the exhaust system components, including the accessible surfaces of the filters, are vacuumed with a HEPA vacuum. Then the filters are removed and bagged for disposal, and the area inside the filter housing is vacuumed. New filters are inserted to replace the old ones, the LEV system is reassembled, and any residual dust is removed with a HEPA vacuum.

III. SAMPLING AND ANALYTICAL METHODS

Air sampling techniques

Methods used to assess worker exposures in this workplace evaluation included: personal breathing zone and area sampling for airborne metals and particulate (total and respirable fractions); and surface wipe sampling to assess surface contamination. Material safety data sheets and background information on CRTs and other processes in this operation listed several metals, including Pb, Cd, Be and Ni. Additionally, FOH personnel expressed specific interest in Ba. Therefore emphasis is placed on those five analytes in this report.

Personal breathing zone and general area samples were collected and analyzed for total airborne particulate and metals. Samples were collected for as much of the work shift as possible with durations (ranging from 20% to 90% of an 8-hour work shift) indicated below in respective tables of results. Samples were collected at a flow rate of 3 liters/minute (L/min) using a calibrated battery-powered sampling pump (Model 224, SKC Inc., Eighty Four, PA) connected via flexible tubing to a 37-mm diameter filter (0.8 μm pore-size mixed cellulose ester) in a 3-piece, clear plastic cassette sealed with a cellulose shrink band. It is possible to determine both airborne particulate as well as metals on the same sample by using a pre-weighed filter and then post-weighing that filter to determine weight gain according to NIOSH Method 0500 [NIOSH 1994] before subsequent analysis for metals using inductively coupled plasma spectroscopy (ICP) according to NIOSH Method 7303 [NIOSH 1994] with modifications. This combination of analytical techniques produces a measure for dust and a measure of 31 elements, including the five of particular interest mentioned above. Because Method 7303 is an elemental analysis, the laboratory report describes the amount of the element present in each sample (μg/sample) as the element, regardless of the compound in which the element was present in the sample.

Because there is evidence that the presence of an ultrafine component increases the toxicity for chronic beryllium disease and possibly other toxic effects, information on the aerosol size distribution was collected to assist in evaluation of the potential exposure [McCawley et al. 2001]. A subset of samples was collected using BGI cyclones (BGI Incorporated, Waltham, MA) at a flow rate of 4.2 lpm and analysis according to NIOSH Methods 0600 and 7303 [NIOSH 1994] to determine the particulate and metal concentrations, respectively, in the respirable size range.

Bulk sampling and analysis
Unlike the other evaluations conducted in UNICOR facilities, no bulk samples were collected by NIOSH researchers at Lewisburg, but rather wipe samples were used to determine metallic composition of settled dust.

Surface contamination technique
Surface wipe samples were collected using Ghost™ Wipes for metals (Environmental Express, Mt. Pleasant, SC) and Palintest® Dust Wipes for Be (Gateshead, United Kingdom) to evaluate surface contamination. These wipe samples were collected in accordance with ASTM Method D 6966-03 [ASTM 2002], with a disposable paper template with a10-cm by 10-cm square opening. The templates were held in place by hand or taped in place, to prevent movement during sampling. Wipes were placed in sealable test tube containers for storage until analysis. Ghost Wipes™ were sent to the laboratory to be analyzed for metals according to NIOSH Method 9102 [NIOSH 1994]. Palintest wipes were analyzed for Be using the Quantech Fluorometer (Model FM109515, Barnstead International, Dubuque, Iowa) for spectrofluorometric analysis by NIOSH Method 9110 [NIOSH 1994].

<u>Local Exhaust Ventilation Characterization Methods</u>
Methods used to evaluate the local exhaust ventilation system included measuring air velocity at the face of each of the reverse flow horizontal filter modules (HFMs) inside the glass-breaking area, and observing air flows at the plastic curtains enclosing the glass-breaking operation. A Velocicalc Plus Model 8388 thermal anemometer (TSI Incorporated, St. Paul, MN) was used to measure air speeds at the face of each HFM. A Wizard Stick smoke device (Zero Toys, Inc., Concord, MA) was used to visualize air flow.

The face velocity tests were performed by dividing the face of the HFM into 12 rectangles of equal area and measuring the velocity at the center of each square. Face velocities were taken at each center point averaged over a period of 30 seconds, using a 5-second time averaging setting on the instrument. The metal grid in front of the pre-filters was used to support the edge of the probe, and the researcher stood to one side to avoid obstructing air flow. To measure the velocities achieved by the control at each center point, the anemometer probe was held perpendicular to the air flow direction at those points. The same measurements were repeated at the front edge of the plastic strip curtains enclosing the area immediately in front of each HFM to determine the capture velocity at that point.

Smoke was released as the strips of plastic curtain enclosing the glass breaking booth were parted to qualitatively evaluate the air flow patterns and determine areas of concern. By releasing smoke at these points the path of the smoke, and thus any airborne material potentially released at that point, could be qualitatively determined.

Sound pressure measurements
An initial assessment of noise levels during various tasks in all operations was made during the initial walk-through study using a hand held sound level meter. This brief sound-level survey was used to determine where to target noise dosimetry during the follow-up study. During the follow-up study time weighted average noise exposures were determined using personal dosimeters (Quest Technologies model Q300, Oconomowoc, WI) capable of simultaneously logging sound pressure levels under three sets of parameters. For this evaluation data are reported using both the Occupational Safety and Health Administration (OSHA) and NIOSH parameters as follows:

	OSHA	NIOSH
Criteria (dB)	90	85
Exchange rate	5	3
Threshold	80	0
Weight	A	A
Time constant	Slow	Slow

All dosimeters and sound level meters were calibrated on-site prior to use with a 110 dB source and data were downloaded to a laptop computer.

Observations regarding work practices and use of personal protective equipment were recorded. Information was obtained from conversations with the workers and management to determine if the sampling day was a typical workday to help place the sampling results in proper perspective.

IV. OCCUPATIONAL EXPOSURE LIMITS AND HEALTH EFFECTS

In evaluating the hazards posed by workplace exposures, NIOSH investigators use mandatory and recommended occupational exposure limits (OELs) for specific chemical, physical, and biological agents. Generally, OELs suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects[1]. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or

[1] On March 20, 1991, the Supreme Court decided the case of International Union, United Automobile, Aerospace & Agricultural Implement Workers of America, UAW v. Johnson Controls, Inc., 111 S. Ct. 1196, 55 EPD 40,605. It held that Title VII forbids sex-specific fetal protection policies. Both men and women must be protected equally by the employer.

personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the exposure limit. Combined effects are often not considered in the OEL. Also, some substances can be absorbed by direct contact with the skin and mucous membranes in addition to being inhaled, thus contributing to the overall exposure. Finally, OELs may change over the years as new information on the toxic effects of an agent become available.

Most OELs are expressed as a time-weighted average (TWA) exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday[2]. Some chemical substances and physical agents have recommended short-term exposure limits (STEL) or ceiling values where there are health effects from higher exposures over the short-term. Unless otherwise noted, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during a workday, and the ceiling limit is an exposure that should not be exceeded at any time, even instantaneously.

In the U.S., OELs have been established by Federal agencies, professional organizations, state and local governments, and other entities. Some OELs are mandatory, legal limits; others are recommendations. The U.S. Department of Labor Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) [29 CFR 1910 (general industry); 29 CFR 1926 (construction industry); and 29 CFR 1915, 1917 and 1918 (maritime industry)] are legal limits that are enforceable in workplaces covered under the Occupational Safety and Health Act and in Federal workplaces under Executive Order 12196 [NARA 2008]. NIOSH Recommended Exposure Limits (RELs) are recommendations that are made based on a critical review of the scientific and technical information available on the prevalence of hazards, health effects data, and the adequacy of methods to identify and control the hazards. Recommendations made through 1992 are available in a single compendium [NIOSH 1992]; more recent recommendations are available on the NIOSH Web site (http://www.cdc.gov/niosh). NIOSH also recommends preventive measures (e.g., engineering controls, safe work practices, personal protective equipment, and environmental and medical monitoring) for reducing or eliminating the adverse health effects of these hazards. The NIOSH Recommendations have been developed using a weight of evidence approach and formal peer review process. Other OELs that are commonly used and cited in the U.S. include the Threshold Limit Values (TLVs)® recommended by the American Conference of Governmental Industrial Hygienists (ACGIH)®, a professional organization [ACGIH 2008]. ACGIH® TLVs® are considered voluntary guidelines for use by industrial hygienists and others trained in this discipline "to assist in the control of health hazards." Workplace Environmental Exposure Levels (WEELs) are recommended OELs developed by the American Industrial Hygiene Association (AIHA), another professional organization. WEELs have been established for some chemicals "when no other legal or authoritative limits exist" [AIHA 2007].

Employers should understand that not all hazardous chemicals have specific OSHA PELs and for many agents, the legal and recommended limits mentioned above may not reflect the most current

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[2] OSHA PELs, unless otherwise noted, are TWA concentrations that must not be exceeded during any 8-hour workshift of a 40-hour work-week [NIOSH 1997]. NIOSH RELs, unless otherwise noted, are TWA concentrations for up to a 10-hour workday during a 40-hour workweek [NIOSH 1997]. ACGIH® TLVs®, unless otherwise noted, are TWA concentrations for a conventional 8-hour workday and 40-hour workweek [ACGIH 2008]

health-based information. However, an employer is still required by OSHA to protect their employees from hazards even in the absence of a specific OSHA PEL. In particular, OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, NIOSH investigators encourage employers to make use of other OELs when making risk assessment and risk management decisions to best protect the health of their employees. NIOSH investigators also encourage the use of the traditional hierarchy of controls approach to eliminating or minimizing identified workplace hazards. This includes, in preferential order, the use of: (1) substitution or elimination of the hazardous agent, (2) engineering controls (e.g., local exhaust ventilation, process enclosure, dilution ventilation) (3) administrative controls (e.g., limiting time of exposure, employee training, work practice changes, medical surveillance), and (4) personal protective equipment (e.g., respiratory protection, gloves, eye protection, hearing protection).

Both the OSHA PELs and ACGIH® TLVs® address the issue of combined effects of airborne exposures to multiple substances [29 CFR 1910.1000(d)(1)(i), ACGIH 2008]. ACGIH® [2008] states:

> *When two or more hazardous substances have a similar toxicological effect on the same target organ or system, their combined effect, rather than that of either individually, should be given primary consideration. In the absence of information to the contrary, different substances should be considered as additive where the health effect and target organ or system is the same. That is, if the sum of*
>
> $$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \dots \frac{C_n}{T_n} \qquad \textit{Eqn. 1}$$
>
> *exceeds unity, the threshold limit of the mixture should be considered as being exceeded (where C_1 indicates the observed atmospheric concentration and T_1 is the corresponding threshold limit…).*

A. Exposure Criteria for Occupational Exposure to Airborne Chemical Substances

The OELs for the five primary contaminants of interest, in micrograms per cubic meter (µg/m^3), are summarized and additional information related to those exposure limits is presented below.

Occupational Exposure Limits for Five Metals of Primary Interest (µg/m^3)

	Ba	Be	Cd	Pb	Ni
PEL	500 TWA	2 TWA 5 (30 minute ceiling) 25 (peak exposure never to be exceeded)	5 TWA	50 TWA	1000 TWA
REL	500 TWA	0.5 TWA	Lowest Feasible Concentration	50 TWA	15 TWA

TLV	500 TWA	2 TWA 10 (STEL)	10 (total) TWA 2 (respirable) TWA	50 TWA	1500 TWA (elemental) 100 TWA (soluble inorganic compounds) 200 TWA (insoluble inorganic compounds

This subset of five metals has been selected for consideration through the body of this report because their presence was noted on MSDSs or other information pertaining to CRTs and other processes at this facility (Be, Cd, Pb and Ni) or due to the interest expressed in Ba exposures by FOH personnel.

The occupational exposure limits of all 31 metals quantified in this work are listed in Appendix A. Note that these limits refer to the contaminant as the element (e.g., the TLV®s, Be and compounds, as Be; Cd and compounds, as Cd [ACGIH 2008]). Additionally, the OEL for dust is presented here to place those air sampling results in perspective.

Occupational Exposure Criteria for Ba

The current OSHA PEL, NIOSH REL, and ACGIH® TLV® is 0.5 mg/m^3 as a TWA for airborne Ba exposures (Ba and soluble compounds, except Ba sulfate, as Ba) [29 CFR 1910.1000, NIOSH 2005, ACGIH 2008]. There is no AIHA WEEL for Ba [AIHA 2007]. Skin contact with Ba, and many of its compounds, may cause local irritation to the eyes, nose, throat and skin, and may cause dryness and cracking of the skin and skin burns after prolonged contact [Nordberg 1998].

Occupational Exposure Criteria for Be

The OSHA general industry standard sets a Be PEL of 2 μg/m^3 for an 8-hour TWA, a ceiling concentration of 5 μg/m^3, not to exceed 30 minutes and a maximum peak concentration of 25 μg/m^3, not to be exceeded for any period of time [29 CFR 1910.1000]. The NIOSH REL for Be is 0.5 μg/m^3 for up to a 10-hour work day, during a 40-hour workweek [NIOSH 2005]. The current TLV® is an 8-hr TWA of 2 μg/m^3, and a STEL of 10 μg/m^3 [ACGIH 2008]. The ACGIH® published a notice of intended changes for the Be TLV® to 0.05 μg/m^3 TWA and 0.2 μg/m^3 STEL based upon studies investigating both chronic beryllium disease and beryllium sensitization [ACGIH 2008]. There is no AIHA WEEL for Be [AIHA 2007]. Be has been designated a known human carcinogen by the International Agency for Research on Cancer [IARC 1993].

Occupational Exposure Criteria for Cd

The OSHA PEL for Cd is 5 μg/m^3 as a TWA [29 CFR 1910.1027]. Exposure at or above half that value, the Action Level of 2.5 μg/m^3 TWA, requires several actions by the employer. These include providing respiratory protection if requested [29 CFR 1910.1027(g)(1)(v)], medical surveillance if currently exposed more than 30 days per year [1910.1027(l)(1)(i)(A)], and medical surveillance if previously exposed unless potential aggregated Cd exposure did not exceed 60 months [1910.1027(l)(1)(i)(b)]. Initial examinations include a medical questionnaire and biological monitoring of Cd in blood (CdB), Cd in urine (CdU), and Beta-2-microglobulin in urine (β2-M) [29 CFR 1910.1027 Appendix A]. An employee whose biological testing results during both the initial and follow-up medical examination are elevated above the following trigger levels must be medically removed from exposure to Cd at or above the action level: (1) CdU level: above 7 μg/g creatinine, or (2) CdB level: above 10 μg/liter of whole blood, or (3) β2-M level: above 750 μg/g creatinine and (a) CdU exceeds 3 μg/g creatinine or (b) CdB exceeds 5 μg/liter of whole blood [OSHA 2004].

The ACGIH® TLV® for Cd and compounds as Cd is 10 $\mu g/m^3$ as a TWA, and 2 $\mu g/m^3$ TWA for the respirable fraction of airborne Cd and compounds, as Cd [ACGIH 2008]. The ACGIH® also published a Biological Exposure Index® that recommends that Cd blood level be controlled at or below 5 μg/L and urine level to be below 5 μg/g creatinine [ACGIH 2008]. There is no AIHA WEEL for Cd [AIHA 2007].

In 1976, NIOSH recommended that exposures to Cd in any form should not exceed a concentration greater than 40 $\mu g/m^3$ as a 10-hour TWA or a concentration greater than 200 $\mu g/m^3$ for any 15-minute period, in order to protect workers against kidney damage and lung disease. In 1984, NIOSH issued a Current Intelligence Bulletin, which recommended that Cd and its compounds be regarded as potential occupational carcinogens based upon evidence of lung cancer among a cohort of workers exposed in a smelter [NIOSH 1984]. NIOSH recommends that exposures be reduced to the lowest feasible concentration [NIOSH 2005]. This NIOSH REL was developed using a previous NIOSH policy for carcinogens (29 CFR 1990.103). The current NIOSH policy for carcinogens was adopted in September 1995. Under the previous policy, NIOSH usually recommended that exposures to carcinogens be limited to the "lowest feasible concentration," which was a non-quantitative value. Under the previous policy, most quantitative RELs for carcinogens were set at the limit of detection (LOD) achievable when the REL was originally established. From a practical standpoint, NIOSH testimony provided in 1990 on OSHA's proposed rule on occupational exposure to Cd noted that, "NIOSH research suggests that the use of innovative engineering and work practice controls in new facilities or operations can effectively contain Cd to a level of 1 $\mu g/m^3$. Also, most existing facilities or operations can be retrofitted to contain cadmium to a level of 5 $\mu g/m^3$ through engineering and work practice controls" [NIOSH 1990].

Early symptoms of Cd exposure may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or cough. Short-term exposure effects of Cd inhalation include cough, chest pain, sweating, chills, shortness of breath, and weakness. Short-term exposure effects of ingestion may include nausea, vomiting, diarrhea, and abdominal cramps [NIOSH 1989]. Long-term exposure effects of Cd may include loss of the sense of smell, ulceration of the nose, emphysema, kidney damage, mild anemia, an increased risk of cancer of the lung, and possibly of the prostate [NIOSH 1989, Thun et al. 1991, Goyer 1991].

Occupational Exposure Criteria for Pb

The OSHA PEL for Pb is 50 $\mu g/m^3$ (8-hour TWA), which is intended to maintain worker blood Pb level (BLL) below 40 μg/deciliter (dL). Medical removal is required when an employee's BLL reaches 50 μg/dL [29 CFR 1910.1025]. The NIOSH REL for Pb (8-hour TWA) is 0.050 mg/m^3; air concentrations should be maintained so that worker blood Pb remains less than 0.060

mg Pb/100 g of whole blood [NIOSH 2005]. At BLLs below 40 μg/dL, many of the health effects would not necessarily be evident by routine physical examinations but represent early stages in the development of disease. In recognition of this, voluntary standards and public health goals have established lower exposure limits to protect workers and their children. The ACGIH® TLV® for Pb in air is 50 $\mu g/m^3$ as an 8-hour TWA, with worker BLLs to be controlled to ≤ 30 μg/dL. A national health goal is to eliminate all occupational exposures that result in BLLs >25 μg/dL [DHHS 2000]. There is no AIHA WEEL for Pb [AIHA 2007].

Occupational exposure to Pb occurs via inhalation of Pb-containing dust and fume and ingestion from contact with Pb-contaminated surfaces. Symptoms of Pb poisoning include weakness, excessive tiredness, irritability, constipation, anorexia, abdominal discomfort (colic), fine tremors, and "wrist drop" [Saryan and Zenz 1994, Landrigan et al. 1985, Proctor et al. 1991a]. Overexposure to Pb may also result in damage to the kidneys, anemia, high blood pressure, impotence, and infertility and reduced sex drive in both genders. In most cases, an individual's BLL is a good indication of recent exposure to and current absorption of Pb [NIOSH 1978].

Occupational Exposure Criteria for Ni
The NIOSH REL for Ni metal and other compounds (as Ni) is 15 $\mu g/m^3$ based on its designation as a potential occupational carcinogen [NIOSH 2005]. The ACGIH® TLV® for insoluble inorganic compounds of Ni is 200 $\mu g/m^3$ (inhalable fraction). For soluble inorganic Ni compounds the TLV® is 100 $\mu g/m^3$ (inhalable fraction). The TLV® for elemental Ni is 1,500 $\mu g/m^3$ (inhalable fraction) [ACGIH 2008]. The OSHA PEL for Ni is 1,000 $\mu g/m^3$ TWA [29 CFR 1910.1000]. Metallic Ni compounds cause allergic contact dermatitis [Proctor et al. 1991b]. NIOSH considers Ni a potential occupational carcinogen [NIOSH 2005]. There is no AIHA WEEL for Ni [AIHA 2007].

Occupational Exposure Criteria for Airborne Particulate
The maximum allowable exposure to airborne particulate not otherwise regulated is established by OSHA at 15 mg/m^3 for total and 5 mg/m^3 for the respirable portion [29 CFR 1910.1000]. A more stringent recommendation of 10 mg/m^3 inhalable and 3 mg/m^3 respirable is presented by the ACGIH® which feels that "even biologically inert insoluble or poorly soluble particulate may have adverse health effects" [ACGIH 2008]. There is no AIHA WEEL for these substances [AIHA 2007].

B. Surface Contamination Criteria
Occupational exposure criteria have been discussed above for airborne concentrations of several metals. Surface wipe samples can provide useful information in two circumstances; first, when settled dust on a surface can contaminate the hands and then be ingested when transferred from hand to mouth; and second, if the surface contaminant can be absorbed through the skin and the skin is in frequent contact with the surface [Caplan 1993]. While the OSHA lead standard mandates that surfaces be maintained as free of lead as practicable, there is currently no surface contamination criteria included in OSHA standards [OSHA 2008].[3] The health hazard from these

[3] OSHA has referenced a Department of Housing and Urban Development (HUD) lead criteria in documents related to its enforcement of the lead standard [Fairfax 2003].

regulated substances results principally from their inhalation and to a smaller extent from their ingestion; those substances are by and large "negligibly" absorbed through the skin [Caplan 1993]. NIOSH RELs do not address surface contamination either, nor do ACGIH TLVs or AIHA WEELs. Caplan [1993] stated that "There is no general quantitative relationship between surface contamination and air concentrations..." He also noted that, "Wipe samples can serve a purpose in determining if surfaces are as 'clean as practicable'. Ordinary cleanliness would represent totally insignificant inhalation dose; criteria should be based on surface contamination remaining after ordinarily thorough cleaning appropriate for the contaminant and the surface." With those caveats in mind, the following paragraphs present guidelines that help to place the results of the surface sampling conducted at this facility in perspective.

Surface Contamination Criteria for Five Metals of Primary Interest

Surface Contamination Criteria for Pb

Federal standards have not been adopted that identify an exposure limit for Pb contamination of surfaces in the industrial workplace. However, in a letter dated January 13, 2003 [Fairfax 2003], OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for Pb in the construction workplace [29 CFR 1926.62(h)(1), 1926.62(i)(2)(i) and 1926(i)(4)(ii)] interpreted the level of Pb-contaminated dust allowable on workplace surfaces as follows: a) All surfaces shall be maintained as 'free as practicable' of accumulations of Pb, b) The employer shall provide clean change areas for employees whose airborne exposure to Pb is above the permissible exposure limit, c) The employer shall assure that lunchroom facilities or eating areas are as free as practicable from Pb contamination, d) The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of HUD's acceptable decontamination level of 200 $\mu g/ft^2$ (21.5 $\mu g/100\ cm^2$) for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas, e) In situations where employees are in direct contact with Pb-contaminated surfaces, such as, working surfaces or floors in change rooms, storage facilities, lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level, and f) For other surfaces, OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of Pb contamination meets the definition of "practicable." OSHA notes that "the term 'practicable' was used in the standard, as each workplace will have to address different challenges to ensure that Pb-surface contamination is kept to a minimum. It is OSHA's view that a housekeeping program which is as rigorous as 'practicable' is necessary in many jobs to keep airborne Pb levels below permissible exposure conditions at a particular site" [Fairfax 2003]. Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the Pb in place), as necessary to mitigate Pb exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable Pb exposure, such as would potentially be caused by re-entrained Pb dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of Pb dust does not become a source of employee Pb exposures. OSHA has stated that any method that achieves this end is acceptable.

In the United States, standards for final clearance following Pb abatement were established for public housing and facilities related to children. However, no criteria have been recommended for other types of buildings, such as commercial facilities. One author has suggested criteria based upon Pb-loading values. Lange [2001] proposed a clearance level of 1000 μg/ft^2 for floors of non-Pb free buildings and 1100 μg/ft^2 for Pb-free buildings, and states that "no increase in BLL should occur for adults associated or exposed within a commercial structure" at the latter level. These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions such as: a) Pb uptake following ingestion is 35% absorption of Pb in the gastrointestinal system, b) Fingers have a total "touch" area of 10 cm^2 and 100% of the entire presumed Pb content on all 10 fingers is taken up, c) The average 'normal' environmental Pb dose (from 'uncontaminated food/water/air) is 20 μg per day, d) The weight of the exposed person is 70 kg, and e) Daily Pb excretion is limited to an average of 48 μg. Lange [2001] notes that "use of the proposed values would provide a standard for non-child-related premises (e.g. commercial, industrial, office)..." but cautions that, "Further investigation is warranted to evaluate exposure and subsequent dose to adults from surface lead."

Surface Contamination Criteria for Be

A useful guideline is provided by the U.S. Department of Energy, where DOE and its contractors are required to conduct routine surface sampling to determine housekeeping conditions wherever Be is present in operational areas of DOE/NNSA facilities. Those facilities must maintain removable surface contamination levels that do not exceed 3 μg/100 cm^2 during non-operational periods. The DOE also has release criteria that must be met before Be-contaminated equipment or other items can be released to the general public or released for use in a non-Be area of a DOE facility. These criteria state that the removable contamination level of equipment or item surfaces does not exceed the higher of 0.2 μg/100 cm^2 or the level of Be in the soil in the area of release. Removable contamination is defined as "beryllium contamination that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing."

Surface Contamination Criteria for Cd

Like Pb and Be, Cd poses serious health risks from exposure. Cd is a known carcinogen, is very toxic to the kidneys, and can also cause depression. However, OSHA, NIOSH, AIHA and ACGIH® have not recommended criteria for use in evaluating wipe samples. The OSHA Cd standard [29 CFR 1910.1027] mandates that "All surfaces shall be maintained as free as practicable of accumulations of cadmium," that, "all spills and sudden releases of material containing cadmium shall be cleaned up as soon as possible," and that, "surfaces contaminated with cadmium shall, wherever possible, be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne."

Surface Contamination Criteria for Ni

NIOSH, OSHA, AIHA and ACGIH® have not established occupational exposure limits for Ni on surfaces.

Surface Contamination Criteria for Ba

NIOSH, OSHA, AIHA and ACGIH® have not established occupational exposure limits for Ba on surfaces.

C. Noise Exposure Criteria

The OSHA standard for occupational exposure to noise [29 CFR 1910.95] specifies a maximum PEL of 90 dB(A) for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship, or exchange rate. This means that a person may be exposed to noise levels of 95 dB(A) for no more than 4 hours, to 100 dB(A) for 2 hours, etc. Conversely, up to 16 hours exposure to 85 dB(A) is allowed by this exchange rate. NIOSH, in its Criteria for a Recommended Standard, proposed an REL of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard [NIOSH 1972]. The NIOSH 1972 criteria document also used a 5 dB time/intensity trading relationship in calculating exposure limits. However, the 1998 revised criteria recommends a 3 dB exchange rate, noting that it is more firmly supported by scientific evidence [NIOSH 1998]. The ACGIH® also changed its TLV® in 1994 to a more protective 85 dB(A) for an 8-hour exposure, with the stipulation that a 3 dB exchange rate be used to calculate time-varying noise exposures. Thus, a worker can be exposed to 85 dB(A) for 8 hours, but to no more than 88 dB(A) for 4 hours or 91 dB(A) for 2 hours.

In 1983, a hearing conservation amendment to the OSHA noise standard took effect [29 CFR 1910.95(c)] that requires employers to "administer a continuing, effective hearing conservation program" whenever employee noise exposures equal or exceed an 8-hour TWA of 85 dBA or, equivalently, a dose of fifty percent. The requirements include noise monitoring, audiometric testing, providing hearing protectors, training workers, and recordkeeping.

V. RESULTS AND DISCUSSION

The work described here was conducted in January, 2008 at the USP Lewisburg, UNICOR recycling factory electronic components recycling operations. During this testing air, surface wipe, and noise data were collected in locations where the electronics recycling operations were taking place and measurements were made relating to air flow of the local exhaust ventilation system. The primary purposes of this evaluation were to estimate the potential exposures of inmates and staff to toxic substances and noise encountered during the recycling of electronic components and to recommend remedial measures to reduce exposures if necessary.

A statistical summary of air sampling results is presented in Table 1. Results of personal breathing zone and area air sampling are shown in Table 2 for total particulate and Table 3 for particulate <10 μm diameter. Surface wipe sample results are contained in Table 4; noise measurements are shown in Table 5. As mentioned in Section III above, all samples were analyzed for 31 metals due to the parameters of the analytical method. While the data in these tables represent the results of just the five metals of primary interest in this evaluation, results of all analyses are contained in the appendices. All data indicate levels well below the OELs, even when results for combined exposures as calculated by Equation 1 are considered, although the detection limit for arsenic was not low enough for comparison to the most stringent OEL. Because arsenic was not found in any wipe or bulk samples either, it was not considered a potential hazard at this facility.

A. Air Sample Results

Air measurements were collected during both normal and non-routine operations in the areas identified, including the glass breaking operation. Data presented here and in Table 2 and 3 are for the duration of the samples rather than for an 8-hour time weighted average since the concentrations of contaminants are so low. Most personal breathing-zone measurements, however, were for five hours duration or greater. Measurements made during the filter change operation are presented at the bottom of Table 2 and discussed separately below since this was not a routine production operation. The full data set of all 31 metals is presented in Appendix B. Results of metal and dust measurements of particle size <10μm diameter are presented in Table 3, with the full data set of all 31 metals in Appendix C.

These data indicate low levels of airborne particulate and metals. Thirty-four samples were taken during normal production during the January, 2008 study. These data can be identified by date in Tables 2 and 3, but the magnitudes of the exposures were not generally different by date. Measurements during routine operations revealed that Ba concentrations ranged between <0.05 and 2 μg/m^3 and were unremarkable. Be levels also were all below the limit of detection, which varied with sample volume, most being <0.006 μg/m^3. Cd, Pb and Ni, likewise, were found at low levels ranging up to 0.1, 4, and 0.8 μg/m^3, respectively. Pb was the metal found in highest quantity, with 13 of 21 samples above the limit of detection and the highest concentration was approximately 10% of the occupational exposure limits. Airborne total particulate concentrations ranged to 650 μg/m^3 (0.1 to 0.7 mg/m^3). No distinction could be made between samples from different locations within the UNICOR factory or between different jobs, primarily due to the high variability in measured contaminant. Sample durations ranged from approximately 2.5 to 7 hours.

The filter change operation in the glass breaking area, discussed in the Process Description (Section II), was the task of most concern regarding exposures of workers to toxic metals. Visual observations did not indicate high levels of airborne dust, and measurements of metals and particulate confirmed these observations. No airborne levels of any metals were found in excess of the most stringent occupational exposure criteria. Ba ranged from <0.07 to 2 μg/m^3. No Be was detected (LOD of 0.03 μg/m^3). Cd ranged from <0.06 to 3 μg/m^3 with no Cd detected in respirable samples. Again, Pb was the metal in highest concentration ranging from <0.3 to 10 μg/m^3. All air samples collected during the filter change were approximately 1.5 hours duration.

Airborne total particulate measurements ranged generally between 300 and 650 μg/m^3, with one sample collected during the filter change operation of 1,100 μg/m^3. Respirable particulate ranged from 30 to 290 μg/m^3. While no statistical comparison was made because of the dissimilarity of the sample conditions, a day-by-day comparison of total and respirable particulate and Pb (from Tables 2 and 3 respectively) would suggest that a large portion of the airborne particulate and metals was in the respirable range.

It should be reiterated here that no shredding or melting of components was done at Lewisburg and these processes would be expected to produce a greater potential for exposures to metals than the disassembly processes.

B. Surface Wipe Sample Results

The surface wipe sample results collected during the visit in the electronic recycling operations at the USP Lewisburg are summarized below and in Table 4 for the metals of interest, and the entire surface wipe sample data set is contained in Appendix D. Results of spectrofluorometric analysis for Be only confirmed ICP measurements and are not repeated in the tables.

Wipe samples taken in the UNICOR electronic recycling factory did not indicate levels of Ba on work surfaces at levels of concern as discussed in Section IV above in the surface contamination subsection. The highest Ba concentration detected was 250 μg/sq ft. No Be was detected in samples from the recycling factory; the limit of detection was 0.1 μg/sq ft. Surfaces tested for Pb indicated levels exceeding the OSHA recommended 200 μg/sq ft. in 3 of 11 instances, although 2 of those samples (LMWW-05 & 06) were from CPU fan blades which were presumably contaminated prior to arrival. While an argument could be made as to the applicability of this criterion to these samples, nevertheless it is felt that 200 μg/sq ft is a useful target value for judging the effectiveness of a cleanup operation. While there are no criteria for evaluating Cd surface contamination, the highest Cd measurement was less than 10% of the recommended Pb level (200 μg/sq ft) which arguably could be used as a target for measuring clean-up effectiveness. Ni surface contamination was less than 70 μg/sq ft in all samples.

C. Sound Level Measurements

The data collected with noise dosimeters is presented in Table 5 for the 16 sets of data collected. Four area samples were collected in the glass breaking operation and 12 samples were collected in other locations in the factory. For each day of sampling, each sample is described, and the start and stop times are presented along with the sample duration (run time). Following that, the mean sound pressure level for the duration of the run (TEST AVERAGE DB) and the time weighted average sound pressure level for an eight hour day (TWA DB) is shown. Sound pressure levels are in dB, A weighted, slow response and presented for both the OSHA and NIOSH criteria. Time weighted calculations assume no exposure during the un-sampled time which for 15 of 16 samples was from 1 to 2 hours. Several of the noise samples exceeded the REL and TLV of 85 dBA and are highlighted in bold print in Table 5.

While the REL and TLV are more conservative criteria for protecting workers from over exposure to noise, the OSHA noise standard [29 CFR 1910.95] is legally enforceable. This standard instructs the employer to calculate the allowable noise dose from more than one sample as follows:

> *When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: C(1)/T(1) + C(2)/T(2) C(n)/T(n) exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level.*

This means that, using the OSHA exchange values, none of the samples collected on these two days exceeded the allowable dose to document an overexposure to the PEL of 90 dBA, although measurements above 85 dBA (OSHA criteria) are considered to be an action level which triggers the requirement for a hearing conservation program.

The maximum 8-hour TWA noise measurement during the Lewisburg evaluation was 88 dBA (sample LST-03) on top of the glass breaking booth. The highest personal exposures were the bailers (samples LSW-01 and -05) which were 85 and 84 dBA 8-hour TWA.

D. Local Exhaust System Measurements

The HFMs were designed and manufactured by Atmos-Tech Industries (model HFM24-ST/RF/SP, Ocean City, NJ). Each unit is equipped with a bank of 35% efficient pleated pre-filters and a HEPA filter, a direct-drive 1200 cfm fan with a ½ horsepower motor, and a control panel with a minihelic pressure gauge and variable speed control. Air enters through the pre-filters in the front of the unit, passes through the HEPA filter, and is discharged into the room through a grille at the back of the unit. A frame attached to the front of each unit supports 24-in long plastic strip curtains on the front and sides. The top is enclosed with a sheet of ¼-inch clear polycarbonate plastic. The pre-filters are held in place by a metal grille. Glass breaking is performed on top of an angle-iron grate inside the area enclosed by the strip curtains. Both HFMs are in an area enclosed by a building wall on 3 sides and a curtain composed of plastic strips on the other. Figure IV shows the right HFM, number 1.

The average face velocity measured at HFM-1 (the one on the right when facing them from the front) was 160 feet/minute (fpm), range 150 to 170 fpm; the average air velocity at the side was 140 fpm, range 130 to 150 fpm. The average face velocity measured at HFM-2 was 140 fpm, range 130 to 150 fpm; the average air velocity at the side was 120 fpm, range 110 to 130 fpm.

Because the HFMs discharge into the GBO enclosure (rather than to the outside of the building, for example) and re-circulate the filtered air, the enclosure is not under negative pressure with regard to the rest of the glass breaking booth. Recirculation of air from industrial exhaust systems into workroom air can result in hazardous air contaminant concentrations in the facility if not designed properly [ANSI/AIHA 2007]. The evaluation of this process indicates that the recirculation as it occurred causes no increased exposures to workers in the glass breaking booth. If exhausting to the outside, any ventilation system must be designed to meet applicable fire, safety, or environmental codes that apply to this facility and operations

To provide air circulation between the glass breaking booth and the general workplace, two exhaust fans were placed in the ceiling of the glass breaking booth (which is approximately 5 feet below the ceiling of the general workplace) to move air from the booth, through filters, into the general work area. The assumption was that air would be pulled from the general work area, through the plastic strip curtains forming the front wall of the glass breaking booth (not visible in Figure IV) or other openings. Smoke released at the plastic curtain showed little air flow into the enclosed area indicating that those two exhaust fans placed on top of the glass breaking enclosure were not sufficient to produce significant flow across the pressure drop caused by the plastic curtain.

VI. CONCLUSIONS AND RECOMMENDATIONS

The primary purpose of sampling is to determine the extent of employee exposures and the adequacy of protection. Sampling also permits the employer to evaluate the effectiveness of engineering and work practice controls and informs the employer whether additional controls need to be installed. Values that exceed OELs indicate that additional controls are necessary. This study focused on the evaluation of airborne exposures and noise, with additional data collected on surface contamination. The results of air sampling during this January 2008 survey found that Pb, Cd, and other metals are generated and released during the recycling operations at this facility. No exposures to airborne metals or particulate were found that exceeded the OSHA Action Level for these substances during normal production or during the monthly filter change operation. Recommendations are presented below to assure the continued safe conditions at Lewisburg Federal Correctional facility.

Although there was initial concern about Be and literature that pertains to e-waste recycling report that Be is present in electronic components, none was detected in air or wipe samples collected at this facility. One explanation for this is based on the work of Willis and Florig [2002]. They note that Be "in consumer products is used in ways that are not likely to create beryllium exposures during use and maintenance." The recycling operations (except the glass breaking operation) involve disassembly of electronics and sorting of the components. While some breakage occurs during the disassembly process, the components likely to contain Be are not subject to further processing that might create the potential for Be exposures.

Of the UNICOR recycling facilities evaluated to date, Lewisburg has the most adequate arrangement for donning and doffing personal protective clothing and equipment. While some situations require showers as a part of the decontamination process, this is not considered necessary for the work conducted at Lewisburg since the levels of contaminant are low. The arrangement in its present configuration is deemed adequate. Assurance needs to be made, however, that respirators and clean protective clothing are stored in lockers in the work area, where they are not at risk of contamination.

While the recommendations presented here address certain areas and issues observed during this evaluation, there needs to be a site-specific health and safety program at Lewisburg. Based on the data presented above, the following recommendations are made. These recommendations are divided into 3 categories, described as programmatic issues, procedural issues, and housekeeping issues.

Programmatic issues:

1. The respiratory protection program for this facility should be evaluated for this operation in order to ensure that it complies with OSHA regulation 1910.134.
2. A hearing protection program should be implemented and compliance with all provisions of the OSHA standard for occupational exposure to noise [29 CFR 1910.95] should be verified.
3. Training of workers should be scheduled and documented in the use of techniques for dust suppression, the proper use of local ventilation, personal protection equipment (e.g., coveralls, respirators, gloves) and hazard communication.
4. Frequently while conducting the on-site work, NIOSH researchers observed tasks being conducted in a manner that appeared to be very awkward. Tasks should be evaluated to determine if there are excesses in repetitive stress trauma and if modifications in procedures or equipment would provide benefit to this workplace.
5. Heat stress should be periodically evaluated during hot weather (e.g., the summer months).
6. All UNICOR operations, including but not limited to recycling should be evaluated from the perspective of health, safety and the environment in the near future.
7. A program should be established within the Bureau of Prisons to assure that these issues are adequately addressed by competent, trained and certified individuals. While a written program to address these issues is necessary at each facility, adequate staffing with safety and health professionals is required to ensure its implementation. One indication of adequate staffing is provided by the United States Navy, which states "Regions/Activities with more than 400 employees shall assign, at a minimum, a full time safety manager and

adequate clerical support" [USN 2005]. That document also provides recommended hazard-based staffing levels for calculating the "number of professional personnel needed to perform minimum functions in the safety organization."

8. A comprehensive program is needed within the Bureau which provides sufficient resources, including professional assistance, to assure each facility the assets needed to assure both staff and inmates a safe and healthy workplace.

Procedural issues:

9. The use of an alternative method (e.g., static pressure drop) should be investigated to determine frequency of filter change. The manufacturer of this system may have guidelines in this regard.
10. Workers performing the filter change operation should continue to utilize respiratory protection as part of a comprehensive respiratory protection program. The PAPRs used provide adequate protection for the filter change operation.
11. Because the facility already provides uniforms to its workers, management should evaluate the feasibility of providing and laundering work clothing for all workers in the recycling facility, instead of the current practice of providing disposable clothing for glass breaking workers only. Contaminated work clothing must be segregated from other clothes and laundered in accordance with applicable regulations.
12. The use of alternative methods to break cathode-ray tubes should be investigated by Lewisburg management to determine if further improvements are feasible. Lee et al. [2004] present different methods to separate panel glass from funnel glass in CRT recycling (sec 2.1) and for removing the coatings from the glass (sec 2.2). The hot wire and vacuum suction methods (supplemented with local exhaust ventilation) described by Lee et al. may produce fewer airborne particulates than breaking the glass with a hammer. The authors [Lee et al. 2004] describe a commercially-available method in which an electrically-heated wire is either manually or automatically wound around the junction of the panel and funnel glass, heating the glass. After heating the glass for the necessary time, cool (e.g., room temperature) air is directed at the surface, fracturing the glass-to-glass junction using thermal shock. The separated panel and funnel glass can then be sorted by hand. They also describe a method wherein a vacuum-suction device is moved over the inner surface of the panel glass to remove the loose fluorescent coating [Lee et al. 2004]. The vacuum used must be equipped with HEPA filtration. Industrial central vacuum systems are available; they may cost less in the long run than portable HEPA vacuum cleaners. These modifications may also reduce the noise exposure to glass breakers.
13. Because of the noise levels found in the glass breaking operation, engineering controls should be designed or selected using noise reduction as a criterion. Until noise in the glass breaking operation can be reduced through engineering controls, a hearing conservation program including noise monitoring, audiometric testing, providing hearing protectors, training workers, and recordkeeping must be implemented for workers in the glass breaking operation.

Housekeeping:

14. Due to the levels of surface contamination of Pb measured in the recycling facility, workers should wash their hands before eating, drinking, or smoking.
15. Given the concentrations of Pb and Cd detected in the surface wipe samples and air measurements, periodic industrial hygiene evaluations and facility inspections are

recommended to confirm that exposures are maintained below applicable occupational exposure limits.

16. Daily and weekly cleaning of work areas by HEPA-vacuuming and wet mopping should be continued, taking care to assure no electrical or other safety hazard is introduced. The BG/BIA guidelines [2001] recommend daily cleaning of tables and floors with a type-H vacuum cleaner. Type H is the European equivalent of a HEPA vacuum, where the H class requires that the filter achieve 99.995% efficiency, where 90% of the test particles are smaller than 1.0 um and pass the assembled appliance test, 99.995% efficiency where 10% of the particles are smaller than 1.0 um, 22% below 2.0 um, and 75% below 5.0 um. While some surface contamination was measured in work areas, this would be much greater if it were not for the good housekeeping practices in effect in all locations observed. Other practices not observed during the time of this evaluation, but which have been observed at other facilities should be discouraged; these include the use of compressed air to clean parts or working surfaces, and the consumption of food, beverage or tobacco in the workplace.

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Table 1

Summary Statistics for Airborne Metal Measurements*
Collected at USP Lewisburg
(Concentration unit for means is μg/m^3)

	Particulate	Ba	Be	Cd	Pb	Ni
15 total particulate samples collected in recycling operations (excluding GBO)						
Ar. Mean	540	0.262	0.004	0.031	0.451	0.157
Ar. St. Dev	147	0.126	0.001	0.020	0.278	0.109
Geo Mean	521	0.235	0.003	0.024	0.380	0.130
GSD	1.378	1.630	1.254	2.315	1.836	1.824
5 total particulate samples collected in GBO, normal operation						
Ar. Mean	463	1.117	0.003	0.077	2.427	0.322
Ar. St. Dev	221	0.642	0.001	0.039	1.479	0.140
Geo Mean	373	0.710	0.003	0.067	1.822	0.298
GSD	2.480	4.347	1.192	1.851	2.797	1.570
4 respirable samples collected in GBO, normal operation						
Ar. Mean	95	0.232	0.003	0.030	0.518	0.137
Ar. St. Dev	49	0.166	0.000	0.000	0.180	0.082
Geo Mean	83	0.159	0.003	0.030	0.495	0.119
GSD	1.924	3.381	1.174	1.000	1.415	1.866
4 total particulate samples collected during filter change operation						
Ar. Mean	451	0.621	0.013	0.886	3.096	0.692
Ar. St. Dev	435	1.078	0.000	1.373	4.792	0.230
Geo Mean	340	0.149	0.013	0.376	1.370	0.653
GSD	2.240	7.120	1.000	4.099	3.833	1.519
4 respirable samples collected during filter change operation						
Ar. Mean	163	0.248	0.010	0.110	0.856	0.349
Ar. St. Dev	90	0.247	0.002	0.020	0.587	0.125
Geo Mean	147	0.142	0.010	0.109	0.741	0.334
GSD	1.672	3.960	1.202	1.183	1.795	1.395

*Ar. Mean = arithmetic mean
Ar. St Dev = arithmetic standard deviation
Geo Mean = geometric mean
GSD = geometric standard deviation
All "non-detected" samples were set at half the limit of detection for statistical calculations.

Table 2
Lewisburg Federal Penitentiary
Personal Breathing Zone and Area Air Sample Results for Total Particulate (TP), Barium (Ba), Beryllium (Be), Cadmium (Cd), Lead (Pb), and Nickel (Ni)

Sample Number	Job Description/ Work Location	Sample Date	Sample Time (min.)	Sample Type*	TP Conc. (µg/m³)	Ba Conc. (µg/m³)	Be Conc. (µg/m³)	Cd Conc. (µg/m³)	Pb Conc. (µg/m³)	Ni Conc. (µg/m³)
LMTM-01	Runner	1/29/2008	152	P	na	na	<0.013	na	na	na
LMTM-04	Disassembly	1/29/2008	327	P	na	na	<0.006	na	na	na
LMTM-08	Disassembly outside glass break room	1/29/2008	326	P	na	0.19	<0.007	<0.06	0.81	<0.20
LMTT-01	Glass breaker/feeding glass	1/29/2008	349	P	506	1.15	<0.007	0.09	2.01	0.42
LMTT-03	Feeding glass/glass breaking (GB)	1/29/2008	320	P	608	1.78	<0.007	0.12	4.40	0.26
LMTT-04	Disassembly (cable boxes)	1/29/2008	331	P	652	0.42	<0.007	0.08	0.75	0.36
LMTT-05	Disassembly outside glass break room	1/29/2008	354	P	585	0.54	<0.007	<0.08	1.13	0.37
LMWM-05	Breaking hard drives	1/30/2008	304	P	na	0.15	<0.008	<0.07	<0.55	<0.22
LMWM-06	Disassembly outside glass break room	1/30/2008	166	P	na	0.22	<0.014	<0.12	<1.01	<0.40
LMWT-01	Feeding glass/GB	1/30/2008	300	P	534	1.33	<0.008	0.10	2.56	0.51
LMWT-03	Disassembly of CPUs in middle building	1/30/2008	308	P	597	0.38	<0.008	<0.09	<0.43	0.25
LMWT-04	Glass breaker/feeding glass	1/30/2008	316	P	593	1.27	<0.007	<0.08	2.86	0.25
LMTM-02	On work bench in disassemble area outside GB room	1/29/2008	381	A	na	na	<0.005	na	na	na
LMTM-03	Work bench in monitor testing area	1/29/2008	410	A	na	na	<0.005	na	na	na
LMTM-05	Memory testing area, 5 feet from workers	1/29/2008	412	A	na	na	<0.005	na	na	na
LMTM-06	Work bench outside GB room	1/29/2008	391	A	na	0.17	<0.006	<0.06	0.62	<0.17
LMTM-07	Memory testing area, 5 feet from workers	1/29/2008	412	A	na	0.23	<0.006	<0.05	0.41	<0.16
LMTM-09	Work bench outside GB room	1/29/2008	391	A	na	0.10	<0.006	<0.05	0.43	<0.17
LMTM-10	Work bench in monitor testing area	1/29/2008	410	A	na	0.29	<0.006	<0.05	0.41	<0.16
LMTT-02	On top of GB booth, center 1 foot from front	1/29/2008	432	A	74	0.05	<0.005	<0.06	0.31	0.16
LMWM-01	Work shelf in printer/monitor testing area	1/30/2008	378	A	na	0.41	<0.006	<0.05	<0.44	<0.18
LMWM-02	On shelf in wire area	1/30/2008	387	A	na	0.10	<0.006	<0.05	<0.43	<0.17
LMWM-03	On work shelf near CPU disassembly	1/30/2008	386	A	na	0.28	<0.006	<0.05	0.46	<0.17
LMWM-04	Work bench in CPU testing area	1/30/2008	381	A	na	0.21	<0.006	<0.05	<0.44	<0.18
LMWP-02	In laptop area near work desk	1/30/2008	383	A	na	na	<0.005	na	na	na
LMWP-03	On work shelf near CPU disassembly	1/30/2008	386	A	na	na	<0.005	na	na	na
LMWP-04	On shelf in wire area	1/30/2008	389	A	na	na	<0.005	na	na	na
LMWT-02	BZ level on work shelf directly opposite of glass break booth	1/30/2008	411	A	324	0.22	<0.006	<0.06	<0.32	0.30
LMHT-01	On work shelf opposite GB booth	1/31/2008	93	A	199	<0.07	<0.025	<0.29	<1.44	0.79
LMHT-02	On work shelf opposite GB booth	1/31/2008	91	A	202	<0.07	<0.026	<0.29	<1.47	0.77
LMHT-03	GB booth cleaning and filter changing	1/31/2008	96	P	1099	2.23	<0.025	2.94	10.3	0.85
LMHT-04	Outside documenting cleanup/filter change procedure	1/31/2008	95	P	303	0.18	<0.025	0.30	<1.42	<0.71

* P = personal sample
A = area sample

Table 3
Lewisburg Federal Penitentiary
BGI Cyclone Respirable Air Sample Results for Respirable Particulate (RP), Barium (Ba), Beryllium (Be), Cadmium (Cd), Lead (Pb), and Nickel (Ni)

Sample Number	Job Description/Work Location	Sample Date	Sample Time (min.)	Sample Type*	RP Conc. ($\mu g/m^3$)	Ba Conc. ($\mu g/m^3$)	Be Conc. ($\mu g/m^3$)	Cd Conc. ($\mu g/m^3$)	Pb Conc. ($\mu g/m^3$)	Ni Conc. ($\mu g/m^3$)
LMTR-01	Feeding glass/glass breaking	1/29/2008	311	P	150	0.43	<0.007	<0.06	0.73	0.17
LMTR-02	Glass breaker/feeding glass	1/29/2008	349	P	110	0.26	<0.007	<0.06	0.37	<0.14
LMTR-03	Disassembly of CPUs in middle building	1/29/2008	329	P	230	0.22	<0.007	<0.06	0.29	0.23
LMWR-01	Disassembly of CPUs in middle building	1/30/2008	396	P	132	0.27	<0.003	<0.03	0.27	0.10
LMWR-02	Feeding glass/glass breaking	1/30/2008	305	P	86.6	0.21	<0.006	<0.06	0.60	0.24
LMWR-03	Glass breaker/feeding glass	1/30/2008	325	P	33.0	0.027	<0.005	<0.06	0.37	<0.15
LMHR-04	Glass breaking booth cleaning and filter changing	1/31/2008	97	P	87.5	0.57	<0.018	<0.20	1.72	0.52
LMHR-01	Glass breaking booth cleaning and filter changing	1/31/2008	70	P	158	0.30	<0.025	<0.28	<1.40	<0.70
LMHR-02	On work shelf opposite glass breaking booth	1/31/2008	93	A	117	<0.05	<0.018	<0.21	<1.04	<0.52
LMHR-03	On work shelf opposite glass breaking booth	1/31/2008	92	A	291	0.10	<0.019	<0.21	<1.06	<0.53

* P = personal sample
A = area sample

Table 4
Lewisburg Federal Penitentiary
Surface Wipe Sample Results for metals of primary interest, in µg/sq ft

Sample Number	Sample Location	Sample Date	Ba	Be	Cd	Pb	Ni
LMTW-04	Work bench canvas surface outside glass breaking booth	1/29/2008	91	<0.1	8	279	35
LMTW-05	Coated surface from LED plastic screen	1/29/2008	1	<0.1	<1	<8	<5
LMTW-06	Uncoated surface from LED plastic screen	1/29/2008	3	<0.1	<1	<8	<5
LMTW-07	Coated surface from LED plastic screen	1/29/2008	7	<0.1	<1	33	<5
LMTW-08	Uncoated surface from LED plastic screen	1/29/2008	1	<0.1	<1	19	<5
LMTW-09	Rubberized mat on work bench in middle building	1/29/2008	39	<0.1	5	58	31
LMTW-10	Metal surface of work bench in middle building	1/29/2008	6	<0.1	3	20	6
LMWW-05	Fan blades from fan removed from a CPU	1/30/2008	250	<0.1	14	7068	89
LMWW-06	Fan blades from fan removed from a CPU	1/30/2008	101	<0.1	14	512	64
LMWW-07	Inside surface of a CPU case	1/30/2008	3	<0.1	<1	<8	<5
LMWW-08	Inside surface of a CPU case	1/30/2008	22	<0.1	1	36	51

Table 5
Noise Exposure Measurements*
January 29, 2008

Sample I D	**LST-02**		**LST-09**		**LST-03**	
Description	Area - on top of glass breaking booth		Area - on operators desk near bailer		Area - on top of glass breaking booth	
Run Time	6:16:22		5:14:37		6:17:51	
Evaluation criteria	OSHA	NIOSH	OSHA	NIOSH	OSHA	NIOSH
Test Average (dB)	87.9	91.2	77.2	82.5	90.4	94
TWA Average (dB)	86.2	**90.2**	74.2	80.7	88.7	**93**

Sample I D	**LST-01**		**LST-06**		**LST-08**	
Description	Worker disassemblying in glass breaking area		Disassembly worker in center of middle room		Area - workbench in memory testing	
Run Time	6:12:20		6:07:25		6:16:18	
Evaluation criteria	OSHA	NIOSH	OSHA	NIOSH	OSHA	NIOSH
Test Average (dB)	78.7	85.3	83.6	87.4	57.4	74.8
TWA Average (dB)	76.9	84.2	81.7	**86.2**	55.7	73.8

Sample I D	**LST-07**		**LST-04**		**LST-05**	
Description	Disassembly worker at far end of middle room		Area - on workbench outside glass breaking booth		Disassembly worker near end of center room	
Run Time	6:09:20		6:06:20		6:08:13	
Evaluation criteria	OSHA	NIOSH	OSHA	NIOSH	OSHA	NIOSH
Test Average (dB)	78.6	86	64.1	76.1	84.4	89.7
TWA Average (dB)	76.7	84.8	62.2	74.9	82.5	**88.5**

Table 5 (Continued)
Noise Exposure Measurements
January 30, 2008

Sample I D	**LSW-08**		**LSW-05**		**LSW-09**	
Description	Area - on top of panel breaking booth		Bailer		Worker in aluminum area	
Run Time	6:19:47		6:02:28		6:31:20	
Evaluation criteria	OSHA	NIOSH	OSHA	NIOSH	OSHA	NIOSH
Test Average (dB)	88.8	92.2	86.1	92	79	84.2
TWA Average (dB)	87.1	**91.2**	84.1	**90.8**	77.6	83.3

Sample I D	**LSW-06**		**LSW-04**		**LSW-07**	
Description	Worker disassemblying opposite glass breaking booth		Worker disassembling misc. devices in middle room		Area - on top of funnel breaking booth	
Run Time	6:55:28		6:36:12		6:20:17	
Evaluation criteria	OSHA	NIOSH	OSHA	NIOSH	OSHA	NIOSH
Test Average (dB)	76.1	81.8	76.5	84.3	87.7	90.9
TWA Average (dB)	75	81.2	75.1	83.5	86	**89.9**

Sample I D	**LSW-01**	
Description	Bailer operater	
Run Time	6:04:43	
Evaluation criteria	OSHA	NIOSH
Test Average (dB)	87.3	92.2
TWA Average (dB)	85.3	**91**

*Numbers in **bold** indicate overexposures.

Appendix A

Occupational Exposure Criteria for Metal/Element

TABLE 2. EXPOSURE LIMITS, CAS #, RTECS

Element (Symbol)	CAS #	RTECS	Exposure Limits, mg/m³ (Ca = carcinogen) OSHA	NIOSH	ACGIH
Silver (Ag)	7440-22-4	VW3500000	0.01 (dust, fume, metal)	0.01 (metal, soluble)	0.1 (metal) 0.01 (soluble)
Aluminum (Al)	7429-90-5	BD0330000	15 (total dust) 5 (respirable)	10 (total dust) 5 (respirable fume) 2 (salts, alkyls)	10 (dust) 5 (powders, fume) 2 (salts, alkyls)
Arsenic (As)	7440-38-2	CG0525000	varies	C 0.002, Ca	0.01, Ca
Barium (Ba)	7440-39-3	CQ8370000	0.5	0.5	0.5
Beryllium (Be)	7440-41-7	DS1750000	0.002, C 0.005	0.0005, Ca	0.002, Ca
Calcium (Ca)	7440-70-2	–	varies	varies	varies
Cadmium (Cd)	7440-43-9	EU9800000	0.005	lowest feasible, Ca	0.01 (total), Ca 0.002 (respir.), Ca
Cobalt (Co)	7440-48-4	GF8750000	0.1	0.05 (dust, fume)	0.02 (dust, fume)
Chromium (Cr)	7440-47-3	GB4200000	0.5	0.5	0.5
Copper (Cu)	7440-50-8	GL5325000	1 (dust, mists) 0.1 (fume)	1 (dust) 0.1 (fume)	1 (dust, mists) 0.2 (fume)
Iron (Fe)	7439-89-6	NO4565500	10 (dust, fume)	5 (dust, fume)	5 (fume)
Potassium (K)	7440-09-7	TS6460000	–	–	–
Lanthanum	7439-91-0	–	–	–	–
Lithium (Li)	7439-93-2	–	–	–	–
Magnesium (Mg)	7439-95-4	OM2100000	15 (dust) as oxide 5 (respirable)	10 (fume) as oxide	10 (fume) as oxide
Manganese (Mn)	7439-96-5	OO9275000	C 5	1; STEL 3	5 (dust) 1; STEL 3 (fume)
Molybdenum (Mo)	7439-98-7	QA4680000	5 (soluble) 15 (total insoluble)	5 (soluble) 10 (insoluble)	5 (soluble) 10 (insoluble)
Nickel (Ni)	7440-02-0	QR5950000	1	0.015, Ca	0.1 (soluble) 1 (insoluble, metal)
Phosphorus (P)	7723-14-0	TH3500000	0.1	0.1	0.1
Lead (Pb)	7439-92-1	OF7525000	0.05	0.05	0.05
Antimony (Sb)	7440-36-0	CC4025000	0.5	0.5	0.5
Selenium (Se)	7782-49-2	VS7700000	0.2	0.2	0.2
Tin (Sn)	7440-31-5	XP7320000	2	2	2
Strontium (Sr)	7440-24-6	–	–	–	–
Tellurium (Te)	13494-80-9	WY2625000	0.1	0.1	0.1
Titanium (Ti)	7440-32-6	XR1700000	–	–	–
Thallium (Tl)	7440-28-0	XG3425000	0.1 (skin) (soluble)	0.1 (skin) (soluble)	0.1 (skin)
Vanadium (V)	7440-62-2	YW240000	–	C 0.05	–
Tungsten	7440-33-7	–	5	5 10 (STEL)	5 10 (STEL)
Yttrium (Y)	7440-65-5	ZG2980000	1	N/A	1
Zinc (Zn)	7440-66-6	ZG8600000	–	–	–
Zirconium (Zr)	7440-67-7	ZH7070000	5	5, STEL 10	5, STEL 10

Appendix B
Lewisburg Federal Penitentiary
Personal Breathing Zone and Area Air Sample Results for Total Particulate (TP) and Thirty-one Elements

Sample Number	TP Conc. (µg/m³)	Al Conc. (µg/m³)	Sb Conc. (µg/m³)	As Conc. (µg/m³)	Ba Conc. (µg/m³)	Be Conc. (µg/m³)	Cd Conc. (µg/m³)	Ca Conc. (µg/m³)	Cr Conc. (µg/m³)	Co Conc. (µg/m³)	Cu Conc. (µg/m³)	Fe Conc. (µg/m³)	La Conc. (µg/m³)	Pb Conc. (µg/m³)	Li Conc. (µg/m³)
LMTT-01	506	3.25	0.57	<2.87	1.15	<0.007	0.09	44.9	0.24	<0.03	0.15	9.56	<0.02	2.01	<0.004
LMTT-02	74	0.65	<0.31	<2.33	0.05	<0.005	<0.06	8.55	<0.08	<0.02	<0.04	<1.6	<0.02	0.31	<0.003
LMTT-03	608	4.71	<0.42	<3.14	1.78	<0.007	0.12	32.5	0.23	<0.03	0.12	10.48	0.04	4.40	<0.004
LMTT-04	652	3.91	0.46	<3.01	0.42	<0.007	0.08	54.2	0.14	<0.03	0.43	22.07	<0.02	0.75	0.005
LMTT-05	585	3.68	0.77	<2.83	0.54	<0.007	<0.08	40.6	0.24	<0.03	0.32	29.27	<0.02	1.13	<0.004
LMTM-01	na	na	na	na	na	<0.013	na	na	na	na	na	na	na	na	na
LMTM-02	na	na	na	na	na	<0.005	na	na	na	na	na	na	na	na	na
LMTM-03	na	na	na	na	na	<0.005	na	na	na	na	na	na	na	na	na
LMTM-04	na	na	na	na	na	<0.006	na	na	na	na	na	na	na	na	na
LMTM-05	na	na	na	na	na	<0.005	na	na	na	na	na	na	na	na	na
LMTM-06	na	1.62	<0.34	<2.55	0.17	<0.006	<0.06	28.9	0.09	<0.08	0.11	5.96	<0.01	0.62	<0.005
LMTM-07	na	1.70	<0.32	<2.43	0.23	<0.006	<0.05	16.2	0.07	<0.07	0.13	6.98	<0.01	0.41	<0.005
LMTM-08	na	2.45	<0.41	<3.06	0.19	<0.007	<0.06	29.6	0.16	<0.09	0.28	9.39	<0.01	0.81	<0.006
LMTM-09	na	1.28	<0.34	<2.56	0.10	<0.006	<0.05	14.5	0.07	<0.08	0.09	<4.3	<0.01	0.43	<0.005
LMTM-10	na	1.80	<0.33	<2.47	0.29	<0.006	<0.05	19.6	0.09	<0.07	0.18	8.19	<0.01	0.41	<0.005
LMWT-01	534	3.34	<0.44	<3.34	1.33	<0.008	0.10	50.0	0.19	<0.03	0.11	10.34	<0.02	2.56	<0.004
LMWT-02	324	2.27	<0.32	<2.43	0.22	<0.006	<0.06	49.4	<0.08	<0.02	0.11	8.91	<0.02	<0.32	<0.003
LMWT-03	597	4.34	<0.43	<3.26	0.38	<0.008	<0.09	43.4	0.13	<0.03	0.45	23.89	<0.02	<0.43	0.005
LMWT-04	593	3.71	0.81	<3.18	1.27	<0.007	<0.08	71.0	0.19	<0.03	0.14	10.59	<0.02	2.86	<0.004
LMWP-02	na	na	na	na	na	<0.005	na	na	na	na	na	na	na	na	na
LMWP-03	na	na	na	na	na	<0.005	na	na	na	na	na	na	na	na	na
LMWP-04	na	na	na	na	na	<0.005	na	na	na	na	na	na	na	na	na
LMWM-01	na	2.49	<0.36	<2.66	0.41	<0.006	<0.05	23.1	0.08	<0.08	0.27	15.09	<0.01	<0.44	0.007
LMWM-02	na	<0.87	<0.35	<2.60	0.10	<0.006	<0.05	13.0	0.07	<0.08	0.07	<4.3	<0.01	<0.43	<0.005
LMWM-03	na	3.36	<0.34	<2.59	0.28	<0.006	<0.05	31.9	0.21	<0.08	0.22	11.20	<0.01	0.46	<0.005
LMWM-04	na	1.66	<0.35	<2.63	0.21	<0.006	<0.05	10.5	0.07	<0.08	0.11	5.86	<0.01	<0.44	<0.005
LMWM-05	na	1.43	<0.44	<3.31	0.15	<0.008	<0.07	8.82	0.09	<0.10	0.09	<5.5	<0.01	<0.55	0.019
LMWM-06	na	3.64	<0.81	<6.06	0.22	<0.014	<0.12	46.5	0.16	<0.18	0.38	<10.1	<0.02	<1.01	<0.012
LMHT-01	199	1.23	1.84	<10.8	<0.07	<0.025	<0.29	11.6	0.36	0.13	<0.18	<7.2	<0.07	<1.44	<0.015
LMHT-02	202	1.72	2.68	<11.0	<0.07	<0.026	<0.29	16.9	0.48	<0.11	<0.18	<7.3	<0.07	<1.47	<0.015
LMHT-03	1099	6.03	<1.42	<10.6	2.23	<0.025	2.94	17.4	0.46	<0.11	<0.18	8.51	<0.07	10.28	<0.014
LMHT-04	303	2.35	<1.42	<10.7	0.18	<0.025	0.30	27.0	0.75	<0.11	<0.18	11.03	<0.07	<1.42	<0.014

Appendix B cont.
Lewisburg Federal Penitentiary
Personal Breathing Zone and Area Air Sample Results for Total Particulate (TP) and Thirty-one Elements

Sample Number	Mg Conc. (µg/m³)	Mn Conc. (µg/m³)	Mo Conc. (µg/m³)	Ni Conc. (µg/m³)	P Conc. (µg/m³)	K Conc. (µg/m³)	Se Conc. (µg/m³)	Ag Conc. (µg/m³)	Sr Conc. (µg/m³)
LMTT-01	2.29	0.15	<0.19	0.42	7.84	1.72	<4.78	<0.03	0.21
LMTT-02	0.54	<0.04	<0.16	0.16	<5.44	0.46	<3.89	<0.02	0.03
LMTT-03	2.10	0.10	<0.21	0.26	<7.33	2.20	<5.24	<0.03	0.31
LMTT-04	3.61	0.22	0.21	0.36	<7.02	2.61	<5.02	<0.03	0.16
LMTT-05	2.27	0.53	<0.19	0.37	<6.61	1.42	<4.72	<0.03	0.23
LMTM-01	na	na	na	na	na	na	na	na	na
LMTM-02	na	na	na	na	na	na	na	na	na
LMTM-03	na	na	na	na	na	na	na	na	na
LMTM-04	na	na	na	na	na	na	na	na	na
LMTM-05	na	na	na	na	na	na	na	na	na
LMTM-06	1.28	<0.17	<0.17	<0.17	<4.26	0.85	2.30	<0.03	0.10
LMTM-07	1.14	<0.16	<0.16	<0.16	<4.06	0.81	<1.62	<0.03	0.07
LMTM-08	1.74	<0.20	<0.20	<0.20	<5.10	1.43	<2.04	<0.04	0.15
LMTM-09	0.72	<0.17	<0.17	<0.17	<4.26	0.85	1.88	<0.03	0.05
LMTM-10	0.21	<0.16	<0.16	<0.16	<4.09	0.98	<1.64	<0.03	0.10
LMWT-01	2.45	0.11	0.22	0.51	<7.78	2.45	<5.56	<0.03	0.27
LMWT-02	2.51	0.09	<0.16	0.30	<5.67	1.21	5.02	<0.02	0.13
LMWT-03	3.15	0.26	<0.22	0.25	<7.60	1.95	<5.43	<0.03	0.17
LMWT-04	3.50	0.17	<0.21	0.25	<7.42	2.33	<5.30	<0.03	0.28
LMWP-02	na	na	na	na	na	na	na	na	na
LMWP-03	na	na	na	na	na	na	na	na	na
LMWP-04	na	na	na	na	na	na	na	na	na
LMWM-01	1.78	0.20	<0.18	<0.18	<4.44	1.42	<1.78	<0.04	0.36
LMWM-02	0.79	<0.17	<0.17	<0.17	<4.34	0.54	<1.74	<0.03	0.04
LMWM-03	2.24	<0.17	<0.17	<0.17	<4.31	1.55	4.31	<0.03	0.11
LMWM-04	0.82	<0.18	<0.18	<0.18	<4.38	0.96	<1.75	<0.04	0.06
LMWM-05	0.73	<0.22	<0.22	<0.22	<5.51	<0.44	<2.21	<0.04	0.03
LMWM-06	1.98	<0.43	<0.40	<0.40	<10.1	<0.81	5.66	<0.08	0.13
LMHT-01	1.44	<0.18	<0.72	0.79	<25.7	<0.72	<18.1	<0.11	0.03
LMHT-02	1.25	<0.18	<0.73	0.77	<25.7	0.73	<18.3	<0.11	0.04
LMHT-03	1.52	<0.18	0.78	0.85	<24.8	4.26	<17.7	<0.11	0.60
LMHT-04	1.67	<0.18	<0.71	<0.71	<24.9	<0.71	<17.8	<0.11	0.10

Appendix B cont.
Lewisburg Federal Penitentiary
Personal Breathing Zone and Area Air Sample Results for Total Particulate (TP) and Thirty-one Elements

Sample Number	Te Conc. (µg/m³)	Tl Conc. (µg/m³)	Sn Conc. (µg/m³)	Ti Conc. (µg/m³)	V Conc. (µg/m³)	Y Conc. (µg/m³)	Zn Conc. (µg/m³)	Zr Conc. (µg/m³)
LMTT-01	<0.38	<0.96	<0.96	0.04	0.04	12.4	22.9	<0.19
LMTT-02	0.42	<0.78	<0.78	<0.02	0.02	0.04	1.55	<0.16
LMTT-03	0.76	<1.05	<1.05	0.03	<0.03	48.2	72.3	<0.21
LMTT-04	0.41	<1.00	<1.00	0.08	0.03	0.07	9.13	<0.20
LMTT-05	<0.38	<0.94	<0.94	0.15	0.04	0.67	6.33	<0.19
LMTM-01	na	na	na	na	na	na	na	na
LMTM-02	na	na	na	na	na	na	na	na
LMTM-03	na	na	na	na	na	na	na	na
LMTM-04	na	na	na	na	na	na	na	na
LMTM-05	na	na	na	na	na	na	na	na
LMTM-06	<0.60	<0.68	<0.68	<0.09	<0.03	0.22	2.47	<0.03
LMTM-07	<0.57	<0.65	<0.65	<0.08	<0.02	<0.005	0.75	<0.03
LMTM-08	<0.71	<0.82	<0.82	0.14	<0.03	0.21	5.10	<0.04
LMTM-09	<0.60	<0.68	<0.68	<0.09	<0.03	0.01	1.28	<0.03
LMTM-10	<0.57	0.82	<0.57	0.13	<0.02	0.01	0.81	<0.03
LMWT-01	<0.44	<1.11	<1.11	0.03	<0.03	14.5	24.5	<0.22
LMWT-02	<0.32	<0.81	<0.81	0.03	0.04	0.25	2.83	<0.16
LMWT-03	<0.43	<1.09	<1.09	0.11	<0.03	0.09	8.25	<0.22
LMWT-04	0.66	<1.06	<1.06	0.04	0.03	8.69	17.0	<0.21
LMWP-02	na	na	na	na	na	na	na	na
LMWP-03	na	na	na	na	na	na	na	na
LMWP-04	na	na	na	na	na	na	na	na
LMWM-01	<0.62	0.82	<0.62	0.33	<0.03	0.01	1.07	<0.04
LMWM-02	<0.61	<0.70	<0.70	<0.09	<0.03	0.01	1.04	<0.03
LMWM-03	<0.60	<0.69	<0.69	0.17	<0.03	0.01	3.62	0.04
LMWM-04	<0.61	<0.70	<0.70	0.13	<0.03	<0.005	0.96	0.04
LMWM-05	<0.77	<0.88	<0.88	<0.11	<0.03	<0.007	0.55	<0.04
LMWM-06	<1.42	2.43	1.52	<0.20	<0.06	0.40	13.1	<0.08
LMHT-01	<1.44	<3.61	<3.61	<0.07	<0.11	0.30	5.06	<0.72
LMHT-02	2.09	<3.67	<3.67	<0.07	<0.11	0.36	5.87	<0.73
LMHT-03	<1.42	<3.55	<3.55	<0.07	<0.11	95.7	174	<0.71
LMHT-04	<1.42	<3.56	<3.56	<0.07	<0.11	4.27	12.8	<0.71

Appendix C
Lewisburg Federal Penitentiary
BGI Cyclone Respirable Air Sample Results for Respirable Particulate (RP) and Thirty-one Elements

Sample Number	RP Conc. (µg/m³)	Al Conc. (µg/m³)	Sb Conc. (µg/m³)	As Conc. (µg/m³)	Ba Conc. (µg/m³)	Be Conc. (µg/m³)	Cd Conc. (µg/m³)	Ca Conc. (µg/m³)	Cr Conc. (µg/m³)	Co Conc. (µg/m³)	Cu Conc. (µg/m³)	Fe Conc. (µg/m³)	La Conc. (µg/m³)	Pb Conc. (µg/m³)	Li Conc. (µg/m³)
LMTR-01	117	0.86	0.45	<2.34	0.34	<0.005	<0.06	6.80	<0.08	<0.02	<0.04	<1.6	0.02	0.73	<0.003
LMTR-02	79	0.67	0.34	<2.15	0.19	<0.005	<0.06	4.16	0.07	<0.02	<0.04	<1.4	<0.01	0.37	<0.003
LMTR-03	168	1.53	<0.29	<2.19	0.16	<0.005	<0.06	14.6	0.07	<0.02	0.09	5.8	<0.01	0.29	<0.003
LMWR-01	132	1.11	0.34	<1.28	0.12	<0.003	<0.03	10.7	0.04	<0.01	0.06	6.0	<0.01	0.27	<0.002
LMWR-02	87	1.02	<0.31	<2.36	0.17	<0.006	<0.06	7.32	0.08	<0.02	<0.04	1.8	<0.02	0.60	<0.003
LMWR-03	33	0.34	<0.29	<2.20	0.02	<0.005	<0.06	2.12	0.07	<0.02	<0.04	<1.5	<0.01	0.37	<0.003
LMHR-01	158	2.03	1.44	<10.5	0.30	<0.025	<0.28	<1.75	0.46	<0.11	<0.18	<7.0	<0.07	<1.40	<0.014
LMHR-02	117	1.09	<1.04	<7.77	<0.05	<0.018	<0.21	6.48	0.26	<0.08	<0.13	<5.2	<0.05	<1.04	<0.010
LMHR-03	291	1.37	1.51	<7.93	0.10	<0.019	<0.21	11.9	0.26	<0.08	<0.13	<5.3	<0.05	<1.06	<0.011
LMHR-04	87	2.27	<1.00	<7.50	0.57	<0.018	<0.20	4.00	0.25	<0.07	<0.12	<5.0	<0.05	1.72	<0.010

Sample Number	Mg Conc. (µg/m³)	Mn Conc. (µg/m³)	Mo Conc. (µg/m³)	Ni Conc. (µg/m³)	P Conc. (µg/m³)	K Conc. (µg/m³)	Se Conc. (µg/m³)	Ag Conc. (µg/m³)	Sr Conc. (µg/m³)
LMTR-01	0.40	<0.04	<0.16	0.17	<5.48	0.50	<3.91	<0.02	0.16
LMTR-02	0.35	<0.04	<0.14	<0.14	<5.02	0.34	<3.59	<0.02	0.04
LMTR-03	1.09	0.05	<0.15	0.23	<5.10	0.95	<3.64	<0.02	0.05
LMWR-01	0.85	0.05	<0.09	0.10	<2.98	0.64	<2.13	<0.01	0.04
LMWR-02	0.54	<0.04	<0.16	0.24	<5.51	0.43	<3.94	<0.02	0.09
LMWR-03	0.21	<0.04	<0.15	<0.15	<5.13	<0.15	<3.66	<0.02	0.01
LMHR-01	<0.70	<0.18	<0.70	<0.70	<24.5	<0.70	<17.5	<0.11	0.13
LMHR-02	0.62	<0.13	<0.52	<0.52	<18.1	<0.52	<13.0	<0.08	<0.02
LMHR-03	0.95	<0.13	<0.53	<0.53	<18.5	<0.53	<13.2	<0.08	0.04
LMHR-04	0.80	<0.12	<0.50	0.52	<17.5	1.12	<12.5	<0.07	0.20

Appendix C cont.
Lewisburg Federal Penitentiary
BGI Cyclone Respirable Air Sample Results for Total Particulate (TP) and Thirty-one Elements

Sample Number	Te Conc. (μg/m³)	Tl Conc. (μg/m³)	Sn Conc. (μg/m³)	Ti Conc. (μg/m³)	V Conc. (μg/m³)	Y Conc. (μg/m³)	Zn Conc. (μg/m³)	Zr Conc. (μg/m³)
LMTR-01	<0.31	<0.78	<0.78	<0.02	<0.02	0.94	3.51	<0.16
LMTR-02	0.29	<0.72	<0.72	<0.01	<0.02	0.40	2.01	<0.14
LMTR-03	<0.29	<0.73	<0.73	0.02	0.03	0.07	3.28	<0.15
LMWR-01	<0.17	<0.43	<0.43	0.02	0.01	0.16	2.56	<0.09
LMWR-02	0.33	<0.79	<0.79	<0.02	<0.02	0.30	1.89	<0.16
LMWR-03	0.39	<0.73	<0.73	<0.01	<0.02	0.13	1.17	<0.15
LMHR-01	<1.40	<3.51	<3.51	<0.07	<0.11	2.52	9.47	<0.70
LMHR-02	1.30	<2.59	<2.59	<0.05	0.10	<0.016	3.37	<0.52
LMHR-03	<1.06	<2.64	<2.64	<0.05	<0.08	0.40	5.29	<0.53
LMHR-04	1.55	<2.50	<2.50	0.16	<0.07	1.45	7.00	<0.50

Appendix D
Lewisburg Federal Penitentiary
Surface Wipe Sample Results for Twenty-three Elements

Sample Number	As (µg/100cm^2)	Ba (µg/100cm^2)	Be (µg/100cm^2)	Cd (µg/100cm^2)	Cr (µg/100cm^2)	Co (µg/100cm^2)	Cu (µg/100cm^2)	Fe (µg/100cm^2)	La (µg/100cm^2)	Pb (µg/100cm^2)	Mn (µg/100cm^2)	Mo (µg/100cm^2)
LMTW-04	<3	9.78	<0.01	0.9	2.90	0.24	410	450	0.13	30	9.1	0.25
LMTW-05	<3	0.08	<0.01	<0.1	0.10	<0.09	1.1	8.4	<0.03	<0.9	0.14	<0.1
LMTW-06	<3	0.32	<0.01	<0.1	0.10	<0.09	0.58	15	<0.03	<0.9	0.19	<0.1
LMTW-07	<3	0.73	<0.01	<0.1	0.27	<0.09	0.80	31	<0.03	3.6	1.2	<0.1
LMTW-08	<3	0.15	<0.01	<0.1	<0.06	<0.09	<0.5	14	0.041	2.0	0.30	<0.1
LMTW-09	<3	4.18	<0.01	0.5	1.60	<0.09	12	220	<0.03	6.2	2.9	<0.1
LMTW-10	<3	0.65	<0.01	0.3	0.54	<0.09	2.9	59	<0.03	2.1	0.76	<0.1
LMWW-05	<3	26.9	<0.01	1.5	7.30	0.58	52	2400	<0.03	760	25	2.0
LMWW-06	<3	10.9	<0.01	1.5	5.70	0.37	47	1400	<0.03	55	15	1.6
LMWW-07	<3	0.33	<0.01	<0.1	0.27	<0.09	<0.5	8.1	<0.03	<0.9	0.12	<0.1
LMWW-08	<3	2.38	<0.01	0.2	5.60	0.10	13	270	<0.03	3.9	2.1	0.39
LMWW-15	<3	0.16	<0.01	<0.1	0.56	<0.09	0.50	8.3	<0.03	<0.9	0.22	0.19
LMWW-16	<3	0.085	<0.01	<0.1	0.08	<0.09	<0.5	3.6	<0.03	<0.9	0.094	<0.1

Sample Number	Ni (µg/100cm^2)	P (µg/100cm^2)	Se (µg/100cm^2)	Ag (µg/100cm^2)	Sr (µg/100cm^2)	Te (µg/100cm^2)	Tl (µg/100cm^2)	Sn (µg/100cm^2)	V (µg/100cm^2)	Y (µg/100cm^2)	Zn (µg/100cm^2)
LMTW-04	3.8	170	<5	0.89	4.3	<1	<1	33	0.055	1.1	200
LMTW-05	<0.5	<40	<5	<0.03	0.11	<1	<1	<3	<0.04	0.057	<20
LMTW-06	<0.5	<40	<5	<0.03	0.095	<1	<1	<3	<0.04	0.025	<20
LMTW-07	<0.5	<40	<5	0.064	0.62	<1	<1	<3	<0.04	0.087	<20
LMTW-08	<0.5	<40	<5	<0.03	0.11	<1	<1	<3	<0.04	0.87	<20
LMTW-09	3.3	<40	<5	0.38	1.3	<1	<1	8.6	<0.04	0.099	110
LMTW-10	0.66	<40	<5	0.068	0.34	<1	<1	3.3	<0.04	0.048	21
LMWW-05	9.6	120	<5	1.2	6.6	<1	<1	13	1.2	0.79	220
LMWW-06	6.9	150	<5	1.1	4.7	1.1	<1	20	0.72	0.51	480
LMWW-07	<0.5	<40	<5	<0.03	0.20	<1	<1	<3	<0.04	<0.008	<20
LMWW-08	5.5	<40	<5	0.14	1.0	<1	<1	3.2	0.11	0.053	2000
LMWW-15	<0.5	<40	<5	<0.03	0.16	<1	<1	3.6	<0.04	0.010	<20
LMWW-16	<0.5	<40	<5	<0.03	0.069	<1	<1	<3	<0.04	<0.008	<20

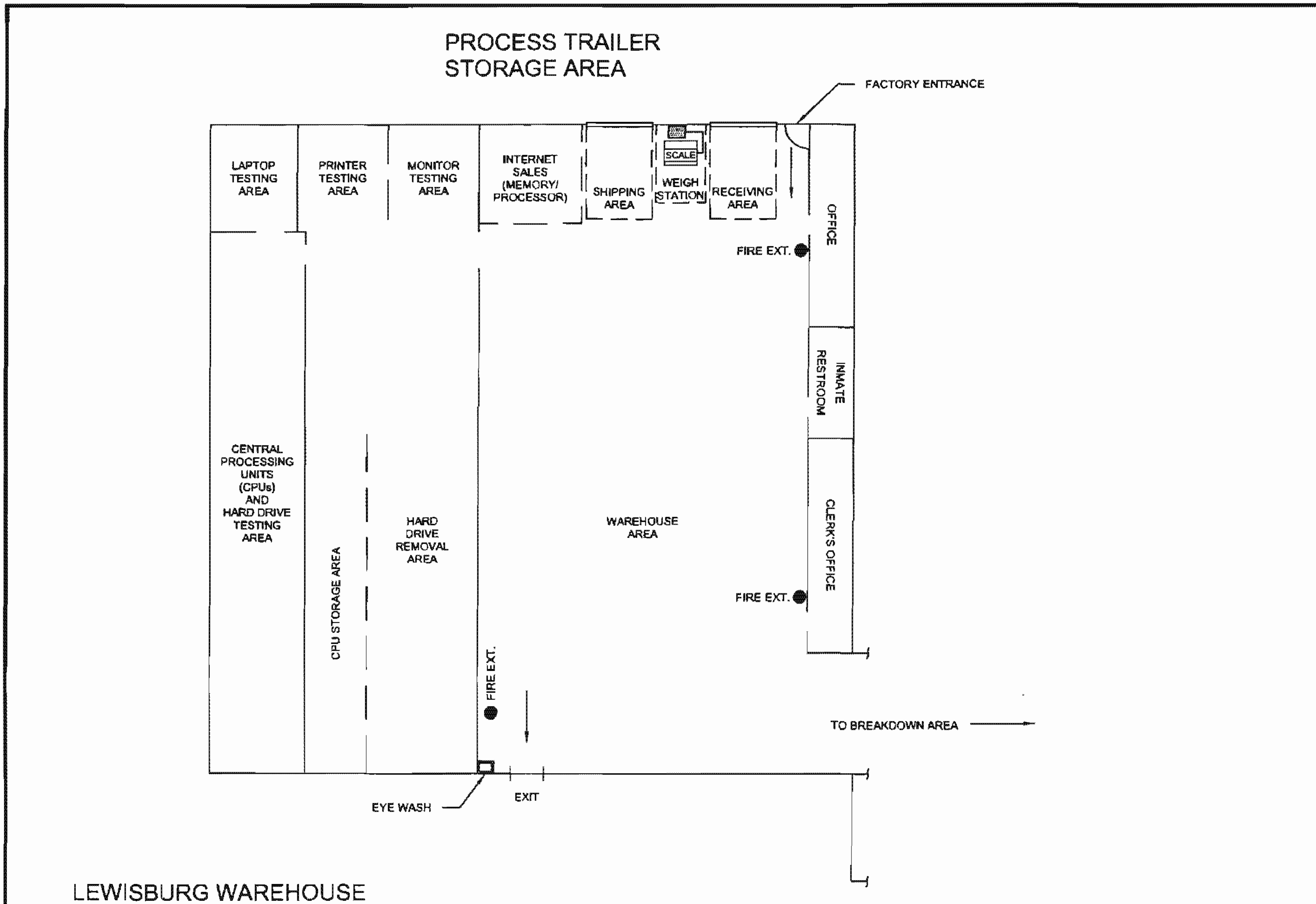
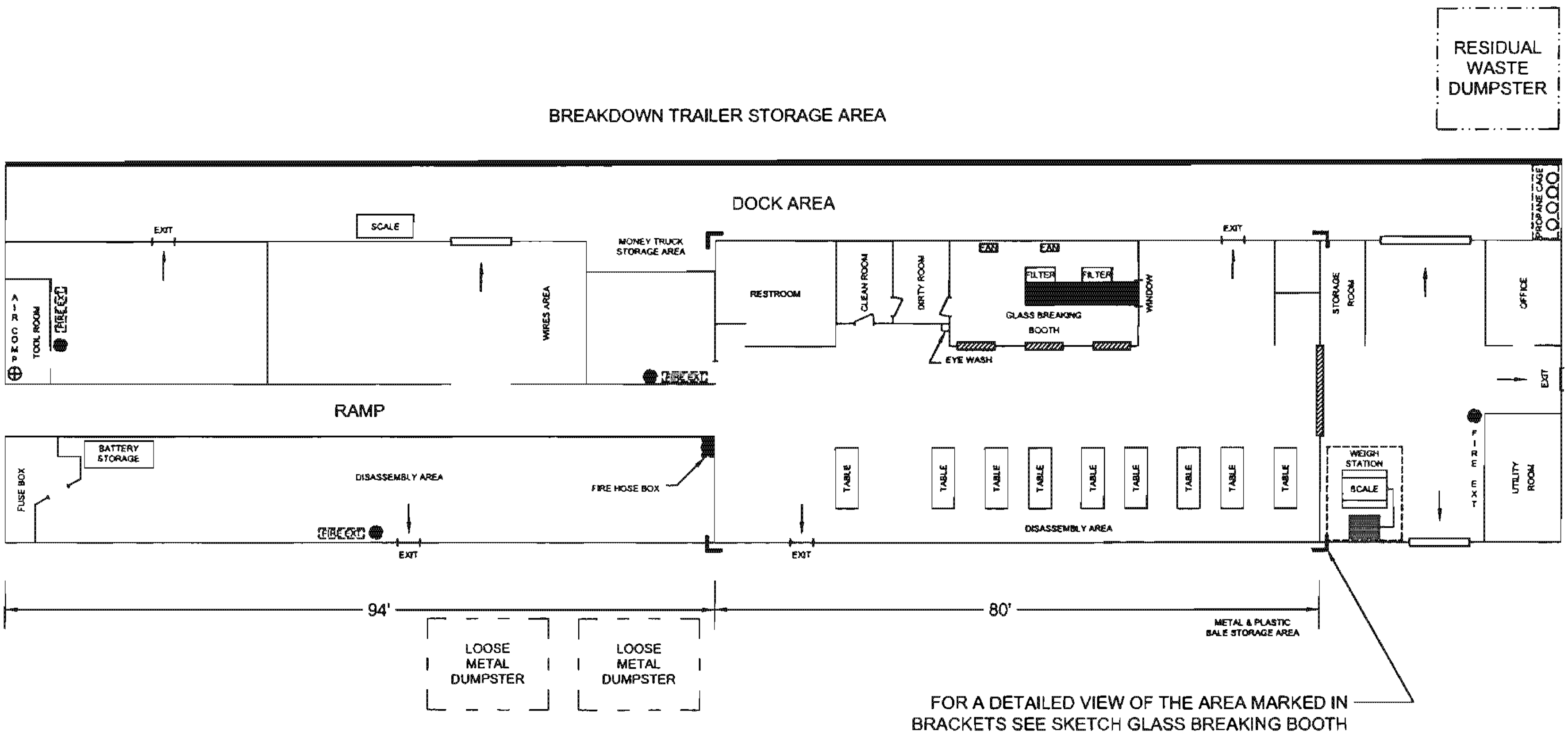
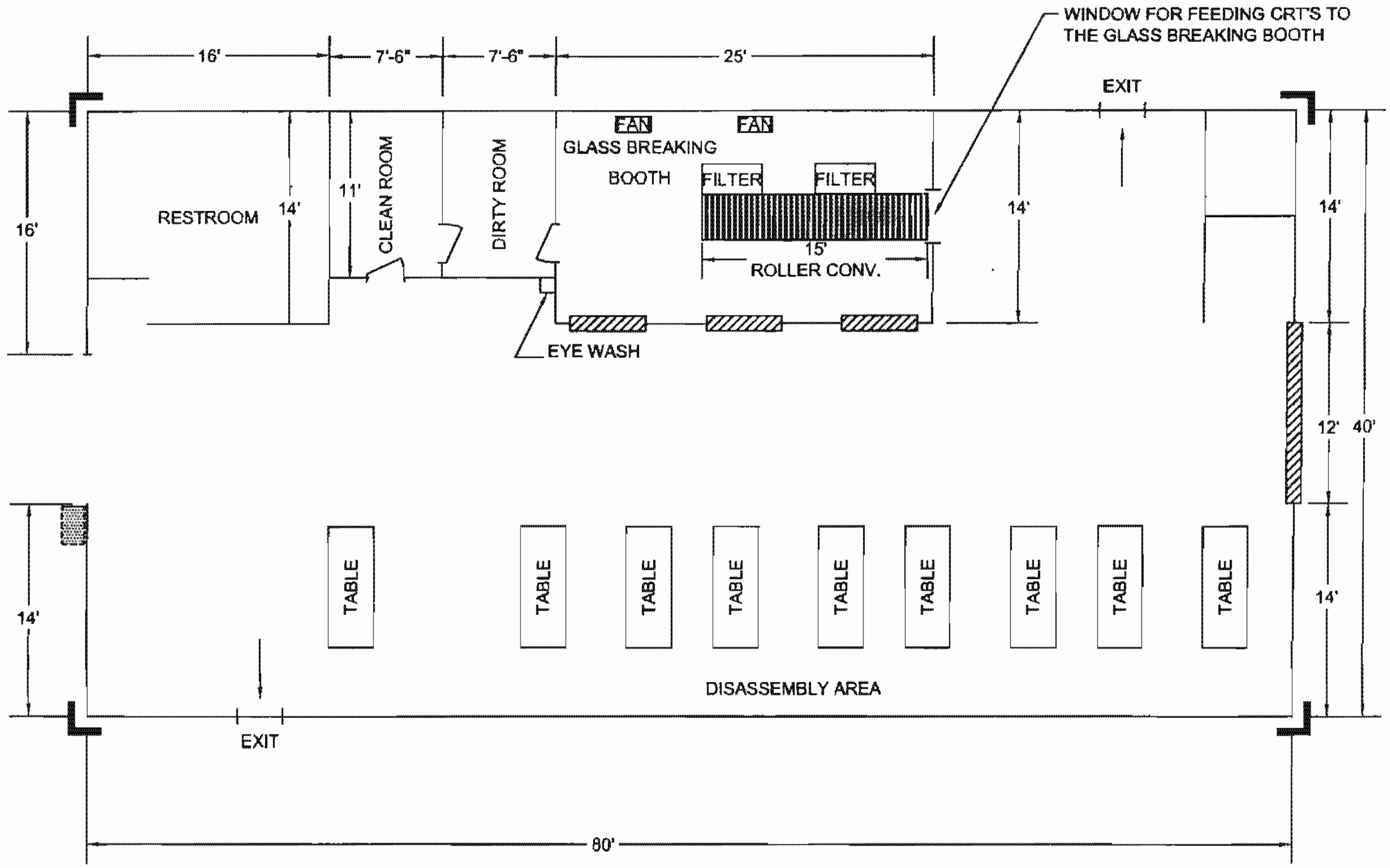

PROCESS TRAILER
STORAGE AREA
FACTORY ENTRANCE
LAPTOP TESTING AREA
PRINTER TESTING AREA
MONITOR TESTING AREA
INTERNET SALES (MEMORY/ PROCESSOR)
SHIPPING AREA
SCALE
WEIGH STATION
RECEIVING AREA
OFFICE
FIRE EXT.
INMATE RESTROOM
CENTRAL PROCESSING UNITS (CPUs) AND HARD DRIVE TESTING AREA
CPU STORAGE AREA
HARD DRIVE REMOVAL AREA
WAREHOUSE AREA
CLERK'S OFFICE
FIRE EXT.
FIRE EXT.
TO BREAKDOWN AREA
EYE WASH
EXIT
LEWISBURG WAREHOUSE
DRAWING NOT TO SCALE

Figure I



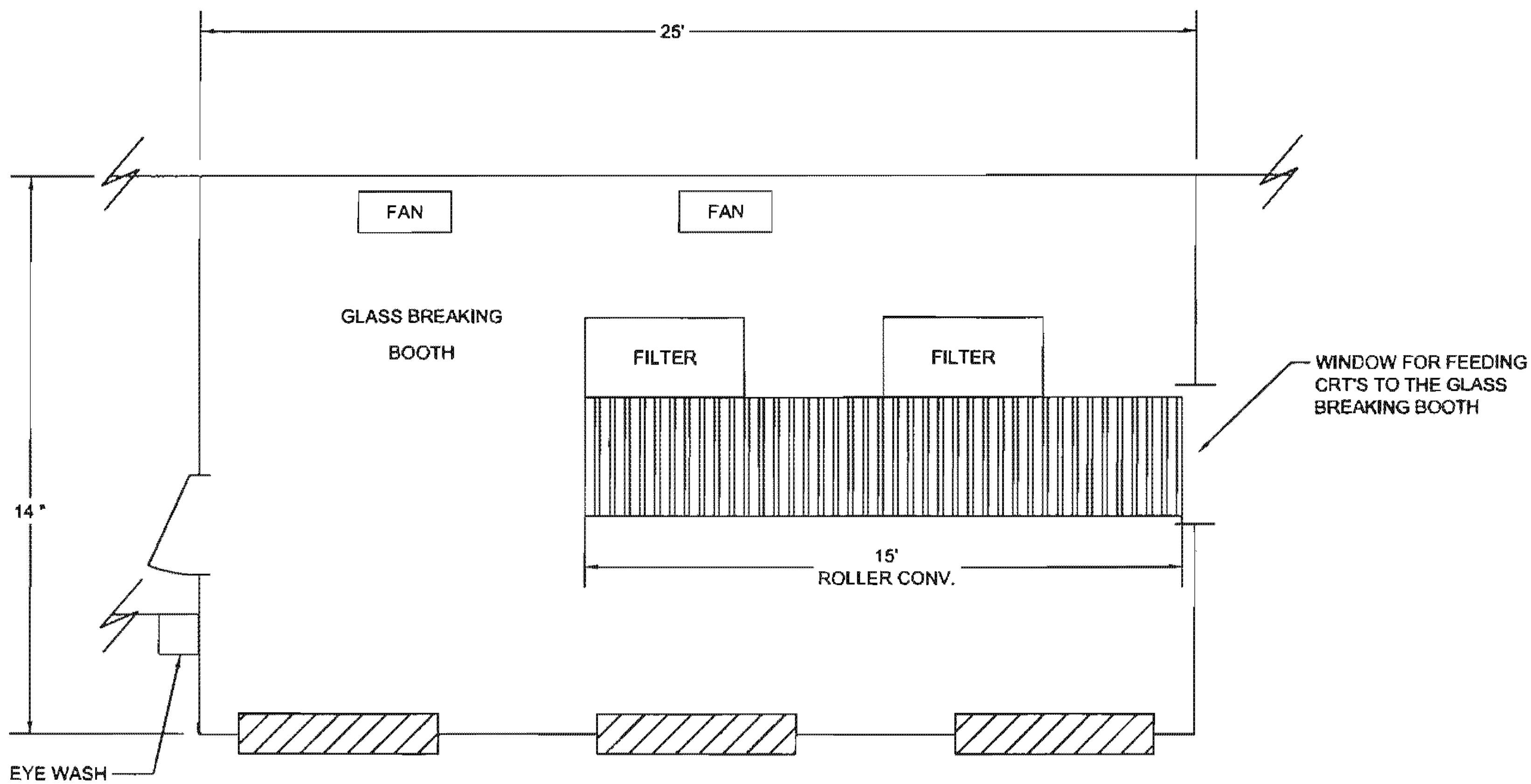
LEWISBURG RECYCLING FACTORY BREAKDOWN AREA
DRAWING NOT TO SCALE

Figure II



GLASS BREAKING BOOTH
DRAWING NOT TO SCALE

Figure III



GLASS BREAKING BOOTH WORK STATIONS
DRAWING NOT TO SCALE

Figure IV

Attachment 2

Attachment 2a.

Wipe/Bulk Sample Data-FOH Samples
Camp Building, USP Lewisburg

Field #	Date Collected	Sample Type	Surface/Item	Lead		Cadmium	
		W=Wipe B=Bulk		µg/ft²	mg/kg	µg/ft²	mg/kg
XLMWG1	5/23/2007	W	Inside glass breaking area	1,200		880	
XLMWG2	5/23/2007	W	Inside glass breaking area (hood #2)	1,300		360	
XLMWG3	5/23/2007	W	Inside glass breaking area (hood 1); from roller surface	1,100		200	
XLMWG4	5/23/2007	W	Outside GBO; Floor of top step feeder platform	410		13	
XLMWG5	5/23/2007	W	Dirty room adjacent to GB; atop work bench	18		4	
XLMWG6	5/23/2007	W	Clean room adjacent to GB; Atop water heater and ledge of hook rack	30		6	
XLMWG7	5/23/2007	W	Shelf above work bench outside GBO; disassembly area #7B	450		15	
XLMWG8	5/23/2007	W	Clean room; from battery packs and shelves	18		8	
XLMWG9	5/23/2007	W	Work bench in disassembly area #7A	25		3	
XLMWG10	5/23/2007	W	Work bench in disassembly area #7A	34		5	
XLMWG11	5/23/2007	W	Warehouse; top of work bench	30		10	
XLMWG12	5/23/2007	W	CPU Area # 5A; top of work bench	10		2	
XLMWG13	5/23/2007	W	Laptop area #4; top of metal storage shelf	10		1	
XLMWG14	5/23/2007	W	Office Area #1; top of printer table	1		0	
XLMWG15	5/23/2007	W	Clerks office Area #2; top of desk	4		1	
XLMWG16	5/23/2007	W	Bailing house; front lip of metal bailing machine	21		11	
XLMHG1	5/24/2007	W	CPU Area #5A; table top with composite chipboard surface	6		1	
XLMHG2	5/24/2007	W	Disassembly Area #7A; rubber mat work surface on metal table	180		300	
XLMHG3	5/24/2007	W	Board/parts separation area #6; from mat (old conveyer belt) on top of wood table	97		110	
XLMHG4	5/24/2007	W	Disassembly area #7B; from top of metal work table	120		1	
XLMHG5	5/24/2007	W	Hazardous waste storage area; from bottom of cover on box labled UNICOR H. W.	25		1	
XLMHG6	5/24/2007	W	Inside Gaylord box containing scrap metal from inside CRT's (ribbing, etc.)	1,200		38	
XLMWB3	5/23/2007	B	Above ceiling in disassembly area #7B (above old GB area)		19,000		62

Attachment 2b.

TCPL Data Table-FOH Samples
Camp Building, USP Lewisburg

Field #	Date Collected	Sample Type	Description	Lead	Cadmium
				mg/l (extractable)	mg/l (extractable)
XLMWB1	5/23/2007	TCLP	Waste water (from mop bucket) about to be dumped on ground.	<0.1	<0.01
XLMWB2	5/23/2007	TCLP	Waste water (mop) in GBO.	0.3	<0.01

Attachment 2c.

Wipe/Bulk Sample Results-FOH Samples
Camp Building, USP Lewisburg

Field #	Date Collected	Sample Type	Surface/Item	Elevation	Lead		Cadmium	
		W=Wipe; B=Bulk		(feet)	µg/ft^2	mg/kg	µg/ft^2	mg/kg
FLTWC 4	1/29/2008	W	Surfaces of vacuum hoses & dust pans in glass breaking area	0-6'	4,000		44	
FLTWC 6	1/29/2008	W	From gloves worn by a glass breaker	n/a	160		7	
FLTWC 7	1/29/2008	W	From surface of the glass breaking curtains (inside booth)	n/a	8,400		63	
FLWWC -1	1/30/2008	W	From plastic sleeves worn by breakers	n/a	170		20	
FLWW2CLW	1/30/2008	W	From windowsills in middle section of building (outside glass breaking area but with within recycling facility)	4-6'	1,100		27	
FLWW2CGW	1/30/2008	W	Composite wipe from windowsils in middle section of building (outside glass breaking area but with within recycling facility)	~4'	390		22	
FLWB-1 (N)	1/30/2008	B	Access panel in drop ceiling; north side of room	~18'		18,000		50
FLWB-2 (S)	1/30/2008	B	Access panel in drop ceiling; south side of room	~18'		5,800		33
FLWB5	1/30/2008	B	Debris sampled on the floor where the glass breaking filters were changed out	0'		8,000		110
FLWB6	1/30/2008	B	Dust taken from a canister vacuum cleaner located in the glass breaking area	0'		330		33

Attachment 2d.

TCLP Sample Data Table-FOH Samples
Camp Building, USP Lewisburg

Field #	Date Collected	Sample Type	Surface/Item	Lead	Cadmium
				mg/l (extractable)	mg/l (extractable)
FLT-TCLP-1	1/29/2008	TCLP	Mop bucket water from mopping in glass breaking area	0.78	<0.01
FLW-TCLP-1	1/30/2008	TCLP	Mop bucket water from middle area of recycling area (outside GB area)	<0.1	0.01
FLW-TCLP-2	1/30/2008	TCLP	Mop bucket water from south hall area of building (where e-wastes are transported to the outside)	<0.1	<0.01
FLWB4	1/30/2008	TCLP	Debris from steel roll-off container where scrap metal e-wastes (primarily metal bands and ribbing) are collected	8.8	0.014

Attachment 3

U. S. Department of Labor
Occupational Safety and Health Administration

Notice of Alleged Safety or Health Hazards

Wed Apr 20, 2005 1:53pm

		Complaint Number	204997704
Establishment Name	U.S. DEPT OF JUSTICE, USP LEWISBURG		
Site Address	RD#5, Lewisburg, PA 17837		
	Site Phone (570) 523-1251	Site FAX	(570) 522-7746
Mailing Address	P O Box 2000, Lewisburg, PA 17837		
	Mail Phone (570) [redacted]	Mail FAX	
Management Official	[redacted]	Telephone	
Type of Business	prison	Ownership	
Primary SIC	9223	Primary NAICS	922140

HAZARD DESCRIPTION/LOCATION. Describe briefly the hazard(s) which you believe exist. Include the approximate number of employees exposed to or threatened by each hazard. Specify the particular building or worksite where the alleged violation exists.

DESCRIPTION:

1. Staff members and inmate employees are required to consume food and/or beverages in an area with identified toxic material contamination in violation of 1910.141(g)(2). The UNICOR Warehouse lunchroom surfaces, including but not limited to tables, are contaminated with lead, cadmium, and barium from work processes, compressed air cleaning processes ~~and employee clothing. The lunchroom is not sealed off from the work area.~~

2. The food service facility and operations handling food consumed by staff members and inmate employees is not carried out in accordance with sound hygienic principles. The food dispensed is not processed, prepared, handled, and stored in such a manner as to be protected against contamination from lead, cadmium and barium particulate that disperses throughout the UNICOR warehouse from work processes, employee clothing and aerosolized particles resulting from compressed air utilized for cleaning. 1910.141(h)

3. The UNICOR warehouse triage, production and storage areas where staff members and inmate employees work are not kept clean tot he extent that the nature of the work allows. The work surfaces are contaminated with lead, cadmium and barium. 1910.141(a)(3)(i). Compressed air utilized to clean the work surfaces only aerosolized the particles where they spread and settle onto the work surface again as well as spread throughout the warehouse contaminating other areas.

4. Staff members and inmate employees exposed to lead, cadmium and barium are experiencing skin and eye irritation. They have not been provided with the PPE identified in the PPE hazard assessment to ensure protection from the absorption, inhalation or physical contact hazards with the identified chemicals. 1910.132(d)(1)(i)

5. Staff members and inmate employees working in the UNICOR warehouse are exposed to compressed air utilized for cleaning that exceeds 30 p.s.i. during use by inmates. 1910.242(b)

6. Staff members and inmate employees have not received effective information and training on cadmium and barium utilized in the UNICOR warehouse in accordance with 1910.1200(h)(2) and (3). No training on cadmium and barium has occurred.

7. Staff members and inmate employees assigned to UNICOR duties have not been informed upon first entering into employment and at least annually thereafter, of the requirements of 1910.1020(g)(1) including on the existence, location, and availability of any records covered by this section (sampling data including, but not limited to, air sampling and wipe sampling utilized to evaluate the presence of hazardous substances); identification of the person responsible for maintaining and providing access to the records; and each employees right of access to these records. 1910.1020(g)(1).

LOCATION:

Has this condition been brought to the attention of:	Employer
Please Indicate Your Desire:	Do NOT reveal my name to the Employer
The Undersigned believes that a violation of an Occupational Safety or Health standard exists which is a job safety or health hazard at the establishment named on this form.	D. Other

Complainant Name		Telephone	
Address(Street,City,State,Zip)			
Signature		Date	

If you are an authorized representative of employees affected by this complaint, please state the name of the organization that you represent and your title:

Organization Name: Your Title:

OFFICIAL USE ONLY:

Identification	Reporting ID	0317700	Previous Activity	0	Opt. Number	
	Establishment Name Change? ☐Yes ☐No		Site Address Change? ☐Yes ☐No	Employer ID	City Code: 4410	County Code: 119
Receipt Information	Received By		Send OSHA-7? ☐ Yes ☐ No	Date: 04/19/05 Time: AM PM	Supervisor(s) Assigned	K8559
Industry & Ownership	D. Federal Agency: 1503 - BUREAU OF PRISONS					
Complaint Evaluation	Evaluated By Is this a Valid Complaint? -- Yes Formality -- Non Formal Migrant Farmworker Camp? --		Subject/Severity Health-Serious			
Send Letter	Type: D1. Notification to Employer Without Certified Committee			Date Letter Sent: 04/20/05	Date Response Due: 05/23/05	
Received Letter	Type			Date Letter Received	Evaluation	Abatement Date
Complaint Action	Inspection Planned? No	If Yes, Priority:		If No, Reason:		
	Transfer To (Name)			Transfer Date		
	Transfer To Category					
Strategic Initiatives						
National Emphasis						
Local Emphasis						

Optional Information	Type	ID	Value
	N	10	PHONE

Close Complaint	

COMMENTS

OSHA 001555

U.S. Department of Labor

Occupational Safety and Health Administration
WILKES-BARRE AREA OFFICE
7 North Wilkes-BArre Blvd, Suite 410
Wilkes-Barre, PA 18702-5241

(570) 826-6538
(570) 821-4170

April 20, 2005

Mr. [redacted], Safety Manager
U.S. DEPT OF JUSTICE, USP LEWISBURG
P O Box 2000
Lewisburg, PA 17837

Dear [redacted]

On April 19, 2005, the Occupational Safety and Health Administration (OSHA) received a report of alleged hazardous working conditions in your workplace. The specific nature of the report involves:

1. Staff members and inmate employees are required to consume food and/or beverages in an area with identified toxic material contamination in violation of 1910.141(g)(2). The UNICOR Warehouse lunchroom surfaces, including but not limited to tables, are contaminated with lead, cadmium, and barium from work processes, compressed air cleaning processes and employee clothing. The lunchroom is not sealed off from the work area.

2. The food service facility and operations handling food consumed by staff members and inmate employees is not carried out in accordance with sound hygienic principles. The food dispensed is not processed, prepared, handled, and stored in such a manner as to be protected against contamination from lead, cadmium and barium particulate that disperses throughout the UNICOR warehouse from work processes, employee clothing and aerosolized particles resulting from compressed air utilized for cleaning. 1910.141(h)

3. The UNICOR warehouse triage, production and storage areas where staff members and inmate employees work are not kept clean tot he extent that the nature of the work allows. The work surfaces are contaminated with lead, cadmium and barium. 1910.141(a)(3)(i). Compressed air utilized to clean the work surfaces only aerosolized the particles where they spread and settle onto the work surface again as well as spread throughout the warehouse contaminating other areas.

4. Staff members and inmate employees exposed to lead, cadmium and barium are experiencing skin and eye irritation. They have not been provided with the PPE identified in the PPE hazard assessment to ensure protection from the absorption, inhalation or physical contact hazards with the identified chemicals. 1910.132(d)(1)(i)

5. Staff members and inmate employees working in the UNICOR warehouse are exposed to compressed air utilized for cleaning that exceeds 30 p.s.i. during use by inmates. 1910.242(b)

6. Staff members and inmate employees have not received effective information and training on cadmium and barium utilized in the UNICOR warehouse in accordance with 1910.1200(h)(2) and (3). No training on cadmium and barium has occurred.

7. Staff members and inmate employees assigned to UNICOR duties have not been informed upon first entering into employment and at least annually thereafter, of the requirements of 1910.1020(g)(1) including on the existence, location, and availability of any records covered by this section (sampling data including, but not limited to, air sampling and wipe sampling utilized to evaluate the presence of hazardous substances); identification of the person responsible for maintaining and providing access to the records; and each employees right of access to these records. 1910.1020(g)(1).

OSHA has decided not to conduct an inspection in response to this report. However, since allegations of the violation of standards have been made, you should investigate the alleged hazards. Department of Labor regulations (29 CFR 1960.28) require that your inspection be conducted within 3 working days for potentially serious conditions and within 20 working days for other-than-serious hazards. Any necessary correction(s) should be made within 30 calendar days after completion of the inspection. If correction(s) cannot be made within 30 calendar days, please provide me with a detailed abatement plan. Your plan should include:

(1) All steps taken and the dates of such action to achieve compliance during the prescribed abatement period.

(2) The specific additional abatement time estimated to achieve compliance.

(3) The reasons such additional time is necessary, including the unavailability of professional or technical personnel or of materials and equipment, or because necessary construction or alteration of facilities cannot be completed by the original abatement date.

(4) Interim steps being taken to safeguard the employees against the cited hazard during the abatement period.

Since the complainant has requested to remain anonymous, please advise me in writing, within 30 calendar days after completion of inspection, of your finding(s) and of any action you have taken. Your response should be detailed, stating specifically what corrective action(s), if any, were taken. If it is determined that, based on the report, no hazards exist and an inspection will not be conducted, please notify me in writing within 15 calendar days of receipt of this letter. We have notified the complainant that the complaint has been forwarded to you for action, and, if the hazard is not corrected, to notify us. We will forward a copy of your report to the complainant.

You should enclose any supporting documentation on the action(s) taken, such as monitoring results, new equipment orders, or photograph(s) of corrected condition.

If we do not receive a response from you within 30 calendar days, indicating that appropriate action has been taken or that no hazardous conditions exist, an OSHA inspection may be scheduled. In addition, it is OSHA policy to select for an inspection a random sample of cases where we have received letters from agencies which indicated satisfactory corrective action. Such inspections are to verify that the action described has actually been taken.

If you have any questions or need assistance concerning this matter, please contact our office.

Sincerely,

Andrew J. Hedesh
Area Director

AJH:lam
enclosure
cc:complaint file (204997704)

April 26, 2005

Andrew J. Hedesh, Area Director
Occupational Safety and Health Administration
7 North Wilkes-Barre Boulevard, Suite 410
Wilkes-Barre, PA

Dear Mr. Hedesh,

This correspondence is in response to the fax I received on April 22, 2005, an O.S.H.A. complaint, #204997704,regarding allegations on our Unicor Recycling Factory.

Investigation of these complaints revealed the following.

Allegation #1
Staff members and inmates are required to consume food and/or beverages in an area with identified toxic material contamination in violation of 1910.141(g)(2). The Unicor warehouse lunchroom surfaces, including but not limited to, tables, are contaminated with lead, cadmium, and barium from work, processes, compressed air cleaning processes and employee clothing. The lunchroom is not sealed off from the work area.

Response:
The results of our review indicate that we are not in violation of 1910.141(g)(2). The Unicor Recycling Factory does not have a lunchroom. Inmate workers eat lunch at the Federal Prison Camp Food Service. Unicor staff may eat in the staff dining room, staff lounge, in their office, or any dining establishment in close proximity to the institution. The Unicor Recycling Factory, through good work practices and isolation of the CRT glass breaking area, keeps the areas clean of cross contamination. Unicor recently purchased a cleaning product, "D-lead", to improve sanitation in this area. The use of compressed air to clean work surfaces is forbidden and monitored

by the Unicor staff members.

Allegation #2
The food service facility and operations handling food consumed by staff members and inmates is not carried out in accordance with sound hygienic principles. The food dispensed is not processed, prepared, handled, and stored in such a manner as to ve protected against contamination from lead, cadmium and barium particulate that disperses throughout the Unicor warehouse from work processes, employee clothing and aerosolized particles resulting from compressed air utilized for cleaning.

Response:
This allegation does not apply to this Unicor recycling factory. There is no lunchroom located in the Unicor recycling factory. The breaking of the glass is performed in an isolated area (see attached pictures.) The inmates who perform the glass breaking, utilized Tyvex suits, eye protection, gloves, safety shoes and PAPR. Upon completion of the glass breaking, the inmates clean themselves using a HEPA transporter. At no time do inmates clean with compressed air or are they allowed to eat or drink in this area.

Allegation #3
The Unicor warehouse triage, production and storage areas where staff members and inmates work are not kept clean to the extent that the nature of the work allows. The work surfaces are contaminated with lead, cadmium and barium, 1910.141(a)(3)(i). Compressed air utilized to clean work surfaces only aerosolized the particles where they spread and settle onto the work surface again as well as spread throughout the warehouse contaminating other areas.

Response:
The Unicor recycling factory, through good work practices and isolation of the CRT glass breaking area, keeps the areas clean of cross contamination. Unicor recently purchased a cleaning product "D-lead", to improve sanitation in this area. The use of compressed air to clean work surfaces is forbidden and monitored by the Unicor staff members. **Note:** See attached sampling documentation.

Allegation #4
Staff members and inmate employees exposed to lead, cadmium and barium are experiencing skin and eye irritation. They have not been provided with the PPE identified in the PPE hazard assessment to ensure protection from the absorption, inhalation, or physical contact hazards with the identified chemicals.

Response:
The Unicor recycling factory has not received any report or complaint of skin or eye irritation. The Safety Department monitors all inmate injury assessments which are completed by our medical staff each time an inmate is examined. PPE is being provided as listed in the hazard assessment for this area. (See Attached.)

Allegation #5
Staff members and inmates working in the Unicor warehouse are exposed to compressed air utilized for cleaning that exceeds 30 p.s.i., during use by inmates.

Response:
Inmates do not utilize compressed air when cleaning in this area. Two HEPA vacuums (see attached picture) are utilized at the CRT glass breaking station. Inmates who are performing work in the CRT glass breaking station do not have access to air lines.

Allegation #6
Staff members and inmates have not received effective information and training on cadmium and barium utilized in the Unicor warehouse in accordance with 1910.1200(h)(2) and (3). No training on cadmium and barium has occurred.

Response:
Hazard Communication training was provided for the Unicor recycling detail on March 14, 2005. Hazard communication is also provided upon initial assignment to any detail at the institution. Detailed training was provided to the workers who perform the CRT glass breaking operation on September 22, 2004. Training packets are being developed to specifically address the hazards from the CRT glass breaking operation which will be offered to all the employees who work in the Unicor recycling factory.

Allegation #7

Staff members and inmate employees assigned to Unicor duties have not been informed upon first entering into employment and at least annually thereafter, of the requirements of 1910.1020(g)(1) including on the existence, location, and availability of any records covered by this section (sampling data including, but not limited to, air sampling and wipe sampling utilized to evaluate the presence of hazardous substances); identification of the person responsible for maintaining and providing access to the records; and each employees right of access to these records.

Response:
The Unicor Factory Recovery Technician will ensure that staff and inmate employees are initially and annually notified of the existence, location, and availability of any records pertaining to work place exposures, including sampling data, medical evaluations/tests and the location/presence of hazardous materials. The information is being included in the inmate orientation and staff issued packets. Staff and inmates are to verify completion of initial and annual training by signing a signature sheet.

If I can be of further assistance regarding the response to this complaint, please feel free to call the Safety Department at 570-523-1251, ext. 136.

Sincerely,

/s/

[redacted]
Warden

714

U. S. Department of Labor
Occupational Safety and Health Administration
Wilkes-Barre Area Office
Suite 410, The Stegmaier Building
7 North Wilkes-Barre Area Office
Wilkes-Barre, PA 18702-5241
(570)826-6538

Referral Report

Reporting ID	0317700	Previous Activity	0		Referral Number	201376035	
Establishment Information	Establishment Name	U.S. DEPT OF JUSTICE, USP LEWISBURG			Employer ID		
	Site Address	RD#5 Lewisburg PA 17837			City Code	4410	County Code 119
		Site Phone	(570) 523-1251		Site Fax:	(570) 522-7746	
	Mailing Address	P O Box 2000 Lewisburg PA 17837					
		Mailing Address Phone	(570) 523-1251		Fax:		
Industry & Ownership	Type of Business		Primary SIC	9223	Primary NAICS	922140	No. of Employees 50
	Ownership	D. Federal Agency: 1503 - BUREAU OF PRISONS					
Source	Referred By	B. Federal OSHA			Date Received	10/10/06	
	Source or Contact (Name, Location, Affiliation, Telephone Number):						
Referral Classification	Health - Serious						

HAZARD DESCRIPTION:

Computer Recycling Operations

Employees are exposed to heavy metals, including lead, cadmium and beryllium from the breaking and/or recycling of cathode ray tubes (CRTs). Engineering controls, personal protective equipment, housekeeping, and medical programs may be deficient. Maintenance workers, during repair or maintenance of the systems, may be potentially exposed to heavy metals.

Eric Wolfgang - Compliance Safety and Health Officer
Phone (570) 826-6538, ext #15
FAX (215) 754-4221
e-mail: wolfgang.eric@dol.gov

OSHA-90 (2/96)

REFERRAL NARRATIVE
INSPECTION #- 310227467

This inspection was initiated as a result of a referral from the OSHA National Office regarding cathode ray tube (CRT) recycling operations at the U.S. Penitentiary in Lewisburg, PA. The referral alleged employees (inmates) are exposed to heavy metals, including lead, cadmium and beryllium, from the breaking and/or recycling of cathode ray tubes (CRT's). The initiation of this inspection was delayed because the old recycling building was demolished in 2006 and construction of a new facility was being completed. This inspection was initiated April 10, 2007.

Two employees work in the CRT breaking operation during any one work period. The Bureau of Prisons (BOP) has a work practice policy which directs no more than 4 hours of daily exposure to the breaking operation. Historical industrial hygiene surveys have shown that no employees are exposed to air contaminants above the OSHA PELs at this facility. Typically, the two affected employees will break CRTs either before or after their lunch period. Occasionally, the affected employees may work a short shift before lunch, as well as, a short shift after lunch.

Employees wear full faced, hooded, PAPR's with HEPA filters. Tyvek full body coveralls and several layers of gloves are worn. Layers include a leather/kevlar outer glove, kevlar sleeve-lets, and inner layer consisting of latex gloves. The kevlar sleeve-lets are to protect their lower arms from the sharp glass edges of the cathode ray tubes as they are being broken and handled. Steel toed boots with Tyvek outer booties are also worn.

Breaking of the CRT's occurs within an enclosed room. The room has no exhaust ventilation nor HVAC registers of any kind. Entrance to the room is via a door or through the front wall which is covered by clear plastic strap curtain (photo page 6). One small window is on the side of the room, and is also covered with plastic strap curtain.

Within the breaking room, two small booths are located side by side. Both booths have plastic strap curtains which extend out from each side and cover the face of the booth. The top of this space remains open. Each of these booths has a recirculating ventilation system which provides negative pressure to the outside, pulls air into the booth and filters it. The exhaust air is discharged back into the room (photo page 7 and 8). Their exhaust filters are equipped with both primary and secondary filters. The secondary filters are HEPA rated.

CRT's, both vacuum-intact, and those that may have already been broken in transit, are lifted by a third employee located outside the breaking room. They are manually lifted and passed through the room's curtained window onto a roller conveyor inside the room (photo page 6). This task is designated as "Runner". Typically a paper 1/2 mask dust respirator, Wilson CP1000, is worn by this employee. This respirator is not HEPA rated, but is a basic single strap dust respirator (also worn by a number of employees throughout the general disassembly areas of the UNICOR Recycling facility). The BOP did not fit test employees for these respirators. These employees were informed of the medical evaluation criteria under 1910.134.

The CRT's are pushed into the first booth, designated as Unit 1 B. One employee then reaches through the plastic curtain and breaks the funnel and neck of the CRT with a hammer. Once this is done, the face of the CRT is passed to the adjacent enclosure, designated as Unit 2B, where the face glass is broken. The goal of the two step breaking process is to separate the funnel and neck glass from the face glass. Occasionally, an electronic yolk, which surrounds the neck, is removed during the first breaking operation. This yolk is then handed back to the employee outside of the room through the curtained window.

As the CRT's are broken, the glass pieces fall through the grated opening of the work surface and into containers below. When filled, these containers are removed from the breaking room. The removal is performed by employees who are not in full PPE and do not wear respiratory protection. These material handlers briefly enter the breaking room to assist with switching of the full and empty containers. Prior to removing the containers, the breaking stops. The sides and other exposed surface areas of the containers are sprayed with liquid (de-lead) cleaner and wiped with cloths. Empty containers are brought in as replacements and the breaking continues to the end of the work time.

Typically, the two employees rotate between Unit 1B and Unit 2B about half way through the work shift. The duration of exposure is determined by inventory and available time on that day. Additionally, as noted earlier, daily exposure for any employee is not to exceed 4 hours. Review of past task logs and inventories revealed that this practice was being followed. Review of past logs revealed that the amount of CRT's broken on any particular day varies. This factor is determined by several inventory parameters. Since CRT's with similar attributes are grouped for the purpose of end product glass, daily inventory may vary. It was learned that CRT's are sorted by light color emitted during past operation. For example, monochromatic black and white CRT's would be separated. Monochromatic amber or green tubes also would be separated. Color tubes also were segregated.

Observations made during the breaking operation revealed slight visible dust being liberated from the CRT upon initial shattering. The dust appeared as fine light colored powder. The dust was quickly pulled into the filtering media of the Unit 1B enclosure. Some dust was observed during further breaking of the glass in Unit 2B. In all cases, no dust was observed leaving the booth enclosures. A review of the CRT manufacturing industries history revealed that the dust that is generated is generally comprised of the phosphor coating on the glass. Primarily the face glass is coated glass and the neck glass may or may not have similar coating. The phosphor coating chemical composition is generally that of metal oxides which exhibit light enhancing qualities. Given the violent decompression that occurs when the tube is shattered, any loose dust within the tube is disturbed. Further breaking of the glass disturbs the intact phosphor coating which, up until that point had remained adhered to the glass.

OSHA personal samples were analyzed for the following: Solder ICP (includes: copper, silver, beryllium, zinc, lead, cadmium, antimony, and tin), hexavalent chromium, yttrium, and total dust.

No dust was observed leaving the breaking room through the plastic curtain strips. None the less, it will be recommended that the room be placed under negative pressure with respect to the overall UNICOR Recycling Center. Some guidance on this control was provided to UNICOR.

In addition, HEPA filtration of any recycled air is highly recommended to prevent contaminants from being re-entrained.

A review of maintenance on the Unit 1B and 2B enclosures revealed that any filter changes were performed by the employees who were already in the full PPE as dictated for breaking operations. Filters were periodically discarded into sealed waste containers. As documented by the manufacturer's literature and physical attributes of the enclosure, filter changes are very easily performed and no acute dust exposures are expected. Manometers are mounted on both units and a set-point has been marked to indicate when filters are to be changed. No filter change was performed during the OSHA visit.

There is some potential for settled dust to be transported out of the breaking room on the bottom of employee shoes when the receptacles are removed by the material handlers. A tack mat could be placed on the floor immediately outside of the room, so that employees could clean their shoe bottoms prior to walking to other areas. The tack mat would also clean the wheel surfaces of the hand trucks which also enter the room during receptacle switch. The earlier industrial hygiene evaluations of such surface dust revealed that the amounts quantified via wipe samples were generally not above any applicable consensus standards. Given that no food is consumed in the UNICOR recycling areas, no health hazard is expected. Several bathrooms with sinks are also in the area so that employees can wash their hands.

At the end of the breaking operation, employees would clean the exterior of the units, receptacles, and other horizontal work surfaces. Typically these surfaces were sprayed with the liquid cleaner (de-lead) and wiped with cloths. A HEPA filtered vacuum was also used for cleaning of the floor.

After cleaning, the exposed employee would exit the area to an adjacent enclosed changing and washing room. Employees vacuumed off the exteriors of their PAPR hoods and entire body with a HEPA filtered vacuum. After vacuuming, they removed their PAPR, coveralls, gloves and booties. The coveralls, booties, and latex gloves were discarded. Their PAPR and leather outer gloves were cleaned with (de-lead) spray, after which they washed their hands.

The exposed employees then went to lunch. After lunch, these two employees worked outside of the breaking room. No further breaking was done after lunch. A review of the historical task and inventory records revealed that the day of OSHA sampling was representative of a typical day.

These two employees then performed manual disassembly of television and computer CRT's for the remainder of the day. This job task is referenced by UNICOR as "monitor teardown" or "general disassembly". One employee donned a Wilson CP1000 "dust mask", while the other wore no respiratory protection (photo page 10). The employees who perform monitor teardown, as well as all other employees in the Recycling Center, wear uniforms consisting of cotton long sleeved shirts and long pants. Most employees also wear cotton work gloves. These clothing articles are worn by the employees after leaving the Recycling Center at the end of the workshift. The clothing is laundered under BOP's regular procedures.

A review of the OSHA sampling results are as follows:

Hexavalent Chromium = non-detected

Yttrium = non-detected

Barium = non-detected

Total Particulate = 0.87 mg/M3 8 hour TWA or 5.8% of PEL
(0.39 mg/M3 concentration while in CRT breaking booth)
(2.14 mg/M3 concentration while in general disassembly area)

Lead = 6.19 ug/M3 8 hour TWA or 12% of PEL
(non-detected while in CRT breaking booth)
(all exposure incurred while in general disassembly area)

Cadmium = 0.68 ug/M3 8 hour TWA or 14% of PEL
(non-detected while in CRT breaking booth)
(all exposure incurred while in general disassembly area)

In evaluating the sample results, it is noted that employees receive a majority of particulate, lead and cadmium exposure while performing general disassembly work and only a small percentage of dust exposure in the CRT breaking booth. Noticeable dust was observed during general disassembly when CRT's (television picture tubes) were removed from their cabinetry. The heavy metal exposures incurred in the General Disassembly area, are from oxides of lead and cadmium. Visual dust is generated during rigorous handling of the appliances and sub parts. The source of the metal exposure is from the metallic soldered parts and connections, which are often severely disturbed during disassembly of the televisions, oscilloscopes and other CRT containing appliances. Since some appliances are 30 years old, oxides have no doubt formed on exposed solder and metallic surfaces. Once formed the flaky, dusty oxides are easily made airborne during handling. No compressed air is used to blow out the appliances during disassembly. Air hoses are present for the use of air tools. No blowing nozzles are present in the areas.

An additional source of exposure may be the tracking of lead and cadmium containing dust from the floor of the CRT breaking room. Employees and wheeled hand trucks enter the CRT breaking room to retrieve materials on a limited basis. Settled dust which may be on the floor is tracked out of the room and into the General Disassembly area. Whereas the floor of the CRT breaking room is cleaned with HEPA vacuums and D-Lead spray at the end of the shift, no such interim cleaning takes place. The entry and use of wheeled equipment is necessary throughout the breaking operation.

Brooms were used for floor cleaning in the General Disassembly area. Brooms are specifically prohibited in the CRT breaking room. Several floor pedestal fans were noted in the General Disassembly area. D-Lead cleaning spray and cloths are used to clean bench surfaces and counter tops.

A citation will be proposed under the lead and cadmium standards for lack of appropriate housekeeping to control dust which accumulates on the work benches and floors of the General Disassembly areas. The use of brooms is not a satisfactory means of cleaning and may exacerbate the lead and cadmium exposures. The use of HEPA vacuums, tack cloth or D-Lead spray will be recommended for housekeeping. HEPA vacuums can also be used to vacuum out any highly dusty appliance interiors upon initial cabinet removal. HEPA vacuums can also be used to clean the floor of the General Disassembly area.

The proposed citation will also address potential migration of lead and cadmium from the CRT breaking room to the General Disassembly area. The use of tack mats will be recommended for cleaning the bottom of shoes, as an abatement method. Given the small degree of contamination and exposures below the Action Level (AL), the employer is not required to implement feasible engineering or administrative controls.

A 5(a)(1) letter of recommendation will be sent to the employer to address a potential heat stress hazard. Currently, no air exchange occurs in the CRT breaking room and workers wear heavy full body coverings. During hot days, employees may be at risk to potential heat stress. The installation of a HVAC system within the CRT breaking room can also assist in providing the room with negative pressure to prevent any potential contamination leakage to the outside.

U. S. Department of L
Occupational Safety and Health Administration

Worksheet

Fri Jul 20, 2007 4:17pm

Inspection Number	310227467
Opt. Insp. Number	671

Establishment Name	U.S. DEPT OF JUSTICE, USP LEWISBURG				
Type of Violation	S Serious	Citation Number	01	Item/Group	001 (a)
Number Exposed	8	No. Instances	3	REC	R Referral
Std. Alleged Vio.	1910.1025(h)(1)				

Abatement Period	MultiStep Abatements			Final Abatement	Action Type/Dates
	PPE Period	Plan	Report		
60					
Abatement Documentation Required		Y	Date Verified		

Substance Codes	1591 - LEAD, INORGANIC FUMES & DUSTS (AS PB)(PEL)

AVD/Variable Information:

29 CFR 1910.1025 (h)(1) All surfaces shall be maintained as free as practicable of accumulations of lead:

a) UNICOR Electronics Recycling Center, General Disassembly Area; an individual was exposed to lead at an 8 hour time weighted average of 6.19 $\mu g/M^3$ and dry sweeping of the floor with a push broom was observed in the immediate area, April 18, 2007.

b) UNICOR Electronics Recycling Center, General Disassembly Area; an individual was exposed to lead at an 8 hour time weighted average of 6.19 $\mu g/M^3$ and high volume pedestal floor cooling fans were observed in the immediate area, April 18, 2007.

c) UNICOR Electronics Recycling Center, General Disassembly Area; an individual was exposed to lead at an 8 hour time weighted average of 6.19 $\mu g/M^3$. Individuals were observed walking within and using wheeled carts to remove equipment from the CRT Breaking Booth. The shoe soles of employees and wheels of equipment were not cleaned prior to leaving the CRT Breaking Booth. This allowed the tracking of settled dust from the floor of the CRT Breaking Booth to the adjacent General Disassembly Area, April 18, 2007.

ABATEMENT NOTE:

Instance a) Dry sweeping shall be prohibited in this area. The cleaning of floors via HEPA vacuums and the use of D-LEAD®, or other suitable liquid, is an acceptable means of cleaning the floors.

Instance b) The pedestal fans shall be removed from this area. The high volume of air generated by these units is capable of blowing dust from the floors and other surfaces into the breathing zones of the individuals. The use of slow speed ceiling fans is an acceptable means of providing general ventilation.

Instance c) The placement of adhesive tack floor mats at the open edge of the CRT Breaking Booth, is an acceptable means of control. The placement of additional mats at the two main egresses of the General Disassembly area is highly recommended. The manufacturer's replacement and disposal schedule shall be followed.

"ABATEMENT CERTIFICATION AND DOCUMENTATION REQUIRED"

Penalty Calculations				Adjustment Factors			Proposed Adjusted Penalty
Severity	Probability	Gravity	GBP	Size	Good Faith	History	
L Low	L Lesser	01	1500.00	0	15	0	0.00
Repeat Factor		0					

Employee Exposure:					
Occupation	Inmate	Employer	US Dept of Justice		
Nr of Employees	8	Duration	one month	Frequency	8 hrs/day
Employee Name	[redacted]				
Address	RD#5 Lewisburg, PA 17837		Phone	(570)523-1251	
Occupation	Inmate	Employer	US Dept of Justice		
Nr of Employees	8	Duration	one month	Frequency	8 hrs/day
Employee Name	[redacted]				
Address	RD#5 Lewisburg, PA 17837		Phone	(570)523-1251	

Instance Description:	A. Hazard	B. Equipment	C. Location	D. Injury/Illness	E. Measurements

4. Date/Time
4/17/07 photos 1 through 10 (photos taken by BOP)

20. Instance Description - Describe the following:

a) Hazards-Operation/Condition-Accident; see AVD Lead dust is present in the General Disassembly area. A slight amount is generated by disassembly operations. Additional slight amounts are tracked into the area from the shoe soles and equipment wheels which travel from the CRT Breaking Booth. Dry sweeping of the General Disassembly area floor was observed which disturbs settled dust and makes it airborne. High powered floor pedestal cooling fans were observed. Interview revealed that they are occasionally used for cooling. Their usage would disturb settled dust and make it airborne.

b) Equipment; CRT Breaking Booth, work floors in the General Disassembly Area
c) Location; General Disassembly Area
d) Injury/Illness; low level lead inhalation exposure
e) Measurements; 6.19 ug/M3 8 hour TWA or 12% of PEL

21. Photo Number	Location on Video
	(X)see #4 () N/A

23. Employer Knowledge : In response to lead exposures, a controlled breaking booth has been installed. Within the booth, all applicable measures are used for airborne and settled dust exposures. The employer can use similar measures for areas outside of the breaking booth.

24. Comments (Employer, Employee, Closing Conference) : Safety Manager, [redacted] indicated that they would follow the recommendations.

25. Other Employer Information : N/A

26. Classification:				
Serious	Knowledge	S or O	Repeat?	Willful?
YES	YES	S	NO	NO

First Repeat	Second Repeat	Repeat Penalty
N/A	N/A	N/A

Event Date	Event Code	Action Code	Citation Type	Penalty	Abate Date	Final Order
	Z Add transaction	**A Add**	**S Serious**	**0.00**		

OSHA002150

U. S. Department of Labor
Occupational Safety and Health Administration

Worksheet

Fri Jul 20, 2007 4:17pm

Inspection Number	310227467
Opt. Insp. Number	671

Establishment Name	U.S. DEPT OF JUSTICE, USP LEWISBURG				
Type of Violation	S Serious	Citation Number	01	Item/Group	001 (b)
Number Exposed	8	No. Instances	3	REC	R Referral
Std. Alleged Vio.	1910.1027(k)(1)				

Abatement Period	MultiStep Abatements			Final Abatement	Action Type/Dates
	PPE Period	Plan	Report		
60					

Abatement Documentation Required	Y	Date Verified		

Substance Codes	C141 - CADMIUM (TWA)

AVD/Variable Information:

29 CFR 1910.1027 (k)(1) All surfaces shall be maintained as free as practicable of accumulations of cadmium:

a) UNICOR Electronics Recycling Center, General Disassembly Area; an individual was exposed to cadmium at an 8 hour time weighted average of 0.68 $\mu g/M^3$ and dry sweeping of the floor with a push broom was observed in the immediate area, April 18, 2007.

b) UNICOR Electronics Recycling Center, General Disassembly Area; an individual was exposed to cadmium at an 8 hour time weighted average of 0.68 $\mu g/M^3$ and high volume pedestal floor cooling fans were observed in the immediate area, April 18, 2007.

c) UNICOR Electronics Recycling Center, General Disassembly Area; an individual was exposed to cadmium at an 8 hour time weighted average of 0.68 $\mu g/M^3$. Individuals were observed walking within and using wheeled carts to remove equipment from the CRT Breaking Booth. The shoe soles of employees and wheels of equipment were not cleaned prior to leaving the CRT Breaking Booth. This allowed the tracking of settled dust from the floor of the CRT Breaking Booth to the adjacent General Disassembly Area, April 18, 2007.

ABATEMENT NOTE:

Instance a) Dry sweeping shall be prohibited in this area. The cleaning of floors via HEPA vacuums and the use of D-LEAD*, or other suitable liquid, is an acceptable means of cleaning the floors.

Instance b) The pedestal fans shall be removed from this area. The high volume of air generated by these units is capable of blowing dust from the floors and other surfaces into the breathing zones of the individuals. The use of slow speed ceiling fans is an acceptable means of providing general ventilation.

Instance c) The placement of adhesive tack floor mats at the open edge of the CRT Breaking Booth, is an acceptable means of control. The placement of additional mats at the two main egresses of the General Disassembly area is highly recommended. The manufacturer's replacement and disposal schedule shall be followed.

"ABATEMENT CERTIFICATION AND DOCUMENTATION REQUIRED"

Penalty Calculations				Adjustment Factors			Proposed Adjusted Penalty
Severity	Probability	Gravity	GBP	Size	Good Faith	History	
L Low	L Lesser	01	1500.00	0	15	0	0.00
Repeat Factor		0					

Employee Exposure:					
Occupation	Inmate	Employer	US Dept of Justice		
Nr of Employees	8	Duration	one month	Frequency	8 hrs/day
Employee Name	[redacted]				
Address	RD#5 Lewisburg, PA 17837		Phone	(570)523-1251	
Occupation	Inmate	Employer	US Dept of Justice		
Nr of Employees	8	Duration	one month	Frequency	8 hrs/day
Employee Name	[redacted]				
Address	RD#5 Lewisburg, PA 17837		Phone	(570)523-1251	

Instance Description:	A. Hazard	B. Equipment	C. Location	D. Injury/Illness	E. Measurements

4. Date/Time
4/17/07 photos 1 through 10 (photos taken by BOP)

20. Instance Description - Describe the following:

a) Hazards-Operation/Condition-Accident; see AVD cadmium dust is present in the General Disassembly area. A slight amount is generated by disassembly operations. Additional slight amounts are tracked into the area from the shoe soles and equipment wheels which travel from the CRT Breaking Booth. Dry sweeping of the General Disassembly area floor was observed which disturbs settled dust and makes it airborne. High powered floor pedestal cooling fans were observed. Interview revealed that they are occasionally used for cooling. Their usage would disturb settled dust and make it airborne.

b) Equipment; CRT Breaking Booth, work floors in the General Disassembly Area
c) Location; General Disassembly Area
d) Injury/Illness; low level cadmium inhalation exposure
e) Measurements; 0.68 ug/M3 8 hour TWA or 14% of PEL

21. Photo Number	Location on Video
	(X)see #4 () N/A

23. Employer Knowledge : In response to lead and cadmium exposures, a controlled breaking booth has been installed. Within the booth, all applicable measures are used for airborne and settled dust exposures. The employer can use similar measures for areas outside of the breaking booth.

24. Comments (Employer, Employee, Closing Conference) : Safety Manager, [redacted] indicated that they would follow the recommendations.

25. Other Employer Information : N/A

26. Classification:				
Serious	Knowledge	S or O	Repeat?	Willful?
YES	YES	S	NO	NO

First Repeat	Second Repeat	Repeat Penalty
N/A	N/A	N/A

Event Date	Event Code	Action Code	Citation Type	Penalty	Abate Date	Final Order
	Z Add transaction	A Add	S Serious	0.00		

OSHA002153

U.S. Department of Labor
Occupational Safety and Health Administration

OSHA-200 Data/Safety and Health Program Evaluation

Sun Apr 8, 2007 9:07pm

Establishment Name	U.S. DEPT OF JUSTICE, USP LEWISBURG			Ownership	D. Federal Agency
Site Address	RD#5 Lewisburg, PA 17837	Site Phone	[redacted]	Site FAX	[redacted]
Mailing Address	P O Box 1000 Lewisburg, PA 17837	Mailing Phone	[redacted]	Mailing FAX	
Controlling Corp				Employer ID	

SUMMARY OSHA-200 DATA				Data Not Available	X	Partial Log Year		# Of Weeks	0
LWDI RATE		LWDII RATE		Log Year	2000	Employment Average	0	Total Hours Worked	0

Occupational Injury Cases						Occupational Illness Cases												
(1) Nbr. of Fatality Dates	(2) Lost Workday Cases	(3) Cases With Days Away	(4) Nbr. of Days Away	(5) Restricted Workdays	(6) Cases w/o Lost Workdays	(7a) Skin Diseases/ Disorders	(7b) Dust Diseases (Lungs)	(7c) Respiratory Toxic Agents	(7d) Poisons	(7e) Disorders Physical Agents	(7f) Repeat Trauma	(7g) Other	(8) Nbr. of Fatality Dates	(9) Lost Workday Cases	(10) Cases With Days Away	(11) Nbr. of Days Away	(12) Restricted Workdays	(13) Cases w/o Lost Workdays
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SUMMARY OSHA-200 DATA				Data Not Available	X	Partial Log Year		# Of Weeks	0
LWDI RATE		LWDII RATE		Log Year	1999	Employment Average	0	Total Hours Worked	0

Occupational Injury Cases						Occupational Illness Cases												
(1) Nbr. of Fatality Dates	(2) Lost Workday Cases	(3) Cases With Days Away	(4) Nbr. of Days Away	(5) Restricted Workdays	(6) Cases w/o Lost Workdays	(7a) Skin Diseases/ Disorders	(7b) Dust Diseases (Lungs)	(7c) Respiratory Toxic Agents	(7d) Poisons	(7e) Disorders Physical Agents	(7f) Repeat Trauma	(7g) Other	(8) Nbr. of Fatality Dates	(9) Lost Workday Cases	(10) Cases With Days Away	(11) Nbr. of Days Away	(12) Restricted Workdays	(13) Cases w/o Lost Workdays
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SUMMARY OSHA-200 DATA				Data Not Available	X	Partial Log Year		# Of Weeks	0
LWDI RATE		LWDII RATE		Log Year	1998	Employment Average	0	Total Hours Worked	0

Occupational Injury Cases						Occupational Illness Cases												
(1) Nbr. of Fatality Dates	(2) Lost Workday Cases	(3) Cases With Days Away	(4) Nbr. of Days Away	(5) Restricted Workdays	(6) Cases w/o Lost Workdays	(7a) Skin Diseases/ Disorders	(7b) Dust Diseases (Lungs)	(7c) Respiratory Toxic Agents	(7d) Poisons	(7e) Disorders Physical Agents	(7f) Repeat Trauma	(7g) Other	(8) Nbr. of Fatality Dates	(9) Lost Workday Cases	(10) Cases With Days Away	(11) Nbr. of Days Away	(12) Restricted Workdays	(13) Cases w/o Lost Workdays
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

U. S. Department of L[illegible]r
Occupational Safety and Health Administration

Worksheet

Sun Apr 8, 2007 9:08pm

Inspection Number	310225305
Opt. Insp. Number	658

Establishment Name	U.S. DEPT OF JUSTICE, USP LEWISBURG				
Type of Violation	O Other	Citation Number	01	Item/Group	001
Number Exposed	1	No. Instances	1	REC	R Referral
Std. Alleged Vio.	1910.0134(h)(4)(ii)				

Abatement Period	MultiStep Abatements			Final Abatement	Action Type/Dates	
	PPE Period	Plan	Report			
15				11/27/06	A Abatement Due	03/01/07
Abatement Documentation Required		Y	Date Verified			

Substance Codes	0310 - BARIUM (SOLUBLE COMPOUNDS) 0360 - BERYLLIUM & COMPOUNDS C142 - CADMIUM (ACTION LEVEL) 1592 - LEAD, INORGANIC FUME & DUST (ACTION LEVEL)

AVD/Variable Information:

OLD VIOLATION

29 CFR 1910.134(h)(4)(ii): Repairs to respirators were not made according to the manufacturer's recommendations and specifications for the type and extent of repairs to be performed.

a) Unicor Recycling Factory, USP Lewisburg: Employees wore Neoterik model MB-14 powered air purifying hooded respirators for protection against potential exposure to low levels of barium, beryllium, cadmium and lead. One respirator was observed with an installed replacement facepiece manufactured by a different manufacturer - US Safety Headgear Inc. This use of a non-original equipment manufacturer, replacement facepiece, voided the NIOSH Certified Equipment Listing Approval number TC-21C-402, October 18, 2006.

"ABATEMENT CERTIFICATION AND DOCUMENTATION REQUIRED"

ABATEMENT NOTE: This deficiency can be corrected by using the original equipment manufacturer's part # 815-M40, for future replacement of facepieces.

Penalty Calculations				Adjustment Factors			Proposed Adjusted Penalty
Severity	Probability	Gravity	GBP	Size	Good Faith	History	
N Minimal	L Lesser	01	0.00	0	15	10	0.00
Repeat Factor		0					

Employee Exposure:					
Occupation	Recycling Technician	Employer	USP		
Nr of Employees	4	Duration	3 years	Frequency	2 to 4 hrs/day
Employee Name	[redacted]				
Address	Post Office Box 2000 Lewisburg, PA 17837	Phone	[redacted]		

OSHA002250

Instance Description:	A. Hazard	B. Equipment	C. Location	D. Injury/Illness	E. Measurements

4. Date/Time
10/18/2006 10:00am

20. Instance Description - Describe the following:

a) Hazards-Operation/Condition-Accident; Employees wore loose fitting, hooded PAPRs for protection against exposure to low levels of barium, beryllium, cadmium and lead at levels less than 10% of the PELs. Over time and use, the plastic facepieces were becoming scratched, and the visual qualities were being reduced. One Neoterik MB14 PAPR was observed as having a replacement faceshield with the markings of another manufacturer. A total of 4 or 5 such PAPRs are used in the facility. The other units were packed away given the total rehabilitation of the facility, and were not examined. Upon investigation, it was learned that UNICOR had difficulty obtaining original equipment manufacturer (OEM), facepieces from Neoterick Company. As an alternative, the faceshield of another manufacturer was modified to fit the soft hood of the respirator, thus voiding the NIOSH CEL approval. They used the US Safety Headgear "Double Matrix", as a substitute given it similar physical dimensions and ANSI Z 87 rating. The manufacturer of the Neoterik respirator, Global Secure Safety, was contacted. This particular model of respirator has a NIOSH TC # of TC-21C-402. A product specialist of the manufacturer, [redacted] stated that their company does not recommend that the facepiece be replaced with any other manufacturer's facepiece, and is aware that such a practice would void the CEL approval.

OSHA Instruction CPL 2-0.120, Inspection Procedures for the Respiratory Protection Standard, para VIII(D)(5) permits the citation of respirator maintenance violations for all situations where respirator use is elected - regardless of exposure levels. Additionally, para VII (e)(2), permits citation of unapproved respirators, even when an over-exposure has not been established.

b) Equipment; Neoterik MB14 PAPR respirator with Supertop Hood, with non-approved replacement facepiece

c) Location; UNICOR Recycling Factory

d) Injury/Illness; exposure to low levels of heavy metals > no serious health effects expected

e) Measurements; N/A

21. Photo Number	Location on Video
	()see #4 (X) N/A

23. Employer Knowledge : The Production Controller stated that they had difficulty procuring replacement face pieces directly from the OEM. They used the US Safety Headgear "Double Matrix", as a substitute given it similar physical dimensions and ANSI Z 87 rating.

24. Comments (Employer, Employee, Closing Conference) :

OSHA002251

The Safety Manager replied that they would immediately cease this practice and only use OEM replacement parts.

25. Other Employer Information : N/A

26. Classification:				
Serious	Knowledge	S or O	Repeat?	Willful?
NO	YES	O	NO	NO

First Repeat	Second Repeat	Repeat Penalty
N/A	N/A	N/A

Event Date	Event Code	Action Code	Citation Type	Penalty	Abate Date	Final Order
11/06/06	**Z Add transaction**	**A Add**	**O Other**	**0.00**	**11/27/06**	

U.S. Department of Labor

Occupational Safety and Health Administration
WILKES-BARRE AREA OFFICE
7 North Wilkes-Barre Boulevard, Suite 410
Wilkes-Barre, PA 18702-5241

(570) 826-6538
Fax (570) 821-4170

August 6, 2007

Mr. [redacted] Safety Manager
U.S. Department of Justice, USP Lewisburg
Post Office Box 1000
Lewisburg, PA 17837

Dear [redacted]

An inspection of your workplace on April 18, 2007 disclosed the following potential hazards:

> Individuals working within the CRT breaking room, of the UNICOR Electronics Recycling Center, were observed performing heavy arm and upper body work while wearing several layers of full body protective clothing. The CRT breaking room is not ventilated and no powered air exchanges take place during its operation. A potential for heat stress exists for the individuals who work in this area.

Since no OSHA standard applies and it is not considered appropriate at this time to invoke Section 5(a)(1), the general duty clause of the Occupational Safety and Health Act, no citation will be issued for these hazards.

In the interest of workplace safety and health, however, I recommend that some corrective action be taken to address the observed potential hazards.

It is suggested that a ventilation system be added to the CRT breaking room to facilitate powered air exchanges. Air conditioning capability must be part of the system. The rate of exhaust from the room should be slightly higher than the input so that the area is under negative pressure in relation to it's exterior. This will prevent migration of fugitive dust from the enclosure into the adjacent work areas. It was noted that the airborne levels of lead, cadmium, yttrium, and hexavalent chromium within the CRT breaking room, did not exceed laboratory detection levels. However, the potential exists for fugitive heavy metal dust to be generated in the room, such that any powered exhaust would transfer it out to the exterior. As such, it is highly recommended that the exhaust air duct work be filtered with low restriction HEPA filtering media. This will prevent any heavy metal dust migration outside of the room. Filter change procedures and disposal methods shall be in accordance with your procedures already in place for the handling of the 1B and 2B Breaking Unit enclosures. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) offers several technical guidance documents on the installation of air handling systems suited for such use in your facility. The information can be obtained directly from ASHRAE via the Internet at http://www.ashrae.org/ or telephone (800) 527-4723.

During the OSHA visit, full shift air sampling was conducted for CRT Breaking and work conducted within the General Disassembly area outside of the CRT Breaking Booth. The following is a table of the

OSHA sampling results. As noted, there were no exposures above the OSHA Permissible Exposure Limits.

JOB TITLE	CONTAMINANT	EXPOSURE LEVEL – 8 hour Time Weighted Average	PERMISSIBLE EXPOSURE LIMIT	DETECTION LIMIT
CRT Breaker	Total Dust	0.87 mg/M^3	15 mg/M^3	0.01 mg
CRT Breaker	Lead	6.19 $\Phi g/M^3$	50 $\Phi g/M^3$	2.5 Φg
CRT Breaker	Cadmium	0.68 $\Phi g/M^3$	5 $\Phi g/M^3$	0.25 Φg
CRT Breaker	Yttrium	Non-detected	1 mg/M^3	5.0 Φg
CRT Breaker	Hexavalent Chromium	Non-detected	5 $\Phi g/M^3$	0.02 Φg
CRT Breaker	Barium	Non-detected	0.5 mg/M^3	5.0 Φg

* mg/M^3 = milligrams per cubic meter of air
* $\Phi g/M^3$ = micrograms per cubic meter of air
* Φg = micrograms per sample

Respectfully,

Andrew J. Hedesh
Area Director

cc: Case file 310227467
Union Local 148

Justice

U.S. Department of

Federal Prison System
United States Penitentiary

Office of the Warden

2400 Robert Miller Drive
Lewisburg, Pennsylvania 17837

August 23, 2007

Andrew J. Hedesh, Area Director
Occupational Safety and Health Administration
Wilkes-Barre Area Office
7 North Wilkes-Barre Boulevard, Suite 410
Wilkes-Barre, PA 18702-5241

OSHA CASE FILE 310227467
(dated: August 6, 2007)

Dear Mr. Hedesh

This correspondence is in response to your Citation concerning Notice of Unsafe or Unhealthful Working Conditions at the Federal Prison Industries, Lewisburg, PA.

The United States Penitentiary Lewisburg, PA, operates a Federal Prisons Industries (UNICOR) Computer Recycling Program. The Satellite Prison Camp employs 74 inmates in the UNICOR program.

UNICOR's unique, full-service recycling program is an integrated part of national e-scrap solution for obsolete electronics. UNICOR's processing methods begin with receiving, testing, and auditing the equipment. Equipment is first assessed to determine whether it can be used for its original purpose. If reuse is not an option, the equipment is then de-manufactured for recycling. Non-functional equipment is mined for functional components such as memory, wire, circuit boards, mice, and Ethernet cards before it is de-manufactured. Using a method called single-stream recycling, non-functioning equipment is broken down into residual materials.

If I can provide you with any additional information, please advise.

Sincerely,

Warden,

Attached is a detail response of your letter, dated August 6, 2007.

Citation 1. Item 1a: Type of Violation: Serious

29 CFR 1910.1025 (h)(1) All surfaces shall be maintained as free as practicable of accumulations of lead:

a) **UNICOR Electronics Recycling Center, General Disassembly Area; an individual was exposed to lead at an 8 hour time weighted average of 6.19 hg/M and dry sweeping of the floor with a push broom was observed in the immediate area, April 18, 2007.**

RESPONSE:

No Dry Sweeping signs will be posted in all disassembly areas. Workers will have spray bottles with H2O to lightly mist the floor before sweeping. D-Lead (clean agent) is then used to clean floors and work benches. All workers will be given training in Personal Hygiene & Clean Up Procedures at a Town Hall meeting to include an signature acknowledgment sheet for the material covered.

b) **UNICOR Electronics Recycling Center, General Disassembly Area; an individual was exposed to lead at 8 hour time weighted average 6.19 hg/M and high volume pedestal floor cooling fans were observed in the immediate area, April 18, 2007.**

RESPONSE:

The pedestal floor fans will be removed from the disassembly areas and air conditioning will be used in the disassembly area. The first set of filters to be changed out of the air conditioning unit will be sent out to be TCLP tested for heavy metals. Until, it is determined the method of disposition of the filters, all personnel performing the filter change will use Personal Protective Equipment.

c) **UNICOR Electronics Recycling Center, General Disassembly Area; an individual was exposed to lead at an 8 hour time weighted average of 6.19 hg/M. Individuals were observed walking within and using wheeled carts to remove equipment from the CRT Breaking Booth. The shoe soles of employees and wheels of equipment were not cleaned prior to leaving the CRT Breaking Booth to the adjacent General Disassembly Area, April 18, 2007.**

RESPONSE

Tack mats will be placed at the entrance open edge of the glass breaking booth. The carts will roll over the adhesive tack mats when exiting the booth removing any dust particles. Mats will be placed at the two egresses for all CRT booth workers to step on after removing their booties that are worn in the booth. The tear offs from the adhesive tack mats will be disposed of with the hazardous waste.

FCI MARIANNA

DEPARTMENT OF HEALTH & HUMAN SERVICES

Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

EVALUATION OF ENVIRONMENTAL, SAFETY, AND HEALTH INFORMATION RELATED TO UNICOR E-WASTE RECYCLING OPERATIONS AT FCI MARIANNA

PREPARED FOR THE UNITED STATES DEPARTMENT OF JUSTICE
OFFICE OF THE INSPECTOR GENERAL

Submitted to: [redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
U.S. Department of Justice

Submitted by: Mr. George Bearer, CIH
FOH Safety and Health Investigation Team
Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

April 28, 2010

Table of Contents

Figures

Tables

Images

Attachments

Enclosures

1.0 INTRODUCTION

At the request of the U.S. Department of Justice (DOJ) Office of the Inspector General (OIG), the Federal Occupational Health Service (FOH) coordinated environmental, safety and health (ES&H) assessments of electronics equipment recycling operations at a number of Federal Bureau of Prisons (BOP) facilities around the country. The assessments were conducted as a result of whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium at electronics recycling operations overseen by Federal Prison Industries (UNICOR).[1] The allegations stated that these exposures were occurring from the breaking of cathode ray tubes (CRTs) and other activities associated with the handling, disassembly, recovery, and recycling of electronic components found in equipment such as computers and televisions (i.e., e-waste). [2] It was further alleged that appropriate corrective actions had not yet been taken by BOP and UNICOR officials and that significant risks to human health and the environment remained.

This FOH report[3] consolidates and presents the findings of technical assessments performed at UNICOR's e-waste recycling operations at the Federal Correctional Institution in Marianna, Florida (FCI Marianna) by industrial hygienists and other environmental and safety and health specialists representing federal agencies including FOH, the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH) Division of Applied Research and Technology (DART), NIOSH Division of Surveillance Hazard Evaluation and Field Studies/Hazard Evaluations and Technical Assistance Branch (DSHEFS/HETAB), and the Occupational Safety and Health Administration (OSHA). Reports and field data from these agencies are presented in the attachments and enclosures to this report (see references for these reports in Section 7.0). The primary objectives of these assessments were to characterize current UNICOR operations and working conditions at FCI Marianna in light of the whistleblower allegations and to identify where worker exposures, environmental contamination/degradation, and violations of governmental regulations and BOP policies may still exist so that prompt corrective actions may be taken where appropriate. In addition, this FOH report also relies upon information from documents assembled by the OIG which were developed by various consultants, regulatory agencies, BOP and UNICOR staff.

The overall purpose of this report is to characterize current operations and working conditions at FCI Marianna (i.e., 2003 to present) especially with respect to the potential

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[1] FPI, (commonly referred to by its trade name UNICOR) is a wholly-owned, Government corporation that operates factories and employs inmates at federal correctional institutions.

[2] E-Waste is defined as a waste type consisting of any broken or unwanted electrical or electronic device or component.

[3] FOH prepared this report in June 2009 and its findings and conclusions address e-waste recycling conditions known to FOH at that time. FOH provided the report to the OIG, which shared it with the BOP and sought feedback on it. The BOP and UNICOR later provided their comments to FOH about the report's contents, which resulted in FOH making limited changes to some text and figures, as reflected herein.

for inmate and staff exposures[4] that may result from present day e-recycling activities as well as from legacy contamination on building components from e-recycling operations which took place in the past. This report consolidates findings from those contributing to the OIG investigation and evaluates additional information assembled regarding BOP and UNICOR recycling operations (e.g., consultant reports, programs and procedures, and various records and documents). Conclusions and recommendations presented in this report are based on the entire body of available reports, data, documents, interviews, and other information.

FCI Marianna is one of eight BOP institutions that have ongoing e-waste recycling operations for which an assessment report has been or will be prepared by FOH. On October 10, 2008, FOH issued a separate report entitled "*Evaluation of Environmental, Safety, and Health Information Related to Current UNICOR E-Waste Recycling Operations at FCI Elkton*" detailing current exposure conditions at FCI Elkton. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, pertinent regulatory requirements, and other information that provides additional context to this report on FCI Marianna. FOH will be preparing assessment reports for the remaining BOP institutions that perform recycling upon completion of their respective ES&H assessments.

Currently, e-waste recycling operations at FCI Marianna involve receipt of waste electronics from various locations around the country, disassembly and sorting activities ('breakdown'), and the associated material handling and facilities maintenance required to support these operations. Although glass breaking was suspended in February 2008, this report also addresses the glass breaking operation as it was conducted during the field activities performed by FOH and NIOSH/DART in August 2007. FCI Marianna recycling facilities and operations are described below in Section 2.0 in greater detail.

2.0 UNICOR E-WASTE RECYCLING FACILITIES AND OPERATIONS AT FCI MARIANNA

UNICOR e-waste recycling operations commenced at FCI Marianna in 1996 as a pilot project. As the operation grew, it was moved in 1998 to an offsite leased building, known as the Blue Building. Some UNICOR staff and inmates reported that computer monitors were broken in Gaylord boxes in the back of semi-trailers while work was underway in the Blue Building; however, others disputed this assertion. In approximately 1999, a demilitarization (demil) operation was started at the Federal Prison Camp (FPC) that involved disassembly and refurbishment of electronics from local military bases. The demil operation was closed in 2001. Blue Building operations were transitioned to another offsite leased building known as the Gold Building in mid-2001. Then in August

[4] In this report, the term "exposure" refers to the airborne concentration of a contaminant (e.g., lead or cadmium) that is measured in the breathing zone of a worker but outside of any respiratory protection devices used. Unless otherwise noted, "exposure" should not be confused with the ingestion, inhalation, absorption, or other bodily uptake of a contaminant. Concentrations reported and discussed in this report are not adjusted based on respirator protection factors. However, when reported, it is indicated whether the exposure was within the protective capacity of the respirator.

2002, UNICOR began transitioning and expanding its operations to the FPC and the FCI's main compound from the Gold Building. Operations began at the FCI in late 2002. These operations involved computer disassembly and monitor refurbishment, including sanding of the plastic that encases the monitor. Beginning in late 2005, CRT glass breaking was performed at the FPC using a glass breaking booth with high efficiency particulate air (HEPA) filtration under a conditional air permitting exemption issued by the Florida Department of Environmental Protection. Based on a decision by an FCI Marianna Associate Warden, glass breaking was suspended in February 2008 and has not been restarted. Disassembly of computer monitors continues at FCI Marianna, but CRTs (i.e., the glass tubes) are then shipped whole to a private recycling company. De-soldering and chip recovery have never been performed at FCI Marianna according to the Factory Manager.

As part of the OIG investigation, FOH and NIOSH/DART performed an on-site evaluation of the recycling workplace in August 2007 to evaluate worker exposures to toxic metals and other workplace hazards. Glass breaking was routinely performed at the time of this evaluation. In its report (see Enclosure 1), NIOSH/DART described FCI Marianna's e-waste recycling facilities and operations. This section summarizes information from the NIOSH/DART report and other sources, and the information below represents prevailing conditions and operations in August 2007. See Enclosure 1 for more detailed information on FCI Marianna operations.

The recycling of electronic components at FCI Marianna is performed in two separate buildings: the main factory located within the FCI's main compound, and the FPC located approximately a quarter mile to the south on the same property. Diagrams of these work areas are shown in Figures 1 and 2, respectively, with an enlargement of the glass breaking area shown in Figure 3. These figures also provide the general layout of the work process, although workers often move throughout the various areas in the performance of their tasks. The UNICOR FCI recycling facility employs approximately 205 inmate workers while the FPC employs approximately 86.

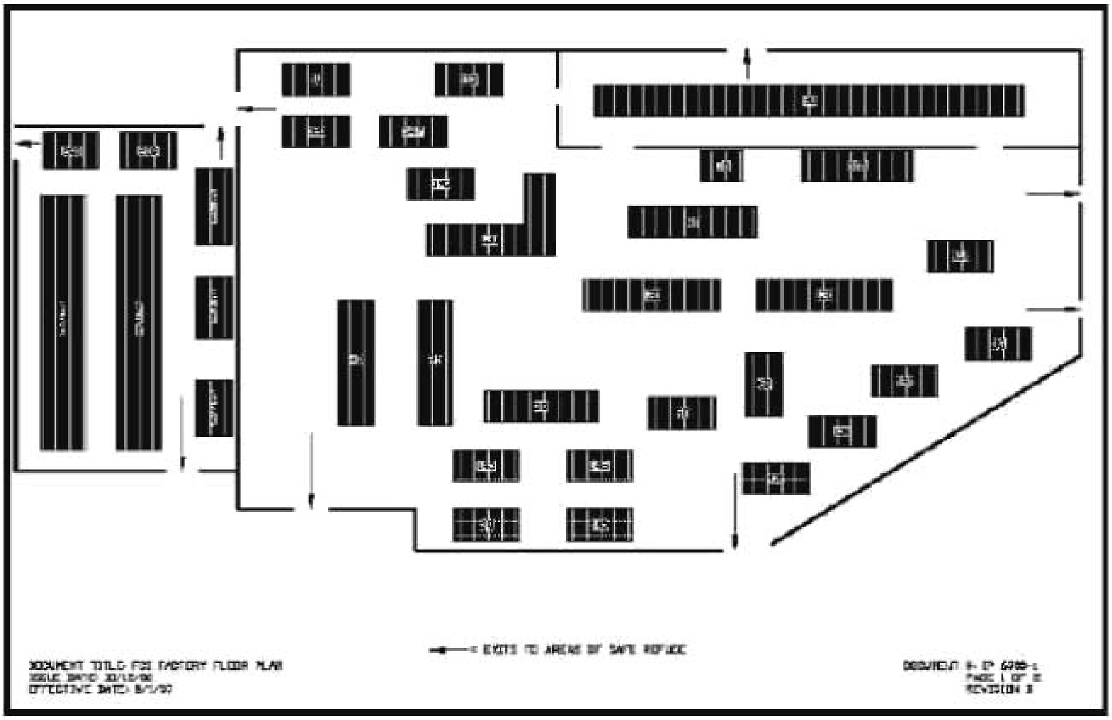

Figure 1: Marianna FCI UNICOR Factory Floor Plan (a) [NIOSH 2008b

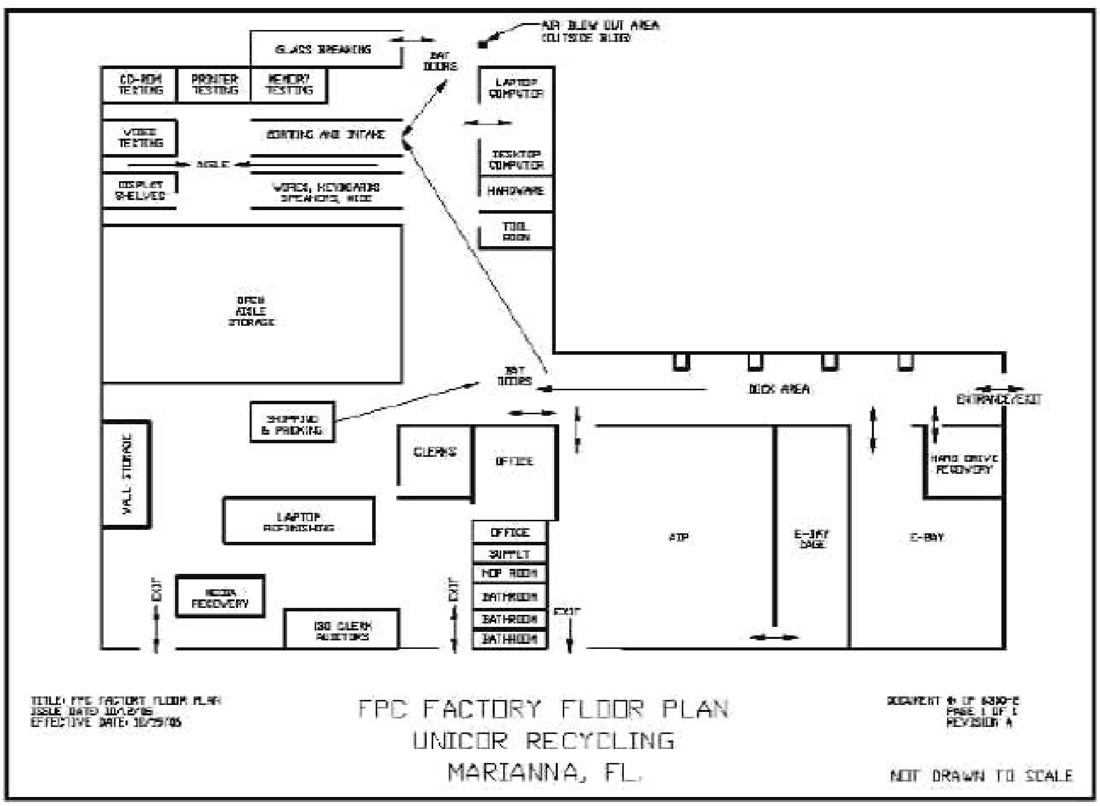

Figure 2: Marianna FPC UNICOR Factory Floor Plan (b) [NIOSH 2008b]

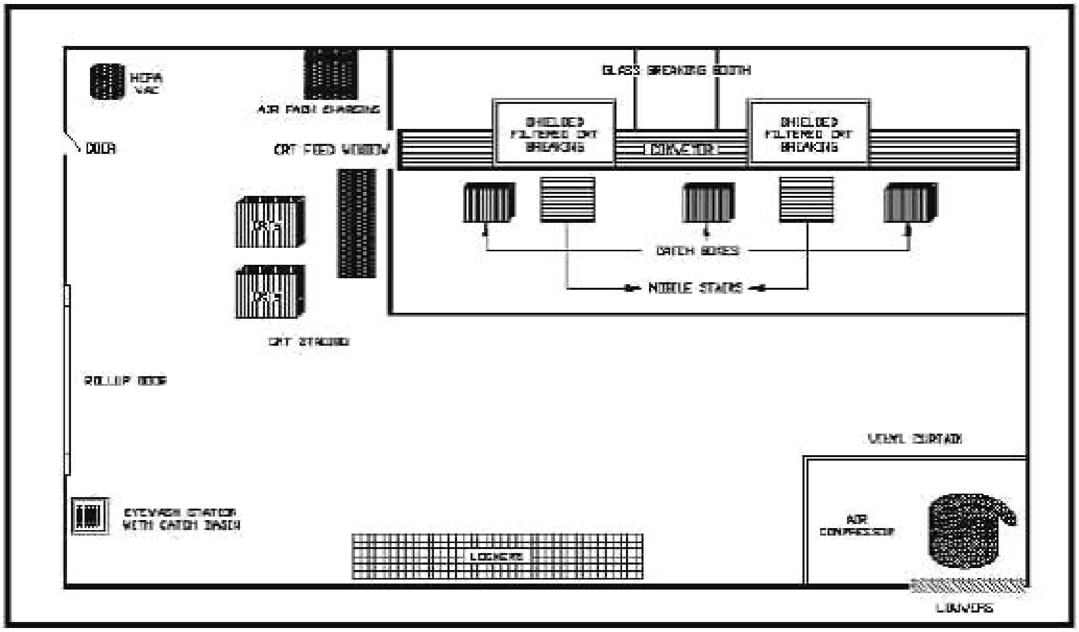

Figure 3: Marianna FPC Glass Breaking Area [NIOSH 2008b]

As with other UNICOR e-waste recycling operations, the recycling of electronic components at this facility can be organized into four production processes: receiving and sorting, disassembly, glass breaking operations (currently suspended), and packaging and shipping. Cleaning and maintenance in support of these processes are also conducted.

Incoming materials destined for recycling are received at a warehouse at the FPC where they are examined and sorted. Some items, such as notebook computers, can be upgraded and resold. These items are sorted for that task. Electronic memory devices (e.g., hard drives, disks, etc.) are removed and degaussed or shredded. Computer central processing units (CPUs), servers, and similar devices are sent for disassembly at the FCI. Monitors and other devices (e.g., televisions) that contain CRTs are separated and sent for disassembly and removal of the CRT at another location within the FPC. Printers, copy machines, and any other device that could potentially contain toner, ink, or other expendables are segregated. Inks and toners are removed before those devices are sent to the FCI disassembly area.

In the disassembly process, external cabinets are removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing are removed and sorted by grade for further treatment (e.g., stripping insulation from copper wire), if necessary. Components such as circuit boards or chips that may have value or that may contain precious metals such as gold or silver are removed and sorted. With few exceptions, each of the workers in the main factory performs all tasks associated with the disassembly of a piece of equipment using power tools and hand tools. Tasks include removing screws and other fasteners from cabinets, unplugging or clipping electrical cables, removing circuit boards, and otherwise breaking the devices down into their component parts. Essentially all components currently are sold for some type of recycling.

Image 1: Marianna FPC Glass Breaking Booth

Image 2: Marianna FPC Glass Breaking Booth Work Station (Plastic curtain pulled to the left to show first work station)

As observed in August 2007, glass breaking operations (GBO) (indefinitely suspended since February 2008) involve the breaking of CRT glass from computer monitors and televisions. Two inmate workers outside the glass breaking room move inventory for workers conducting glass feeding (feeders) and glass breaking (breakers) activities. The glass breaking room is equipped with horizontal flow modules (HFMs) which collect and filter the air and recirculate the filtered air inside the booth. The booth is enclosed on four sides and on top. There is no mechanical ventilation (i.e., at the time of the NIOSH/DART field investigation) in the GBO besides the HFMs inside the booth (Images 1 and 2 above).

Feeders lift the CRTs by hand from Gaylord boxes and place them on a roller conveyor through an opening on the side of the glass breaking enclosure. The breakers roll the CRTs onto an angle-iron grate for breaking. Each breaker stands on an elevated platform facing the grate which is positioned in front of a local exhaust ventilation (LEV) unit described by the manufacturer as a reverse flow horizontal filter module (HFM). As the CRTs move from left to right in the booth, the electron gun is removed by tapping with a hammer to break it free from the tube. Then a series of hammer blows are used to break the funnel glass and allow it to fall through the grate into large Gaylord boxes (cardboard boxes approximately 3 feet tall designed to fit on a standard pallet) positioned below the grate. The CRT is then moved to the right where any internal metal framing or lattice is removed before the panel glass is broken with a hammer by a second breaker. As the glass is broken, it is allowed to fall into a Gaylord box. Various sources on-site stated that "normal production" was approximately 300 CRTs per day. [Note: Also see Section 4.1.3 for addition information on the glass breaking facility that is presented in the context of personal exposures determined by NIOSH/DART.]

The packaging and shipping processes returned the various materials segregated during the disassembly and glass breaking processes to the warehouse to be sent to contracted purchasers of those materials. To facilitate shipment, some bulky components such as plastic cabinets or metal frames are placed in a hydraulic baler and compacted for easier shipping. Other materials are boxed or containerized and removed for subsequent sale to a recycling operation.

In addition to the routine daily activities in the four production processes described above, cleaning and change-out of the LEV's high efficiency particulate air (HEPA) filter system is performed as a non-routine activity. The two sets of filters in this ventilation system are removed and replaced. This operation is of particular interest because of its potential to result in worker exposures to toxic metals, particularly lead and cadmium. The filter change is a maintenance operation that occurs at approximately monthly intervals during which the ventilation system is shut down, and all filters are removed and replaced. Initially, the exhaust system components, including the accessible surfaces of the filters, are vacuumed with a HEPA vacuum. Then the filters are removed and bagged for disposal. The area inside the filter housing is vacuumed. New filters are inserted. The LEV system is then reassembled and any residual dust is HEPA vacuumed.

The NIOSH/DART report presents details on personal protective equipment (PPE), respiratory protection, engineering controls, and work practices used during glass breaking, filter maintenance, and other recycling activities. These controls are summarized in Sections 3.0 and 4.0 of this report and detailed in the NIOSH/DART report, Enclosure 1.

3.0 BOP/UNICOR SAFETY AND HEALTH PROCEDURES AND PRACTICES AT FCI MARIANNA

Under 29 CFR 1960 each federal agency is obligated to develop a comprehensive and effective safety and health program. Such programs establish requirements and processes for controlling occupational hazards and meeting federal occupational safety and health regulations. The BOP has established an ES&H policy entitled Occupational Safety, Environmental Compliance, and Fire Protection (BOP Program Statement 1600.09). UNICOR's compliance with this policy will be evaluated in the OIG's final report.

Various OSHA standards require written programs or plans to address occupational hazards or implement hazard control measures. Examples applicable to UNICOR's e-waste recycling activities performed at FCI Marianna, particularly for glass breaking include:

- 29 CFR 1910.1025: Lead requires a written lead compliance plan;
- 29 CFR 1910.1027: Cadmium requires a written cadmium compliance plan;
- 29 CFR 1910.134: Respiratory Protection requires a written respiratory protection program; and
- 29 CFR 1910.95: Occupational Noise Exposure requires a written hearing conservation program.

In addition to the specific OSHA standards listed above, another hazard associated with FCI Marianna recycling operations is heat exposure, particularly when conducting glass breaking and associated non-routine operations while wearing PPE and using respiratory protection. Although OSHA does not have a specific standard for heat exposure, the potential for heat stress at FCI Marianna warrants a heat stress program. OSHA can regulate this hazard under its "General Duty Clause" [OSHA 1970] that requires employers to furnish a workplace that is free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees.

Even when specific hazards do not meet the exposure threshold for a written standard specific plan/program, a good practice approach warrants that a general safety and health plan should be in place to identify workplace hazards and specify appropriate hazard controls and safe work practices.

UNICOR's ES&H practices and programs associated with the e-waste recycling activities conducted at FCI Marianna are discussed below.

3.1 Safety and Health Practices and Procedures to Control Toxic Metals Exposure

UNICOR-FCI Marianna issued a policy/guidance document entitled "Glass Recycling Operational Requirements" (effective July 21, 2006), which specifies requirements for lead and cadmium biological monitoring, training, engineering controls, exposure monitoring, PPE, respiratory protection, hygiene practices, housekeeping and cleaning practices, and others. It also contains information that is required in a lead and/or cadmium compliance plan.

NIOSH/DART reported on the type of PPE and respiratory protection that was worn by breakers and feeders during glass breaking operations. The PPE was consistent with the requirements of the UNICOR operational requirements. The respiratory protection used by breakers consisted of hooded powered air purifying respirators (PAPRs), which is different from the full face-piece air purifying respirators specified in the operational requirement; however, protection factors are similar for these respirators. UNICOR should ensure that both its written requirements and current practices are consistent. This document should be improved to accurately reflect all aspects of glass breaking safety and health practices, hazard controls, and work practices if glass breaking operations are resumed.

Since UNICOR at FCI Marianna requires use of respiratory protection during glass breaking, non-routine maintenance of LEV HEPA filters, and cleaning activities, a written respiratory protection program is required. FCI Marianna has a written "Respiratory Program" dated October 7, 2005 and another very similar version with the same document number dated October 24, 2005 (with pages dated October 24, 2006). These documents address medical clearance, respirator selection, fit testing, training, cleaning and maintenance, recordkeeping, and other subject matter. These respiratory protection documents are for the institution as a whole, are fairly generic in nature, and do not provide much specific information as it applies to respirators used during glass breaking, LEV HEPA filter maintenance, or cleaning activities for recycling operations.

However, the "Glass Breaking Operational Requirements" discussed above supplements the written respirator program with certain specific information on respiratory protection practices for e-waste recycling. An important deficiency in both the operational requirements and the respirator program is that neither document mentions the type of respiratory protection in use: that is, hooded PAPRs. UNICOR should correct these omissions by including requirements for proper use, cleaning, maintenance and other requirements for the hooded PAPRs in use.

For general activities conducted on the factory floor (i.e., disassembly and materials handling), a written safety and health document to define existing workplace hazards and control measures is not in place for UNICOR recycling conducted specifically at FCI Marianna. As a "good practice" approach, such a document should be developed and implemented to concisely define the safety and health practices and requirements specific to FCI Marianna recycling. The document should address PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping and cleaning practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Non-routine or periodic work activities should also be addressed in the document, particularly those that potentially disturb dusts such as cleaning and handling/disposing of wastes from HEPA vacuums or containers. The document could also specify requirements for periodic site assessments, hazard analyses, inspections, monitoring, and regulatory compliance reviews.

3.2 Safety and Health Practices and Procedures to Control Heat Exposure

During an inspection in November 2006, OSHA raised a concern over possible heat exposure (see OSHA report, Enclosure 2). While at FCI Marianna in August 2007, FOH and NIOSH/DART evaluated the potential for heat stress and found that heat exposure exceeded the guidelines of the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs). OSHA can apply these guidelines in its enforcement of heat exposure controls under the General Duty Clause. [OSHA1970] This condition places inmate workers at FCI Marianna recycling operations at risk of heat stress. FOH issued a report on heat exposure at FCI Marianna in September 2007 (Enclosure 4), which called on UNICOR to establish a heat stress program. In addition, NIOSH/DART presented findings on heat exposure in its report of October 2008 (see Enclosure 1). Findings of these reports are summarized in Section 4.4.1, below.

At the time of the FOH and NIOSH/DART investigation, UNICOR and FCI Marianna did not apply heat related exposure controls and did not have a heat exposure control program. In response to the FOH report of September 2007, UNICOR developed a policy document and a procedure addressing heat exposure and provided them to the OIG. FOH reviewed the UNICOR documents and prepared a second report that identified various deficiencies in the documents. UNICOR then redrafted the heat exposure documents. The final written heat stress program will be evaluated prior to the completion of the OIG investigation. See Section 4.4.2, below for additional information regarding FOH's review of the two initial UNICOR heat stress documents.

3.3 Safety and Health Practices and Procedures to Control Noise Exposure

Noise exposure above the OSHA action level triggers the requirement for a written hearing conservation program and implementation of associated practices. FCI Marianna has a written "Hearing Conservation Program" dated October 7, 2005. This program includes audiometric testing, noise level surveys, training, and availability and use of hearing protection in high noise areas. No information is included in the FCI Marianna Hearing Conservation Program to indicate recycling activities that may require implementation of hearing conservation practices. FOH found areas and activities with noise exposure at levels that requires implementation of a hearing conservation program (see Section 4.5 for further information). UNICOR should evaluate FCI Marianna operations to ensure that sound level measurements are taken for potential high noise areas such as glass breaking and disassembly operations/activities. UNICOR should ensure that measures as required by the Hearing Conservation Program are implemented. See Section 4.5 for a discussion of sound level measurements taken by the FCI Marianna Safety Specialist and FOH, as well as OSHA recommendations that UNICOR perform a complete noise survey. As discussed in Section 4.5, UNICOR has deficiencies in this area at FCI Marianna.

3.4 Other Safety and Health Practices and Procedures

FCI Marianna also has other written safety and health programs, such as for confined space entry and hazard communication. UNICOR should evaluate FCI Marianna operations to ensure that implementation of written programs is effectively achieved.

UNICOR does not have an effective hazard analysis program in place at FCI Marianna for its recycling activities. Some hazard analyses have been performed, but the process is not a fundamental part of a safety and health program and is not adequately performed. This also applies to many other UNICOR recycling factories. The following information discusses the hazard analysis issue.

The FCI Marianna Safety Specialist conducted a hazard analysis of glass breaking in December 2005. OSHA requires that such a hazard analysis be conducted to support the specification and assignment of PPE. The documentation of this hazard analysis could include more detailed information, but it demonstrates awareness of OSHA requirements for use of PPE and intent to comply with its requirements. This hazard analysis calls for the use of respiratory protection and the PPE that is in place for glass breaking. Such an analysis, however, is not evident for filter maintenance activities, although similar PPE and respiratory protection are used for both glass breaking and filter maintenance.

UNICOR has not conducted a complete noise survey at FCI Marianna. Some noise monitoring has been performed but the quality of the data is suspect. (See Section 4.5 for details.) In 2006, OSHA recommended that a complete noise survey be performed.

As part of e-waste recycling operations, FCI Marianna refurbished the plastic casing around laptops. According to written process descriptions and the FCI Marianna Factory

Manager, this refurbishment involved manual sanding of the plastic using sandpaper, sometimes followed by using compressed air to blow off accumulated dusts. This activity was largely discontinued in 2007 and is now limited to the sanding of the plastic comprising the outer portion of disk drive components. UNICOR and FCI Marianna did not conduct a hazard analysis for this operation to identify hazards and implement appropriate controls. Hazards associated with this activity include inhalation of fine dust particles and brominated flame retardants (BFRs), such as polybrominated diphenyl ethers (PBDEs). BFRs in general and PBDEs in particular are found in televisions and computers and have caused both scientific and public concern because they have been found to bioaccumulate in humans. One group that is highly exposed to PBDEs is workers within electronic recycling facilities. [Pettersson-Julander, et.al. 2004] Elevated concentrations of PBDEs have also been observed in an electronics dismantling plant, where elevated serum levels of PBDEs have been documented. [Thuresson 2004]

As part of an overall safety and health program, UNICOR should develop a thorough hazard analysis program. This program should include baseline hazard analysis for current operations and job (activity-specific) hazard analyses for routine activities, activities performed under an operations and maintenance (O&M) plan, non-routine activities, and new or modified activities. This applies to all UNICOR recycling factories.

3.5 Environmental Procedures

FCI Marianna has a Hazardous Materials Management policy/guidance document dated October 7, 2005. This procedure deals with the safe use, storage, and disposal of hazardous materials at FCI and FPC Marianna. It concerns hazardous materials associated with general operations and activities of the institution, but does not address e-waste recycling. According to the document, FCI Marianna is classified and permitted by the Florida Environmental Protection Agency (FL 1151909131) as a Small Quantity Generator. Environmental issues associated with the e-waste recycling operations are discussed in Section 4.6.

4.0 FIELD INVESTIGATIONS AND MONITORING RESULTS

Several field investigations of FCI Marianna e-waste recycling operations have been conducted since 2003. These investigations are listed below:

- The FCI Marianna Safety Specialist conducted noise exposure monitoring in November and December 2005.

- In January 2006, a consulting firm retained by UNICOR and FCI Marianna conducted a field investigation to evaluate surface contamination in the recycling areas, determine personal exposures to toxic metals, and evaluate the effectiveness of the LEV system used as an engineering control for toxic metals emissions during glass breaking.

- At the request of the DOJ/OIG, OSHA conducted toxic metals exposure monitoring at FCI Marianna in November 2006 and also made observations regarding other hazards such as noise and heat (see Enclosure 2 for the OSHA report).

- As part of the DOJ OIG investigation, NIOSH/DART and FOH conducted a field investigation in August 2007 to determine personal exposures to metals, noise, and heat, as well as existing metal surface contamination on various building components. NIOSH/DART prepared a report of its study to assess worker exposures to metals and other occupational hazards, including heat exposure (see Enclosure 1). Separately, FOH prepared a report on heat stress associated with FCI Marianna's recycling operations, and this report is provided as Enclosure 4. FOH testing data for metals are provided in Attachments 1-3.

- As requested by the DOJ/OIG, NIOSH/HETAB assessed the existing medical surveillance program for lead and cadmium exposures in February 2009 (see Enclosure 3 for the NIOSH/HETAB report).

Results of the UNICOR consultant study, OSHA study, the NIOSH/DART and FOH studies, and the NIOSH/HETAB assessment are summarized and discussed in this section.[5]

Toxic metals of greatest interest for occupational exposures related to e-waste recycling include lead, cadmium, and barium. Beryllium can also be associated with e-waste materials and is also of interest because of its adverse health effects and low exposure limit. These metals were the focus of the field investigations. See the FCI Elkton report referenced in Section 1.0 for details regarding e-waste hazards.

Exposure monitoring results are compared to permissible exposure limits (PELs) established by OSHA. In addition, non-mandatory ACGIH TLVs and NIOSH recommended exposure limits (RELs) are also available for reference. Personal exposure limits are often based on 8-hour time weighted average (TWA) exposures and the TWAs are applicable to the exposures discussed in this report. Table 1 provides exposure limits for lead, cadmium, barium, and beryllium. PELs and TLVs for other hazards can be found in OSHA standards (29 CFR 1910) and the 2009 ACGIH TLVs. [ACGIH 2009]

[5] Given the many variables that may impact air sampling and exposure monitoring, testing data and findings can vary from one period to the next. Also, the findings, interpretations, conclusions and recommendations in this report may in part be based on representations by others which have not been independently verified by FOH.

Table 1
Occupational Exposure Limits[1]

	LEAD ($\mu g/m^3$)	CADMIUM ($\mu g/m^3$)	BARIUM ($\mu g/m^3$)	BERYLLIUM ($\mu g/m^3$)
OSHA PEL	50	5.0	500	2[5]
OSHA ACTION LEVEL[2]	30	2.5	N/A	N/A
ACGIH TLV (Total Exposure)	50	10.0	500	0.05[4]
ACGIH TLV (Respirable Fraction)	N/A	2.0	N/A	N/A
NIOSH REL	50	*Ca*[3]	500	0.5

Notes:

1. All limits are based on an 8-hour time weighted average (TWA) exposure. NIOSH RELs are based on TWA concentrations of up to a 10-hour workday during a 40-hour workweek.
2. The action level is an exposure level (often around half of the PEL) that triggers certain actions, such as controls, monitoring, and/or medical surveillance under various OSHA standards.
3. *Ca* (Potential Occupational Carcinogen). NIOSH RELs for carcinogens are based on lowest levels that can be feasibly achieved through the use of engineering controls and measured by analytical techniques. [NIOSH 2005]
4. ACGIH TLV 2009 adoption.
5. OSHA also has 5 $\mu g/m^3$ ceiling and 25 $\mu g/m^3$ peak exposure limits.

Exposure standards for noise and heat are discussed in the sections below where results of the investigations are presented.

4.1 Investigations for Exposure to Toxic Metals

Given the various materials and components in e-waste, recycling activities have the potential to result in worker exposure to toxic metals including, in particular, lead and cadmium. The magnitude and potential health consequences of exposures are dependant on a number of factors such as workplace ventilation, work practices, protective equipment utilized (e.g., respirators, protective clothing, gloves, etc.), duration of exposures, and others. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, their relative toxicities, pertinent regulatory requirements, and other information.

Three investigations that included evaluation of toxic metals exposure during FCI Marianna's e-waste recycling operations are discussed below in chronological order of the studies. These investigations were conducted by a UNICOR consultant, OSHA, and NIOSH/DART.

4.1.1 UNICOR Consultant Monitoring Report for Toxic Metals

A UNICOR consultant conducted exposure monitoring of FCI Marianna glass breaking and associated activities on January 19, 2006. This monitoring included both personal and area air monitoring inside and around the glass breaking room. Four personal exposure samples were collected on inmate workers performing glass breaking. Two background area air samples were also collected. In addition, surface wipe and glove wipe samples were collected. Samples were analyzed for lead, cadmium, barium, and beryllium. Results are summarized below.

- All personal breathing zone samples for the four metals analyzed were below the action levels and PELs. However, the cadmium detection limit was only 2 $\mu g/m^3$ which is almost at the action level of 2.5 $\mu g/m^3$. This detection limit does not provide enough resolution to determine whether cadmium results were near the action level or far below it. Also it is normal for the margin of error to be quite large at or near the detection limit.

- For surface wipe samples, the report stated that one sample was at an elevated level for cadmium and several samples were at elevated levels for lead. However, commentary concerning the meaning or importance of the term "elevated" was not provided. Surface levels found in this report were in the range of those found by NIOSH/DART. See Section 4.2 for the relevancy of surface contamination at these levels.

- Some glove wipe samples were reported by the consulting firm to be at elevated levels for lead and cadmium.

The consulting firm concluded that FCI Marianna "…conducts a clean, efficient, and safe operation considering the nature of the work performed." The consultant recommended improvements in PPE for glass breaking assistants outside the glass breaking room, improved glove removal techniques to avoid skin contamination, hand washing, and additional housekeeping/cleaning practices.

As reported by the UNICOR Factory Manager at FCI Marianna, this sampling episode is the only exposure monitoring for toxic metals performed by UNICOR or its consultants at FCI Marianna.

4.1.2 OSHA Exposure Monitoring for Toxic Metals and Other Findings

OSHA conducted an inspection of e-waste recycling operations at FCI Marianna on November 8, 2006, during which it conducted personal air monitoring, area air monitoring, and surface wipe sampling for the CRT glass breaking operations (see Enclosure 2 for the OSHA report). Samples were analyzed for lead, cadmium, barium, and beryllium. Results and recommendations of this inspection are summarized below.

- Five personal exposure monitoring results were below the detection limit for the four metals analyzed, with one exception for cadmium which was less than 1% of the PEL. Although results were low, OSHA strongly encouraged continued use of PAPRs (i.e., respiratory protection).

- OSHA reported that lead and cadmium contamination was found inside of gloves and other PPE barriers. This indicates that PPE was not completely preventing exposure to skin and inner clothing and consequently OSHA noted potential for an ingestion hazard. These results confirmed similar results reported by the UNICOR consultant 10 months prior to the OSHA inspection. OSHA mentioned the earlier recommendations made by the UNICOR consultant to prevent this exposure, and OSHA reiterated that these recommendations should be implemented. OSHA also recommended closing any gaps or open areas of PPE, such as by taping the transition between protective clothing and gloves.

- OSHA recommended quality assurance checks to verify that contamination is being controlled by the PPE improvements. Such checks could include wipe samples of skin, clothing, and respirator hoods inside of the PPE barrier. Likewise, OSHA recommended surface contamination quality assurance checks of boxes leaving the glass breaking building.

- OSHA also provided other recommendations, including methods to remove PPE without contaminating protected surfaces and cleaning requirements.

FOH made an inquiry to the UNICOR Factory Manager at FCI Marianna regarding whether any PPE recommendations were implemented as a result of the UNICOR consultant's report or OSHA recommendations. He stated that after the consultant's recommendations, an extra layer of gloves were worn, but that taping was not conducted, which might account for the continued contamination problem found during the OSHA inspection. After OSHA's recommendations, the Factory Manager stated that taping was implemented. Regarding quality assurance checks within the PPE barrier and on boxes leaving the glass breaking building, the Factory Manager stated that none were conducted.

In addition to the toxic metals hazard, OSHA also expressed concerns and provided recommendations regarding heat exposure and noise surveys which are discussed in Sections 4.4 and 4.5, below.

4.1.3 NIOSH/DART Monitoring for Toxic Metals

NIOSH/DART conducted a field investigation of the FCI Marianna electronic equipment recycling facilities to assess worker exposure to toxic metals (see Enclosure 1). The study was conducted in August 2007. During the NIOSH/DART investigation the glass breaking work shift was abbreviated due to the high environmental temperature on both days and was further shortened on August 9, 2007 to allow time for the LEV filter change-out activity. During the two days of the NIOSH/DART investigation, 293 and 258 CRTs were broken, which is somewhat less than the normal reported production of 300 CRTs. NIOSH/DART results should be considered in light of this somewhat shortened schedule.

Personal exposure monitoring was conducted for 31 metals. Lead and cadmium were found to be the more significant exposures, but were maintained below the OSHA lead and cadmium PELs as 8-hour TWAs for both routine and non-routine activities. On one day of sampling, however, feeder exposures were at levels that should be reduced (see discussion below). Exposure results for other metals were well below the applicable exposure limits. Exposure monitoring results from the NIOSH/DART study are summarized below:

- Lead and cadmium exposure monitoring results in the FCI recycling factory (not including glass breaking) were well below the action levels and PELs and often below the limits of detection (LOD). The highest lead exposure was approximately 1% of the OSHA PEL of 50 $\mu g/m^3$, and 12 of 18 personal exposure samples collected were below the LOD for lead. The highest cadmium result was 1.8% of the PEL. All other metal exposures were also well below the PELs.

- Exposures for FPC recycling operations (not including glass breaking) were similarly well below the PELs for all metals, including lead and cadmium. [Note: two samples were compromised and these results are excluded from this analysis.]

- Cadmium exposures for feeders and breakers during routine glass breaking were up to 6.8 $\mu g/m^3$ for the duration sampled (i.e., 143 minutes), with a range of less than the LOD to 6.8 $\mu g/m^3$. The highest two measurements (3.8 $\mu g/m^3$ and 6.8 $\mu g/m^3$ on August 8, 2007) were for feeders rather than breakers, indicating inadequate capture and containment of contaminants by the LEV system and enclosure. As an 8-hour TWA, the highest cadmium exposure calculates to 2.0 $\mu g/m^3$, which is below the action level of 2.5 $\mu g/m^3$ and PEL of 5.0 $\mu g/m^3$ (assuming no exposure for the remainder of the work shift). Although this highest result was below the PEL and action level as an 8-hour TWA, the result was above these levels for the 143 minute exposure and was high enough that exposures above the action level even as an 8-hour TWA, at times, cannot be ruled out. This possibility is further supported by the NIOSH/DART observation that the work shift in the GBO was abbreviated on the two sampling days in August due to environmental heat and that the shift was further shortened on August 9, 2007 to allow for the filter change-out procedure. Additionally, exposures above the PEL value, even if for less than an 8-hour shift, demonstrate significant release of contaminants to the breathing zone of workers who, in this case, are outside of the glass breaking enclosure (also see bullet below for further information). FOH considers it important to prevent or reduce this exposure by improving engineering controls (i.e., LEV capture and enclosure containment).

- The highest cadmium exposures, as discussed above, were for the two feeders on August 8, 2007. Breakers had much lower cadmium exposures (see Enclosure 1). Very importantly, feeders do not wear respiratory protection, whereas breakers do wear PAPRs with an assigned protection factor of 25. Therefore, the difference in respiratory protection use between breakers and feeders at FCI Marianna is not supported by these data (see discussion below for possible reasons for feeder exposure). More important than controlling exposure with respirators, this feeder cadmium exposure should be reduced/prevented by limiting its release into and out of the glass breaking enclosure through implementation of improved engineering controls (see NIOSH/DART LEV and ventilation findings and recommendations as well as FCI Marianna HVAC improvements that are discussed in this section below and in Section 6.0, Recommendations).

- Lead exposures during routine glass breaking ranged up to 20 $\mu g/m^3$, for the duration sampled, which is less than the 8-hour TWA action level of 30 $\mu g/m^3$ and the PEL of 50 $\mu g/m^3$. When calculated as an 8-hour TWA, this highest result was approximately 5 $\mu g/m^3$ which is 10% of the PEL. Other metals were well below the PELs during routine glass breaking.

- Lead exposures during glass breaking were similar for both breakers and feeders. For instance, the highest breaker exposure was 20 $\mu g/m^3$ and the highest feeder exposure was 15 $\mu g/m^3$. With breakers wearing respiratory protection and feeders not wearing respiratory protection, feeders potentially have higher lead inhalation uptake than the breakers. The difference in respiratory protection use between breakers and feeders is not supported by these data, but more importantly, feeder lead exposure should be reduced/prevented by limiting its release into and out of the glass breaking enclosure through implementation of improved engineering controls (see NIOSH/DART LEV and ventilation findings and recommendations as well as FCI Marianna HVAC improvements that are discussed in this section below and in Section 6.0, Recommendations).

- The non-routine filter cleaning and change-out activity, conducted approximately monthly, was the task of greatest potential exposure concern. Cadmium exposures during the filter change-out activity ranged from 0.74 $\mu g/m^3$ to 12 $\mu g/m^3$ which calculates to 0.069 $\mu g/m^3$ to 1.4 $\mu g/m^3$ as an 8-hour TWA. The TWA results are below the cadmium action level and PEL. Lead exposures ranged from 5.6 $\mu g/m^3$ to 105 $\mu g/m^3$ which calculates to 0.53 $\mu g/m^3$ to 12 $\mu g/m^3$ as an 8-hour TWA. The TWA results are also below the lead action level of 30 $\mu g/m^3$ and PEL of 50 $\mu g/m^3$. All other metal exposures were well below the PELs. Inmate workers wear PAPRs during this operation with a protection factor of 25; therefore, lead and cadmium exposures (via inhalation) are sufficiently controlled.

- On the day of non-routine LEV filter cleaning and change-out, the feeders assisted in glass breaking (without PAPRs) and filter change-out on the same day (with PAPRs). Breakers performed both breaking (with PAPRs) and filter change-out (with PAPRs). Therefore, the exposures during glass breaking and filter change-out must be added together to calculate the total exposure. If the worst case exposures found by NIOSH/DART were added together for these two operations, then the highest cadmium exposure would be above the action limit but below the PEL as 8-hour TWAs. Also, the highest lead exposure would be very near the action level as an 8-hour TWA. [Note: This worst case calculation is a hypothetical value based on the highest exposures, whether breaker or feeder, on either August 8 or 9, 2007, and do not represent actual exposures found on August 9, 2007 when filter change-out was conducted. The actual exposures on August 9 were less than the lead and cadmium action levels.]

FOH discussed the conditions of the glass breaking room (enclosure) and outer area with the FCI Marianna Factory Manager. As seen in Figure 3 (Section 2.0), the glass breaking enclosure is located within a separate building that has a bay door. At the time of the NIOSH/DART investigation in August 2007, neither the glass breaking enclosure nor the outer room were ventilated or cooled (i.e., no HVAC system). The Factory Manager stated that the bay door could be either opened or closed during glass breaking. Variables of weather conditions and bay door positioning could impact air flow patterns between the enclosure and outer room. Under certain conditions, it could be possible that contamination could be released from the enclosure toward the feeders. This could explain why feeders had higher exposures than breakers on August 8, 2007. Since the NIOSH/DART investigation, an HVAC system and cooling has been added to this building. Therefore, if glass breaking is resumed, the conditions described above could have been resolved, but UNICOR should ensure that air flow patterns between the enclosure and outer area do not result in release of contamination from the enclosure under variable conditions of weather and bay door positioning (also see NIOSH/DART LEV and ventilation findings discussed below in this section for additional improvements needed).

NIOSH/DART detailed the PPE and respiratory protection used during recycling activities. Respiratory protection and PPE worn by breakers performing glass breaking inside the glass breaking room included hooded powered air purifying respirators (PAPRs), spun-bonded olefin coveralls over work pants and tee-shirts, shoe covers over work boots, cloth work gloves, and Kevlar sleeve guards. During the filter change-out activity, similar coveralls, gloves, and respiratory protection were used. Feeders wore similar PPE during glass breaking but did not wear respiratory protection, even though their inhalation exposures were found by NIOSH/DART to be far greater than breakers on August 8, 2007 for cadmium and similar on both days for lead.

The PPE and respiratory protection is appropriate for breakers and the inmate workers performing filter change-outs. The respiratory protection provides a protection factor of 25, which means that respirators would be effective in controlling exposures up to 25 times greater than the PEL. However, the feeders should also have worn respiratory protection during glass breaking under the conditions evaluated by NIOSH/DART, although the feeder exposure should have been prevented by means discussed above.

In addition to the PPE and respiratory protection evaluation, NIOSH/DART also conducted an evaluation of the LEV system that serves the glass breaking room, as well as the change rooms and processes used to transition to and from contaminated to clean areas. NIOSH/DART ventilation and change room findings are summarized below.

The LEV system is described by the manufacturer as reverse flow horizontal filter modules (HFMs). They have a bank of pre-filters and a HEPA filter with a 1,200 cubic feet per minute (cfm) fan and one-half horsepower motor. The control panel has a pressure gauge and variable speed control. Inmate workers stand facing a grate on which the CRT glass is broken. The HFMs are positioned on the opposite side of the grate, and they draw air from the breaking area/grate and through the pre-filters and HEPA filter. After filtration, all air is recirculated back into the glass breaking room through a grille at the back of the unit. Plastic strips provide a curtain that serves as a partial physical barrier between the workers and the grate where breaking occurs.

NIOSH/DART conducted a visual inspection, qualitative testing using smoke, and quantitative testing for face velocity. Summary results are as follows.

- NIOSH/DART found that the average face velocity measurement of HFM-1 (unit to the left when facing from the front, serial number 11023-1) was in close agreement with the manufacturer's initial test report of 130 feet per minute (fpm), although variability across the face was greater during the NIOSH/DART testing.

- For HFM -2, NIOSH/DART found that the average face velocity was 106 fpm which was lower than the 150 fpm measured by the manufacturer. Again, NIOSH/DART testing showed greater variability across the face than the manufacturer.

- NIOSH/DART found that the face and capture velocities for the HFMs are better in the central portions of the work stations, and performance drops off considerably outside the center of the enclosure. This finding emphasizes the importance of consistent work practices to maintain worker and material positioning to maximize LEV capture of emissions.

- Smoke tests showed that the air and contaminants tended to flow into the enclosed area in front of each HFM as expected.

- NIOSH/DART observed some gaps between the pre-filters on both HFMs and a gap between HFM-2 and the grate. The pre-filter gaps may shorten the life of the HEPA filter by allowing more and larger particles to go around the pre-filters and instead be trapped by the HEPA filter.

- NIOSH/DART noted highly regarded, good practice standards such as American National Standards Institute, ANSI [AIHA/ANSI 2007] that state that workroom air should not consist of 100% recirculated air as is the case for the glass breaking room. Also, OSHA requires continuous monitoring of air streams recirculated to the working environment when lead or other highly toxic substances are involved.

NIOSH/DART recommended various improvements to the LEV system (see Enclosure 1 and Section 6.0 of this report for details). These recommendations include re-engineering the system, with appropriate engineering support, to provide fresh air while maintaining a negative pressure relative to the general factory area, and improving the monitoring of recirculated air from the exhaust streams of the HFMs back to the glass breaking room.

NIOSH/DART also reviewed the processes and facilities for worker transition to/from clean and contaminated areas. In its report (see Enclosure 1, Section VI and the report's Figure VII), NIOSH/DART discussed and illustrated a typical staged sequence of areas for leaving a contaminated work area that includes a decontamination area, "dirty" locker/change area, and clean locker/change area. This type of system is typically used for lead abatement, asbestos abatement, hazardous waste cleanup, and similar work with toxic substances within enclosures, containments, or restricted areas. UNICOR does not apply this type of transition facility or process for its glass breaking operations at FCI Marianna. NIOSH/DART concluded that the UNICOR process has the potential for toxic metal contamination of inmate uniforms, respirators, and clean protective clothing. Because worker exposures are less than OSHA PELs, NIOSH/DART points out that this type of system is not necessarily required, but is a good practice approach given the UNICOR requirement for PPE and respiratory protection during glass breaking.

The following provides a summary of findings based on the NIOSH/DART evaluation for lead, cadmium and other metals exposure at FCI Marianna.

- Inhalation exposures to lead, cadmium, and other metals are minimal for routine activities conducted on the general factory floor, as well as for associated recycling activities, not including glass breaking.

- During glass breaking, cadmium inhalation exposures for feeders were far greater than breakers on the first sampling day, and lead exposures were similar for breakers and feeders on both sampling days. Given that feeders do not wear respiratory protection, that exposures varied significantly from day to day, and that one exposure was above the PEL value for the duration sampled (but not as an 8-hour TWA), the results indicate that feeders, not protected with respirators, have greater potential for metal dust inhalation than breakers. Depending on production rate, duration of work shift, consistency of work practices, and other factors, it is possible that exposures could be greater than those determined by NIOSH/DART, possibly above action levels and/or PELs. This is particularly possible on days that feeders participate in filter change-out after assisting in the glass breaking operations. The data also indicate the importance of a periodic exposure monitoring program to ensure consistent control of cadmium exposures. Although lower relative to the PEL than cadmium, lead exposure was also at levels where periodic monitoring would be beneficial to document the degree of effectiveness of exposure controls. All other metals were at levels well below PELs. The feeder exposure condition should be remedied through the implementation of improvements in engineering controls to prevent release of contaminants outside the glass breaking enclosure.

- For workers wearing PAPRs, respiratory protection was sufficient to protect against exposures up to 25 times the PELs. This level of respiratory protection is appropriate for both glass breaking operations and filter change-out. Appropriate PPE was also used, however, OSHA found certain deficiencies in its use and provided recommendations for corrective action (see Section 4.1.3 for OSHA findings and recommendations for PPE).

- Lead and cadmium exposures during the non-routine filter change-out activity were below the PELs and action levels as 8-hour TWAs. Respiratory protection was sufficient to protect against exposures up to 25 times the PELs. Other appropriate PPE was also used.

- Opportunities exist for improving the LEV system and the transition process from the contaminated glass breaking area to cleaner general factory area.

- Ventilation improvements to the glass breaking area that were implemented after the NIOSH/DART investigation could correct the reason for higher feeder exposures; however, UNICOR should verify adequate negative pressure and air flow patterns if it plans to restart glass breaking. UNICOR should also implement the LEV and ventilation improvements detailed by NIOSH/DART in Section 6.0 and Enclosure 1 if glass breaking is to be resumed.

Based on the exposure characterizations and observations described above, with the exception of feeder exposures at times, FCI Marianna glass breaking operations and associated activities are conducted in a manner that provides for worker protection against toxic metals inhalation exposure. However feeder exposures were found to be elevated on one sampling day and should be further evaluated and reduced. Feeder exposures should be reduced by limiting contaminant release outside the glass breaking enclosure through the implementation of improved engineering controls. If glass breaking is resumed, both feeders and breakers should wear respiratory protection, until ventilation improvements or other improved engineering controls have been shown to be effective in reducing feeder exposure potential. OSHA requires that respirators be made available to feeders when exposures are above the action level. Additional improvements in engineering controls should be made to further reduce exposure and limit migration of contaminated dusts outside the glass breaking enclosure (see Section 6.0, Recommendations).

4.2 Surface Wipe and Bulk Dust Sample Results

As part of the OIG investigation, FOH and NIOSH/DART conducted bulk dust and surface wipe sampling at FCI Marianna in both areas where e-waste recycling had been performed in the past as well as where operations are currently performed. Samples were analyzed for total lead, cadmium, and other toxic metals. In addition, some bulk dust samples were analyzed using the Toxic Characteristic Leaching Procedure (TCLP) in order to determine whether contamination should be treated as hazardous waste. Results for these samples are discussed in Section 4.2.1 and 4.2.2, below for current and legacy areas and facilities.

Federal standards or other definitive criteria have not been developed for acceptable levels of lead or cadmium surface contamination or dust concentrations in industrial areas where activities are performed involving lead and/or cadmium bearing materials. However, several recommendations or guidelines, primarily for lead, provide points of reference to subjectively evaluate the significance of surface contamination. Some guidelines are available and are noted below (see the NIOSH/DART Elkton report for a more detailed discussion of guidelines):

- OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace (i.e., 29 CFR 1926.62) can be summarized and/or interpreted as follows: all surfaces shall be maintained as 'free as practicable' of accumulations of lead; the employer shall provide clean change areas for employees whose airborne exposure to lead is above the PEL; and the employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination. The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of the Department of Housing and Urban Development's (HUD) initially proposed decontamination guidelines of 200 $\mu g/ft^2$ for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas. In situations where employees are in direct contact with lead-contaminated surfaces, such as working surfaces or floors in change rooms, storage facilities, and lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level.

- For other surfaces (e.g., work surfaces in areas where lead-containing materials are actively processed), OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of lead contamination meets the definition of "practicable." Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of lead dust does not become a source of employee lead exposures. OSHA [29 CFR, Part 1910.1025] has stated that any method that achieves this end is acceptable.

- Lange [2001] proposed a clearance level of 1,000 $\mu g/ft^2$ for floors of non-lead free commercial buildings and 1,100 $\mu g/ft^2$ for lead-free buildings. These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions.

- HUD [24 CFR 35] has established clearance levels for lead on surfaces after lead abatement. These levels range from 40 to 800 $\mu g/ft^2$, depending on the type of surface. The level of 200 $\mu g/ft^2$ is most commonly used. These levels, however, apply to occupied living areas where children reside, and are not intended for industrial operations.

- Regarding lead in bulk dust or soil samples, the U.S. EPA [EPA n.d.] has proposed standards for residential soil-lead levels. The level of concern requiring some degree of risk reduction is 400 ppm (mg/kg), and the level requiring permanent abatement is 2,000 ppm (mg/kg). Again, these levels are for residential settings, rather than for industrial locations.

- There is no quantitative guidance for surface cadmium concentrations. OSHA [40 CFR 745.65]states that surfaces shall be as free as practicable of accumulations of cadmium, all spills and sudden releases of cadmium material shall be cleaned as soon as possible, and that surfaces contaminated with cadmium shall be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne.

The discussion regarding surface wipe and bulk dust sample results is presented below in context of these available recommendations and guidelines.

4.2.1 Surface Wipe and Bulk Dust Results at Current Recycling Facilities

During its August 2007 field investigation, NIOSH/DART collected surface wipe and bulk dust samples from various locations in the FCI Marianna recycling facilities both inside the glass breaking room and in the general factory and associated areas. Samples were analyzed for lead and cadmium and other toxic metals. Summary results for these samples are presented below (see Enclosure 1 for complete results).

- Five bulk dust samples were collected in the glass breaking room. All were found to contain significant concentrations of lead ranging from 2,200 to 35,000 mg/kg (0.22% to 3.5% lead). Cadmium was found at lower levels ranging from approximately 1 mg/kg to 260 mg/kg. These sample results confirm that lead and cadmium dusts are released to the work areas during glass breaking and that continued measures to control and/or contain these dust emissions are essential to control exposures. The glass breaking enclosure is intended to contain these dusts inside the glass breaking room and cleaning procedures help to keep the amounts of dust in check. Feeder exposures, as noted in Section 4.1.3, however, indicate that contaminants could be released from the enclosure under certain conditions. [Note: According to the Factory Manager, since the suspension of glass breaking, the glass breaking area has been cleaned. The LEV system remains intact but has not been cleaned.]

- Surface wipe samples were collected in the FCI recycling factory and analyzed for lead and cadmium along with other metals. Many surfaces had lead concentrations above the OSHA-referenced HUD guideline of 21.5 $\mu g/100\ cm^2$ (equivalent to 200 $\mu g/ft^2$). Two samples from surfaces in the breakdown area (a rubber mat/table top and a rough wood surface) were approximately five and seven times this level. This OSHA guideline, however, applies to change areas, storage facilities, and lunchrooms/eating areas, rather than active work areas where lead-containing equipment is processed. The levels proposed by Lange [2001], also for occupied work environments, are 1,000 $\mu g/ft^2$ (the clearance level for floors of buildings containing lead) and 1,100 ug/ft^2 (for floors of lead-free buildings). The level of the two highest surface wipe samples approximates these Lange guidelines.

- Cadmium surface concentrations in the FCI recycling factory ranged from <0.1 $\mu g/100cm^2$ to 65 $\mu g/100\ cm^2$. There is no quantitative guidance for surface cadmium concentrations.

- Surface wipe samples were collected in the FPC. One of these samples produced the highest metal contamination levels. Lead was found at 5,100 $\mu g/100\ cm^2$ (about 50,000 $\mu g/ft^2$). This level is well above surface contamination guidelines discussed in Section 4.2 this report. This sample consisted of accumulated dust collected on top of an electrical conduit attached to the back wall to the left of HFM-1 inside the glass breaking booth. The Factory Manager stated that the glass breaking room, but not LEV system, has been cleaned since glass breaking was stopped. Any decommissioning of the glass breaking room and LEV system should be preceded by additional thorough cleaning followed by surface wipe testing to verify surfaces are adequately free of contamination (see Section 6.0 for more detail regarding necessary steps for system decommissioning.).

- A sample collected in the FPC outside the glass breaking room on top of a bookcase was less than the OSHA/HUD guideline for occupied areas. A sample from a locker in the glass breaking area was also less than the OSHA/HUD guideline.

In addition to the above-referenced samples collected by NIOSH/DART, FOH collected a limited number of bulk and wipe samples from various surfaces (e.g., factory floors, ducts, light fixtures, counter tops, truck trailers) located at or in proximity to the disassembly and refurbishment areas of the FCI as well as the area of the FPC's main warehouse (designated as the location where recycled materials are handled for eventual distribution via e-bay). Attachment 1 provides a table with additional details about sample locations and the analytical results. While the majority of these samples did not reflect the significant presence of lead and cadmium contamination on the sampled surfaces or in the bulk materials, one sample of dust from floor sweepings in the disassembly area showed rather high lead and cadmium concentrations (0.37% and 0.067%, respectively). Similarly, a composite bulk sample taken from three existing post holes which had been placed in the floor of the e-bay area of the FPC's main warehouse showed lead and cadmium concentrations of 0.11% and 0.039%, respectively. A duplicate sample of this composite material was analyzed via the toxic characteristic leaching procedure (TCLP) which showed that this material's leachate exceeded the EPA lead limit by over ten times (and cadmium TCLP limit by two times). According to EPA regulations the bulk dust would need to be treated as a hazardous waste; however, UNICOR should perform additional TCLP testing on materials collected during any clean-up activity to determine proper disposal requirements. Based on this data (and the ratio between total lead/cadmium concentrations and the TCLP values), it is likely that the floor sweepings sample collected from the disassembly factory floor would also be considered hazardous waste; however, UNICOR should also conduct testing of this collected debris to determine proper disposal requirements. Additional samples, including floor sweepings from a trailer used to transport e-waste to FCI Marianna were found not to contain elevated lead and cadmium concentrations.

Accumulations of dusts, such as found in the FPC's post holes and from the FCI's floor sweepings should be tested by UNICOR to determine whether they should be treated as hazardous waste. In light of the presence of these lead and cadmium containing dusts, as well as the Lange guidelines, UNICOR and FCI Marianna should implement procedures to reduce the risk of exposure to surface dusts and dust accumulations. UNICOR and FCI Marianna should implement an operations and maintenance (O&M) plan to limit contact with existing lead and cadmium contamination, limit its accumulation, prevent and/or control any releases of the contamination to the air, and generally prevent potential for inhalation and ingestion (i.e., hand-to-mouth contact) exposure. Further surface testing should be periodically conducted to ensure that surface contamination levels do not increase over time, and/or to take preventive and corrective action should levels start to build up. With proper controls established, this O&M plan could include periodic clean-up of surfaces by inmate or other workers. Elements of an O&M plan are discussed in Section 6.0, Recommendations.

4.2.2 Surface Wipe and Bulk Dust Results at Legacy Recycling Areas

Legacy contamination was characterized by FOH at two offsite facilities where UNICOR performed e-waste recycling activities between 1998 and 2002, after which they were moved to the FCP and FCI factories. These facilities, the 'Blue' and 'Gold' buildings, were previously leased by the BOP but no longer house BOP recycling operations. According to the UNICOR e-waste Factory Manager, the Gold building is now leased by a private company which conducts e-waste recycling (led by a former employee of the UNICOR operations at FCI Marianna).

A limited number of wipe and bulk samples were collected in various locations in/near the Blue and Gold buildings with the objective of screening for legacy contamination on building surfaces and in the nearby environment (see Attachments 2 and 3). Of the 36 wipe samples collected in the Blue and Gold buildings from ducts, I-beams, floors, and other surfaces, 10 showed residual lead contamination in excess of 1,000 ug/ft^2 (all from the Blue Building), and up to about 3,900 ug/ft^2. The concentrations of cadmium in the samples were found to be a fraction of the lead concentration and ranged from 3 to 750 ug/ft^2. As such, the surface contamination in at least the Blue Building appears to be rather elevated in certain places (i.e., based on Lange guidelines). The UNICOR e-waste Factory Manager stated that FCI Marianna no longer leases these buildings and that the Gold Building is currently being used as e-waste recycling facilities by a private company. The current building owner should be informed of the sampling results.

FOH also collected six soil samples from around the Blue Building in locations where water runoff may have deposited dusts from the e-waste recycling operations. Similarly, three dust samples were collected from the floor of the Gold building along with one filter sample from a swamp (i.e., evaporative) cooler (see Attachment 3, "TCLP Results - Blue and Gold Buildings"). These nine samples were tested via the Toxic Characteristic Leaching Procedure (TCLP) to determine whether these materials should be treated as hazardous waste. None of the samples showed any detectable levels of extractable lead or cadmium and, therefore, are not considered hazardous waste with respect to these metals. See Table 2 for TCLP criteria.

Table 2
Maximum Concentration of Selected Contaminants
for the Toxicity Characteristic[1]

Contaminant	TCLP Regulatory Level
Arsenic	5.0 mg/L
Barium	100.0 mg/L
Cadmium	1.0 mg/L
Chromium	5.0 mg/L
Lead	5.0 mg/L
Mercury	0.2 mg/L

[1][40 CFR 261.24].

4.3 Assessment of the Medical Surveillance Program

As part of the DOJ/OIG investigation, NIOSH/HETAB assessed the existing medical surveillance program for inmates and staff exposed to lead and cadmium during e-waste recycling at FCI Marianna. NIOSH/HETAB conducted a site visit on February 17 and 18, 2009 to conduct this assessment. Results are summarized below and are presented in detail in the NIOSH/HETAB report provided in Attachment 3.

- Medical surveillance began in late 2005 for inmates performing glass breaking operations. It is performed annually and consists of biological monitoring for blood lead levels (BLL), blood cadmium (CdB), urine cadmium (CdU), urine beta-2-microglobulin (B-2-M), and zinc protoporphyrin (ZPP). Preplacement testing is performed on inmates prior to being cleared for glass breaking work. The same biological monitoring is performed for UNICOR staff as for inmates. In reviewing the biological monitoring results, NIOSH/HETAB found that the results for both staff and inmates were unremarkable (see Attachment 3 for the results and further discussion).

- Extensive medical records were reviewed for one former staff member who was never assigned to recycling, one current staff member who worked overtime in recycling in the past, an inmate who apparently worked in recycling but apparently not glass breaking, and a staff member who died in 2008 after being medically retired. NIOSH/HETAB found that the records revealed no evidence of any health problems related to recycling exposures.

- NIOSH/HETAB held public meetings with staff and inmates. During these meetings and interviews, exposure concerns were discussed and medical problems were reported. NIOSH/HETAB found that none of the reported health effects are related to potential exposures from electronics recycling.

- NIOSH/HETAB also interviewed 14 staff and 12 inmates onsite, and various health effects were discussed in these interviews. NIOSH/HETAB found that none of the reported health effects can be related to exposure from recycling of electronics. In addition, nine people were interviewed offsite by NIOSH/HETAB. Two were former UNICOR staff assigned to recycling. One was a FCI staff member who did overtime for a brief period in recycling. Four were former staff members who did not work in recycling. Two were former inmates, neither of whom was assigned to recycling. Again, NIOSH/HETAB found that none of the reported health effects can be related to exposure from recycling of electronics.

- NIOSH/HETAB also reviewed the issue of ionizing radiation from radioactive materials that could have been associated with a past demilitarization operation that was started in the camp in approximately 1999 and closed in 2001. This operation involved the disassembly and refurbishment of electronics from military bases. Interviews with Eglin Air Force Base personnel indicated that testing and segregation methods were in place for any items potentially containing radioactive materials and that no radioactive items were supposed to be disposed of in any manner (i.e., according to procedure, such items would not have been sent to FCI Marianna). Staff, however, alleged exposure to ionizing radiation and reported some observations that disputed the assertion that such materials would not have been sent to FCI Marianna. Other staff denied these allegations. NIOSH/HETAB's review of medical records revealed no evidence of any health problems related to ionizing radiation.

- NIOSH/HETAB also conducted an industrial hygiene records review. These records were the same as those discussed in Section 4.1 and 4.2, above.

NIOSH/HETAB concluded that limited monitoring data for glass breaking suggests that exposure to metals may have been sufficiently low that the OSHA mandated medical surveillance under the lead and cadmium standards has not been required, and that medical surveillance results are unremarkable. NIOSH/HETAB recommended, however, that if glass breaking is re-started, UNICOR should continue the limited biological monitoring that is currently in place as an additional safeguard against excessive exposure, and as a reassurance to staff and inmates. There is no need to perform any medical surveillance if glass breaking remains stopped. See Attachment 3 and Section 5.0, Conclusions and Section 6.0, Recommendations for further information on the NIOSH/HETAB medical surveillance assessment.

4.4 Investigations for Heat Exposure

As part of the OIG investigation, FOH and NIOSH/DART conducted a heat hazard evaluation associated with UNICOR's electronics recycling operations at FCI Marianna. This evaluation was conducted on August 8 and 9, 2007, following an assessment by OSHA in November 2006, that noted concerns with heat stress (see Section 4.1.3, above). FOH reported results from this evaluation to the OIG in a report entitled "Worker Heat Stress Measurements – FCI Marianna," on September 21, 2007 (see Enclosure 4 to this report). This investigation found that inmate workers are at risk from excessive heat.

In its report, FOH provided recommendations for the control of the heat hazard, which included the enhancement of UNICOR policies and procedures. In response to FOH recommendations, the BOP provided two programmatic documents to the OIG: (1) *Glass Recycling Operational Requirements*, Document # IP-6400-420, 8/6/07, Revision C and (2) *Heat Stress Procedures,* UNICOR–Federal Correctional Institution Marianna (undated). FOH then evaluated the BOP documents and prepared a follow-up report that provided a review of the revised FCI Marianna programmatic documents (see Enclosure 5). The follow-up report entitled "Review of Heat Stress Procedures and Operational Requirements Associated with Electronics Recycling Operations at FCI Marianna" provided general feedback on the overall suitability of the BOP documents as a means to comply with pertinent safety and health requirements and to furnish meaningful protection from heat stress.

In addition to the FOH reports, NIOSH/DART also provided an evaluation of the heat hazard in its report to the OIG provided as Enclosure 1. NIOSH/DART evaluated heat measurements against both the NIOSH recommended exposure limit (REL) and ACGIH TLV for heat exposure.

A summary of FOH and NIOSH/DART findings and recommendations is provided below. This is followed by summary results from the follow-up FOH report on BOP documents that were prepared to address the heat hazard.

4.4.1 FOH and NIOSH/DART Findings and Recommendations for Heat Exposure

Both FOH and NIOSH/DART prepared reports to address heat exposure at FCI Marianna's recycling operations. In September 2007, FOH submitted findings and recommendations to the OIG regarding the evaluation and control of heat exposure at FCI Marianna (see Enclosure 4). This report was prepared immediately after the work site analysis to allow BOP and UNICOR to address the heat exposure issue prior to the next hot weather season.

As part of its overall work site analysis, NIOSH/DART also presented findings and recommendations for heat stress at FCI Marianna in its comprehensive exposure assessment report of October 2008 (see Enclosure 1). These reports were based on the same set of work site heat measurements collected in August 2007 by NIOSH/DART. Summary findings are provided as follows.

- Both FOH and NIOSH/DART found that both glass breakers and feeders performing glass breaking operations were exposed to heat at levels above the ACGIH TLV. NIOSH/DART also concluded that these exposures were above the NIOSH REL and found that this exceedance occurred in the first hour of work. NIOSH/DART also reported that workers outside the glass breaking room also exceeded the TLV when performing moderate work and exceeded the action limit when performing light work.

- FOH found that workers in the FCI who performed work at a moderate rate were also exposed above the TLV in most cases. NIOSH/DART reported a similar finding and also concluded that these exposures exceeded the NIOSH REL.

- FOH and NIOSH/DART found that warehouse workers doing light work were not exposed above the TLV. However, FOH found that workers unloading trucks were exposed above the TLV if their work/rest regimen exceeded 50% work and 50% rest.

Based on their finding that many FCI Marianna workers are at risk from heat exposure, FOH and NIOSH/DART prepared recommendations to control the heat hazard. FOH and NIOSH/DART emphasized the need for BOP to develop a site specific program to evaluate and control excessive exposure to heat. Specific elements of such a program should include engineering controls (if feasible), medical surveillance, PPE measures, training and acclimation, and work/rest regimens, among others. FOH and NIOSH/DART specifically recommended that BOP adopt the ACGIH TLVs for heat exposure as its standard for exposure limits and exposure controls.

4.4.2 FOH Findings and Recommendations on the BOP Documents to Control Heat Exposure

In response to the FOH recommendations, the BOP provided two programmatic documents to the OIG: (1) *Glass Recycling Operational Requirements,* Document # IP-6400-420, 8/6/07, Revision C and (2) *Heat Stress Procedures,* UNICOR–Federal Correctional Institution Marianna (undated). FOH evaluated these documents and submitted a report to the OIG with its findings (see Enclosure 5). NIOSH/DART performed a peer review of the FOH report. Summary findings and recommendations provided in this follow-up FOH report are provided below.

- FOH reiterated that workers performing glass breaking and other activities at FCI Marianna are at risk from heat stress.

- FOH found that FCI Marianna Heat Stress Procedures developed by BOP lack many of the steps, information, and detail necessary to ensure management and control of the heat stress hazard.

- FOH also stated that the heat stress procedures should be rewritten to be consistent with the ACGIH-TLVs, Heat Stress and Heat Strain, as well as OSHA-Recommended Elements of a Heat Stress Program.

- Prior to rewriting these procedures, FOH stated that FCI Marianna should proceed with the recommendations and guidance offered in the previous FOH report, as well as with the ACGIH and OSHA information cited above.

- Specifically, FOH provided a series of detailed steps and elements for control of heat exposure that UNICOR and FCI Marianna should implement and incorporate into a heat control program. FOH provided additional detail for engineering controls, workload determinations, heat measurements and protective clothing adjustments, work/rest regimens, PPE, administrative controls, and other controls and considerations (see Enclosure 4 for this detail).

As a result of the FOH evaluation of the initial heat stress documents, BOP prepared a new document titled Heat Stress Program, dated 09/26/08. An evaluation of this Heat Stress Program will be conducted prior to the completion of the OIG investigation.

4.5 Investigations for Noise Exposure

Noise measurements taken by FCI Marianna and FOH are discussed below. In addition, OSHA inspection recommendations regarding noise are summarized.

For this report, FOH reviewed noise monitoring results measured by the FCI Marianna Safety Specialist in late 2005. Three measurements were taken using a Quest Technologies Q300 Noise Logging Dosimeter. All three results were well below the level that would require implementation of a hearing conservation program. The "booth/work area" had the highest reported noise measurement at 76.9 dB, which is well below the OSHA action level of 85 dBA and the PEL of 90 dBA. However, in reviewing these data, FOH is of the opinion that the reliability of these data are open to question for several reasons as listed below:

- Three measurements appear to have been taken in November and December 2005; however, two of the three had hand written calibration dates for the calibrator listed as 12-22-06.

- The dosimetry measurements are not assigned to an individual. It appears that work areas were monitored, and it is not known whether these measurements reflect personal exposure. This is important because noise levels at relatively short distances from the sources can be much lower than for workers conducting activities very near the sources.

- One result in the UNICOR disassembly area was very low at 44.1 dBA as a TWA. The dosimeter log showed the peak level was about 178 dB, the slow maximum level was about 100 dB, and the slow minimum level was about 70 dB.

In addition, noise exposures in occupied work areas with minimal noise sources would be expected to be higher than 44 dBA.

- All three measurements taken by the FCI Marianna Safety Specialist were significantly lower than comparable data collected by FOH in August 2007 (see discussion below).

UNICOR should not consider the above FCI Marianna noise measurements to be definitive regarding noise exposures during FCI Marianna recycling operations.

During its inspection in November 2006, OSHA did not perform noise measurements. However, OSHA indicated a concern regarding noise exposure and recommended that UNICOR perform a complete noise survey, identify noise producing processes and objects, and if needed lower noise levels with engineering controls. OSHA made these recommendations verbally and in a written report to the FCI Marianna Warden. UNICOR and FCI Marianna have not conducted noise monitoring in response to the OSHA recommendation.

In August 2007, FOH performed noise measurements as part of the OIG investigation. Measurements were taken using a Quest Technologies NoisePro DLX dosimeter. Twenty measurements were made. All measurements were below the OSHA PEL of 90 dBA, but two of the measurements were above the OSHA action level of 85 dBA. Exposures above the action level trigger the requirement for a hearing conservation program. The two results above the action level were for a person performing sanding and another performing copper wire separation in the refurbishment area. Two FOH samples were collected for breakers performing glass breaking. The breaker exposures were near but slightly below the OSHA action level. These samples were about 83 dBA compared to the action level of 85 dBA. As reported by NIOSH/DART, glass breaking on the two sampling days was shortened because of heat and filter change-out activities; therefore, it is possible that the FOH results for breakers are somewhat lower than what would be normally expected, creating potential for typical breaker exposure above the action level. The FOH industrial hygienist who conducted this testing reported that hearing protection (i.e., ear plugs) was available as an option (voluntary use), but was not worn during the measurements.

The FOH noise data of August 2007 was consistently higher than the more limited amount of data taken by the FCI Marianna Safety Specialist in late 2005, and it indicates the need for certain workers to be placed into a hearing conservation program. Such a program includes audiometric testing, training, use of hearing protection, and implementation of other exposure controls, if feasible. The FOH data also emphasizes the need for UNICOR to address the OSHA recommendation that it conduct a complete noise survey and implement controls accordingly. UNICOR should not presume that FOH captured the full range of noise producing activities and should not rely on FOH data to satisfy its monitoring requirements.

4.6 Environmental Issues

FOH conducted a review of available documents pertaining to environmental issues. FOH also tested for legacy contamination in the offsite e-waste recycling facilities (designated the 'Blue' and 'Gold' buildings) which housed the e-waste operations prior to their relocation in 2002 to 2003 to the current facilities within FCI Marianna.

FCI Marianna submitted qualifications to the Florida Department of Environmental Protection (DEP) in December 2001 for registration as a Large Quantity Handler Facility for Universal Waste Devices. Based on these qualifications, the DEP's Hazardous Waste Management Section found that the FPI (Marianna) met the minimum requirements for a "transporter or handler facility for universal waste lamps and devices designated for recycling" and provided registration as a "Large Quantity Handler Facility for Universal Waste Devices" in 2002. The registration included various expressed limitations (e.g., wastes cannot be destined for disposal in a landfill, changes in facilities and procedures must be submitted in writing, etc.) and specified that other requirements must be followed (e.g., packaging, training, recordkeeping, etc.). The registration expired in March 2003 and, according to the Factory Manager, was not renewed because it was no longer needed due to significant reductions in the amount of e-waste being processed (i.e., down from approximately 25,000 units/month to several thousand). The shutdown of the e-waste operations for nine months in 2004 was due to hurricane damage, and subsequent conditional exemptions issued by DEP (see below).

In January 2006, the DEP issued a conditional exemption from air permitting for the UNICOR Marianna CRT glass processing facility. This allowed the glass breaking room equipped with high efficiency air particulate (HEPA) filters to operate based on the estimate that the factory processed approximately 300 CRT units per day with an average of 12 to 15 pounds of waste per tube. The exemption was contingent on a number of conditions including that operations must be conducted in accordance with the FPI CRT Processing Procedures; the booth's ventilation/filtration system must be operated in accordance with manufacturer recommendations; the CRT glass will not be subjected to high temperatures (smelting, burning, etc.); and initial UNICOR air sampling results will be submitted to the DEP. DEP's correspondence did not indicate any expiration date for the conditional exemption, but did require that it could be revoked if conditions were not met or if the installation was substantially modified.

Based on a review of correspondence provided by the DOJ OIG, it is apparent that FPI performed periodic internal evaluations of the glass booth and other e-waste recycling operations with regard to environmental issues. For example, a trip report from a March 2006 inspection reflected concerns over, for example, "inmates dumping mop water from the glass booth onto the outside lawn" and that this water "must be placed in the proper drain system". In addition, the trip report indicated that "a hazardous waste container (i.e., a Gaylord box containing used disposable suits from the glass breaking area) was not appropriately marked or sealed" and that "staff needs to ensure that such containers meet hazardous waste standards and remain closed at all times."

5.0 CONCLUSIONS

Conclusions concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at FCI Marianna are provided below under the following subsections:

- Heavy Metals Exposures;
- Heat Exposure;
- Safety and Health Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

Various conclusions may be applicable to all UNICOR recycling factories with similar operations and activities. These conclusions are supported by the results, findings, and analyses presented and discussed in Sections 3.0 and 4.0 of this report, as well as the documents assembled by the OIG. These conclusions, in part, are consolidated from the various federal agency reports, and are also supplemented by FOH based on the entire body of information assembled and reviewed. See Enclosures 1 – 5 for additional conclusions from the individual contributing federal agencies, including NIOSH/DART, NIOSH/HETAB, OSHA, and FOH.

5.1 Heavy Metals Exposures

1. Based on NIOSH/DART monitoring results in August 2007, current routine e-waste recycling operations conducted in the FCI recycling factory and during FPC recycling operations (not including glass breaking), have minimal inhalation exposure potential to lead, cadmium, and other metals. Lead, cadmium, and other metals exposures were either very low or non-detectable.
2. During glass breaking, exposure monitoring performed by both OSHA in 2006 and NIOSH/DART in 2007, showed that lead, cadmium, and other metals exposures were below the PELs when calculated as 8-hour TWA exposures. However, NIOSH/DART results on one sampling day showed that cadmium exposures for feeders approached the cadmium action level as an 8-hour TWA and had the potential to be excessive during the period of glass breaking. These data showed that exposures can be far higher for feeders who do not wear respirators than for breakers who do wear respirators. In addition, lead results for breakers and feeders were similar. Feeder results were high enough and data were variable enough that the possibility of feeder cadmium exposure above the action level on some days cannot be ruled out. This possibility is particularly relevant should feeders perform filter change-out on the same day as glass breaking (also see Conclusion 3, below). If feeders were to use respiratory protection during glass breaking (within the context of a fully effective respiratory protection program), then their cadmium exposure would be better controlled even if they participate in filter change-out on the same day. However, it is essential to reduce exposures outside the glass breaking enclosure by improving engineering controls (i.e., LEV, ventilation, and enclosure improvements).

3. When performing filter change-out and glass breaking on the same day, worst case cadmium exposure could be above the OSHA action level and worst case lead exposure could be near the action level. However, use of PAPRs with a protection factor of 25 should provide effective control of the worst case exposure (assuming both feeders and breakers wear PAPRs). [Note: The worst case exposure based on NIOSH/DART results is still below the cadmium OSHA PEL, regardless of respiratory protection.]

4. Based on NIOSH/DART exposure monitoring data, there is no basis to differentiate between breakers and feeders regarding their use of respiratory protection. However, feeder exposures should be reduced through improved engineering controls that limit contaminant release outside the enclosure. [Note: NIOSH/DART exposure data only represent two days of operations. Further evaluation is required if glass breaking is resumed.]

5. Since the NIOSH/DART investigation, glass breaking has been stopped and an HVAC system with cooling has been added to the glass breaking area. It is possible that this could alter any pressure differentials or air flow patterns that could have contributed to feeder exposures. If glass breaking is restarted, UNICOR should evaluate air flow patterns and feeder exposures to determine if potential feeder exposure has been mitigated (also see NIOSH/DART conclusions regarding the LEV and ventilation systems for the glass breaking area).

6. A UNICOR consultant performed one episode of exposure monitoring in January 2006. Lead and cadmium exposures were below the action levels and PELs, however, the cadmium detection limit was only slightly below the action level which limits the usefulness of these data. Exposure monitoring prior to this January 2006 episode are not available. This episode is the only exposure monitoring conducted by UNICOR since glass breaking was implemented.

7. Monitoring data collected by the various organizations during glass breaking showed that exposures vary significantly from day to day. For instance, NIOSH/DART found that cadmium exposures were up to 6.8 $\mu g/m^3$ (for the duration sampled) on August 8, 2007 for a feeder, but the highest cadmium result on the following day was 0.7 $\mu g/m^3$ for a breaker. NIOSH/DART also found that lead exposure was as high as 20 $\mu g/m^3$ on August 9, 2007, while OSHA found that lead was not detectable on November 8, 2006.

8. NIOSH/DART concluded that "the feeders' exposures during routine glass breaking operations require further scrutiny to determine the source of their airborne exposures" (see Enclosure 1, Section VI). The method to respond to the NIOSH/DART conclusion is to conduct exposure monitoring and perform other appropriate workplace analyses. This is important to further define the range of exposure and ensure adequate controls and work practices. It is also important because UNICOR should not presume that NIOSH/DART happened to capture

the highest possible exposure, as well as because feeders do not wear respiratory protection. UNICOR should also evaluate the relative pressure and air flow patterns of the glass breaking enclosure and area to determine if ventilation improvements have mitigated the condition contributing to feeder exposures (also see Conclusion 5, above).

9. The UNICOR consultant and OSHA noted deficiencies in the PPE barrier during glass breaking that contributes to inmate worker skin and clothing contamination. Also, glove removal techniques were noted by both the consultant and OSHA as requiring improvements to avoid skin contamination. The consultant made corrective action recommendations to address these issues in its report of February 2006. However, OSHA noted similar deficiencies in its inspection of November 2006. OSHA reiterated that the consultant's recommendations should be implemented and provided additional recommendations, as well. The FCI Marianna Factory Manager stated that further improvements were implemented after the OSHA inspection.

10. Maintenance of existing housekeeping practices and implementation of an operations and maintenance (O&M) plan will serve to control potential exposure from existing contamination. An element of the O&M plan could include periodic clean-up of surfaces by inmate workers: however, this would have to be performed using proper hazard controls and work practices.

11. NIOSH/DART found that a surface wipe sample in the FPC glass breaking room contained very high levels of lead and cadmium, indicating the need for improved cleaning of this area, should glass breaking be restarted or should the enclosure and LEV system be decommissioned. [Note: The FCI Marianna Factory Manager stated that the glass breaking room has been cleaned since glass breaking was suspended in 2008, and that the LEV system remains intact, but has not been cleaned. Effectiveness of cleaning should be verified through surface wipe sampling.]

12. NIOSH/HETAB concluded that the results of medical surveillance conducted on staff and inmates were unremarkable regarding lead and cadmium and that there is no evidence to support allegations of exposure to ionizing radiation. Further medical surveillance is not required unless the glass breaking operations are restarted (see Attachment 3).

13. Based on interviews of 35 staff and inmates at FCI Marianna, NIOSH/HETAB concluded that none of the reported health effects can be related to exposure from recycling of electronics.

5.2 Heat Exposure

14. Based on the FOH and NIOSH/DART heat exposure investigation, heat measurements, and work load estimates, workers performing glass breaking and

many other recycling activities at FCI Marianna are at risk of excessive heat exposure. Heat exposures exceeded the ACGIH-TLVs and the NIOSH RELs (see Enclosures 1, 4, and 5.). An HVAC system has since been installed in the glass breaking building, which could mitigate heat exposure in this area.

15. After reviewing BOP documents initially developed for heat exposure control in response to the heat exposure findings, FOH concluded that FCI Marianna Heat Stress Procedures developed by BOP lacked many of the steps, information, and detail necessary to ensure management and control of the heat stress hazard. FOH emphasized the need to develop a heat stress procedure consistent with ACGIH-TLVs, Heat Stress and Heat Strain, as well as OSHA-Recommended Elements of a Heat Stress Program. In response, UNICOR prepared a document titled Heat Stress Program and dated 09/26/08. This latest program will be evaluated by FOH prior to the completion of the OIG investigation.

5.3 Safety and Health Programs, Plans, and Practices

16. UNICOR's document entitled "Glass Recycling Operational Requirements" specifies requirements for lead and cadmium biological monitoring, training, engineering controls, exposure monitoring, PPE, respiratory protection, hygiene practices, housekeeping and cleaning practices, and others. This procedure contains information that is required in a lead and/or cadmium compliance plan.

17. NIOSH/DART reported on the type of PPE and respiratory protection that was worn by breakers and feeders during glass breaking operations. The PPE was consistent with the requirements of the UNICOR operational requirements. However as discussed in Section 5.1, feeders can be exposed to cadmium at higher levels than breakers and to lead at similar levels. Therefore, the data do not support differences in respiratory protection use between feeders and breakers. More importantly, improvements in engineering controls are necessary to prevent feeder exposure. Also, a UNICOR consultant and OSHA recommended improvements necessary for the PPE barrier and glove removal techniques to prevent skin contamination, and these should be implemented and verified as effective. If glass breaking is resumed, all improvements should be implemented and included in written safety and health documents.

18. UNICOR-FCI Marianna's respiratory protection documentation and its operational requirements do not mention the use of PAPRs, but rather list the use of other types of respiratory protection. UNICOR should update its respiratory protection documentation and operational requirements to reflect the type of respiratory protection in use, as well as the proper use, cleaning, maintenance and other requirements for the hooded PAPRs.

19. For general activities conducted on the factory floor (i.e., disassembly and materials handling), a written safety and health document to define existing workplace hazards and control measures is not in place for UNICOR recycling

conducted specifically at FCI Marianna. As a "good practice" approach, such a document should be developed and implemented and would serve to concisely define the safety and health practices and requirements specific to FCI Marianna recycling, such as PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping and cleaning practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Non-routine or periodic work activities should also be addressed in the document, particularly those that potentially disturb dusts such as cleaning and handling/disposing of wastes from HEPA vacuums or containers. The document could also specify requirements for periodic site assessments, hazard analyses, inspections, and regulatory compliance reviews.

20. UNICOR does not have an adequate hazard analysis program in place at FCI Marianna and many of its other factories. Examples of hazards not properly identified, evaluated, and controlled include heat, noise, dust and PBRs from sanding of laptop plastic casings, and feeder cadmium exposures at times.

5.4 Health and Safety Regulatory Compliance

21. Current routine FCI Marianna operations conducted in the factory and other associated areas (not including glass breaking) are in compliance with the OSHA lead and cadmium standards regarding control of employee exposure.

22. Personal exposures during glass breaking operations were less than the OSHA lead and cadmium PELs as 8-hour TWAs. However, feeder cadmium exposure of up to 6.8 $\mu g/m^3$ (for the duration sampled of 143 minutes) without benefit of respiratory protection should be reduced (see Section 6.0, Recommendations for further information). This exposure as an 8-hour TWA is 2 ug/m3 which is nearly at the action level of 2.5 $\mu g/m^3$. The exposure indicates escape of cadmium dusts from the glass breaking enclosure on some days, and this condition should be corrected prior to any restart of glass breaking. UNICOR and FCI Marianna should not presume that NIOSH/DART captured the highest possible exposure on its two days of sampling.

23. UNICOR's "Glass Recycling and Operational Requirements" provide sufficient documentation to ensure compliance with the lead and cadmium standards, assuming effective implementation. However, if glass breaking is resumed, the improvements to prevent feeder exposure and contaminant release outside the enclosure should be documented in procedure, implemented, and verified as effective.

24. At the time of the August 2007 FOH and NIOSH/DART investigation, UNICOR did not provide for heat exposure controls at FCI Marianna and exposures were above ACGIH TLVs and NIOSH RELs for heat. Although OSHA does not have a heat exposure standard, it can enforce heat exposure controls under the General

Duty Clause. UNICOR should implement FOH and NIOSH/DART recommendations for heat exposure control (see Section 6.0 and also Enclosures 1, 4, and 5).

25. UNICOR has not conducted noise monitoring as recommended by OSHA and as required to ensure compliance with 29 CFR 1910.95, Noise. UNICOR has not conducted quality checks to determine effective control of lead and cadmium contamination as recommended by OSHA (see Enclosure 2). This indicates that UNICOR is not consistently responsive in correcting safety and health deficiencies and responding to findings, conclusions, and recommendations.

26. Also see Conclusion 19 in Section 5.3 regarding the lack of hazard analysis and controls for various hazards.

5.5 Environmental Compliance

27. TCLP results from various accumulated dust samples in the FCI Marianna recycling facilities showed that this material exceeded the TCLP criteria for lead and cadmium. UNICOR should perform additional testing to determine if the collected material should be treated as a hazardous waste according to U.S. EPA regulations.

28. Bulk dust and surface wipe samples collected from the previously leased 'Blue' and 'Gold' buildings show that lead and cadmium contamination is present on various surfaces. All soil samples collected outside the Blue building and dust samples from the floor of the Gold building were not found to be hazardous waste based on TCLP testing for lead and cadmium.

6.0 RECOMMENDATIONS

Recommendations concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at FCI Marianna are provided below under the following subdivisions:

- Heavy Metals Exposures;
- Heat Exposure;
- Safety and Health Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

These recommendations relate to the conclusions presented in Section 5.0, above. Some recommendations are taken from supporting documents such as the NIOSH/DART report (Enclosure 1), OSHA inspection report (Enclosure 2), NIOSH/HETAB report (Enclosure 3) and FOH reports (Enclosures 4 and 5). See these reports for additional recommendations. Other recommendations are developed by FOH from the body of data and documents reviewed to prepare this report. Various recommendations may apply to all UNICOR recycling factories where similar e-waste recycling activities are performed.

Recommendations are provided for current factory operations as well as glass breaking operations that were suspended in early 2008. Recommendations that apply to glass breaking at FCI Marianna are only applicable if glass breaking is resumed there; however, the recommendations may also be relevant to glass breaking operations performed at other UNICOR factories.

As a global recommendation, BOP and UNICOR should ensure that it has and allocates the appropriate level of staff, other personnel resources, and material resources to effectively implement these recommendations and to sustain an effective ES&H program over time.

6.1 Heavy Metals Exposures

1. If glass breaking is to be restarted, UNICOR should evaluate the LEV system, ventilation system, relative pressure conditions, and air flow patterns of the glass breaking enclosure and glass breaking building to ensure that airborne contamination is effectively captured by the LEV, contained in the enclosure, and not released to the breathing zone of feeders and other areas outside the enclosure. Several episodes of feeder monitoring should also be conducted to verify control of feeder exposure. Also see NIOSH/DART glass breaking room LEV and ventilation recommendations, below.

2. Feeders should wear respiratory protection during glass breaking operations at FCI Marianna, until feeder exposures are verified and documented to be controlled at levels well below the lead and cadmium action levels. This recommendation is based on feeder exposures for cadmium at levels far higher than breakers on some days and feeder exposures for lead at levels similar to breakers. UNICOR should also apply this recommendation to other glass breaking factories if data collected for those operations indicate similar exposure conditions as FCI Marianna.

3. As recommended by NIOSH/DART, NIOSH/HETAB, and OSHA, UNICOR should continue use of PAPRs for breakers and for workers conducting filter change-out (see Enclosure 1, Recommendation 9 and Enclosures 2 and 3).

4. NIOSH/DART recommended that UNICOR further evaluate the feeders' exposures during routine glass breaking operations to determine the source of their airborne exposures to cadmium and lead (see Enclosure 1, Section VI). This evaluation should be performed in the context of the improved HVAC system and the further NIOSH/DART recommendations for LEV and ventilation improvements. As part of this evaluation, UNICOR should conduct exposure monitoring for feeders and breakers to determine whether the NIOSH/DART lead and cadmium exposures for feeders found during the OIG investigation have been

mitigated. Several sampling episodes should be conducted to determine the level of feeder exposure relative to breakers and exposure limits, as well as to determine the degree of daily variability in exposure levels. UNICOR could then determine future and on-going respiratory protection requirements for feeders and any additional engineering and work practice controls based on a substantial and conclusive set of data. The evaluation should also gather information such as types and volumes of CRTs processed, weather conditions and the positioning of the bay door, ventilation performance, work practice consistency, and other elements that could contribute to higher or lower exposures.

5. In addition to the exposure monitoring recommended above, UNICOR should periodically conduct at least a limited amount of personal exposure monitoring that characterizes exposures resulting from current work activities conducted during glass breaking, LEV filter change-out, and general factory activities. This monitoring will serve to document continued control of the lead and cadmium hazards. An annual monitoring program would be appropriate. This recommendation, which goes beyond the requirements of the OSHA lead and cadmium standards, would provide important documentation to establish consistently low exposures.

6. As required by OSHA lead and cadmium standards, UNICOR should also promptly conduct exposure monitoring for any future changes that could result in an increased level of exposure, such as changes in work operations, work processes/practices, quantities or types of materials processed, new activities, and non-routine activities. Periodic monitoring should be conducted to evaluate any existing or newly developed engineering controls to make sure that the controls are operating at the design parameters.

7. UNICOR should develop and implement an operations and maintenance (O&M) plan to ensure that surface contamination is minimized and that existing contamination is not released that could result in inhalation or ingestion exposures. Elements of this plan could include:

   - Identification of activities that could disturb contamination (e.g., HVAC maintenance, periodic or non-routine cleaning of elevated or other surfaces, access to areas where higher levels of surface contamination are present, and various building maintenance functions);

   - Processes to identify and control hazards for routine and non-routine activities (e.g., job hazard analysis process prior to conducting certain work with identification of mitigating actions);

   - Mitigating techniques and procedures during activities of concern (e.g., dust suppression and/or clean-up and capture, filter removal and bagging processes, and use of PPE and respiratory protection);

- Training and hazard communication;

- Disposal of contaminated materials based on testing data such as TCLP tests; and

- Periodic inspection, monitoring and evaluation of existing conditions, as appropriate. Exposure monitoring is particularly recommended for activities that can disturb surface dust. [Note: Follow-up surface sampling is important to ensure that surface contamination does not build up and to take preventive and corrective action, if it does.]

At UNICOR's discretion, the O&M plan could also include periodic clean-up of surfaces by inmate or other workers; that is, surfaces that are not subject to routine clean-up and housekeeping activities. If this element were adopted, however, UNICOR should ensure that practices to control exposures are included in the plan and implemented, such as appropriate worker training, PPE, respiratory protection, exposure monitoring, clean-up methods (e.g., HEPA vacuuming and wet methods), waste disposal, hygiene practices, and others deemed appropriate by UNICOR. Initial exposure monitoring should be conducted to determine whether exposure during clean-up is above the action levels for lead and cadmium. TCLP testing should also be conducted on waste materials generated to ensure proper disposal. Controls for future clean-up activities should then be based on exposure results. [Note: See FOH report for USP Lewisburg [FOH 2009] that describes the preparation, hazard analysis, training, controls, work practices, and performance of a clean-up activity conducted for warehouse elevated surfaces. This is a noteworthy practice that could serve as a model for other activities conducted under an O&M plan.]

8. Should UNICOR decide to permanently stop CRT breaking at FCI Marianna, it should decontaminate and decommission the LEV and enclosure systems. If performed, this activity should be preceded by proper hazard analysis, training, preparation, development and implementation of work practices and hazard controls, exposure monitoring, hazardous waste testing and disposal, and clearance sampling. Depending upon the hazard analysis results, this could be performed by a remediation contractor or inmate workers under an O&M Plan. If the latter option is chosen, UNICOR should ensure the preparations described above are in place and should ensure that inmate workers are trained and qualified to perform this task.

9. UNICOR should evaluate the PPE practices for glass breaking at FCI Marianna relative to the UNICOR consultant and OSHA findings and recommendations of 2006 (Enclosure 2). UNICOR should verify and ensure that these recommendations have been implemented and sustained. UNICOR should implement the quality checks (i.e., surface, glove, respirator mask, and skin contamination sampling) recommended by OSHA to verify contamination control.

10. As recommended by NIOSH/DART, UNICOR should improve the LEV system serving the glass breaking room, if glass breaking is to be restarted. Improvements should include operating the system with both outside (fresh) and recirculated air while maintaining a negative pressure in the glass breaking room, and providing continuous monitoring of the exhaust/recirculated air stream to ensure effective capture of toxic metals (see NIOSH/DART report Enclosure 1, Section VI for details). Any modifications of the LEV system should be made in consultation with a qualified industrial ventilation engineer. In addition, UNICOR should investigate the use of an alternative method, such as static pressure drop, to determine the frequency of filter changes for the LEV system (see Enclosure 1, Recommendation 8).

11. As recommended by NIOSH/HETAB, if the glass breaking operations are restarted, UNICOR should continue to perform the limited biological monitoring that is currently in place as an additional safeguard against excessive exposure and to provide reassurance to inmates and staff. There is no need to perform medical surveillance if glass breaking remains suspended. For new, modified, or non-routine activities, job hazard analysis should be performed and if medical surveillance is indicated for these activities, then BOP and UNICOR should perform pre-placement evaluations of exposed staff and inmates that are overseen by an occupational medical physician (see Attachment 3).

6.2 Heat Exposure

12. UNICOR has prepared a Heat Stress Program dated 09/26/08, which will be evaluated prior to the completion of the OIG investigation. UNICOR should ensure that the recommended FOH and NIOSH/DART elements of a heat stress program as detailed in Enclosures 1, 4, and 5 are being implemented. UNICOR should apply the ACGIH-TLVs in the context of a thorough understanding of the various protective clothing ensembles available and used in hot weather periods and the role that PPE plays on the effects of heat stress.

6.3 Safety and Health Programs, Practices, and Plans

13. UNICOR should revise its respiratory protection program and operational procedures to include use, maintenance, cleaning, training and other requirements for PAPRs. UNICOR should ensure that both its written requirements and current practices are consistent. NIOSH/DART further recommends that UNICOR evaluate FCI Marianna's operations to ensure compliance with OSHA respiratory protection requirements. NIOSH/DART also points out that the PAPRs used at FCI Marianna for glass breaking are manufactured by a company in bankruptcy, which could result in PAPR approvals being placed in the "Obsolete" category and could limit availability of parts. UNICOR and FCI Marianna should determine whether current or alternate PAPRs should be used in the future (see Enclosure 1, Recommendation 2). Procedures should be revised accordingly.

This determination applies to all UNICOR facilities that use this manufacturer of PAPRs.

14. As a good practice approach, NIOSH/DART recommends that UNICOR should improve its change room and decontamination process to be consistent with methods and facilities typically utilized for transitioning from contaminated containment areas to general work area. For details, see Enclosure 1, Section VI, and Recommendation 11. This recommendation applies to all UNICOR factories that perform glass breaking.

15. UNICOR should evaluate FCI Marianna work activities for hazards related to lifting and repetitive stress, and implement any appropriate procedures, training, or equipment to address the hazards (see Enclosure 1, Recommendation 3).

16. UNICOR should implement hearing conservation practices as indicated by FOH noise monitoring results and should prepare a written hearing conservation program for the FCI Marianna recycling activities.

17. UNICOR should develop and implement a hazard analysis program that includes baseline hazard analysis for current operations and also job (activity-specific) hazard analysis (JHA) for both routine and non-routine activities. UNICOR and FCI Marianna should conduct JHAs for any new, modified, or non-routine work activity prior to the work being conducted. It should also conduct hazard analyses of existing processes that have not had such an analysis. The JHA process is intended to identify potential hazards and implement controls for the specific work activity prior to starting the work. For instance, the JHA process should be integral to an effective O&M plan, as described in Section 6.1.

18. BOP, UNICOR and FCI Marianna should ensure that staff and consultants conducting ES&H assessments, evaluations, inspections, and monitoring activities are qualified for their assigned tasks and led by certified or highly qualified professionals. One benchmark for vetting individuals performing industrial hygiene services is the ensure certification in the practice of industrial hygiene (CIH) by the American Board of Industrial Hygienists (AIHA). Also see the NIOSH/HETAB regarding this recommendation.

19. BOP and UNICOR should implement a system to list, track, and document closure of any identified deficiencies or recommendations, regardless of the source. Closure of deficiencies and recommendations with documentation of those accepted and implementation details, along with those not accepted or pending (and why) is important to document improvement actions. This recommendation applies to all UNICOR recycling factories. This topic will be discussed in further detail in the final OIG report. [Note: Examples of UNICOR failing to implement recommendations at FCI Marianna include the OSHA recommendations for noise monitoring and contamination control verification testing, among others.]

6.4 Health and Safety Regulatory Compliance

20. UNICOR should conduct a noise survey as recommended by OSHA in 2006 (Enclosure 2) to ensure compliance with 29 CFR 1910.95, Noise. Some noise monitoring was conducted by a safety representative at FCI Marianna in 2005, but this data was questionable (see Section 4.5). UNICOR has not conducted noise monitoring in response to the OSHA recommendation of November 2006. UNICOR should not rely solely upon the FOH noise monitoring conducted as part of the OIG investigation. UNICOR should implement a hearing conservation program as indicated by its monitoring results and FOH data.

21. If glass breaking is resumed, UNICOR should correct the conditions causing elevated feeder exposure and should ensure the effective containment of toxic metal contaminants within the glass breaking enclosure. UNICOR should verify through evaluation and monitoring that exposures for feeders and other personnel outside the glass breaking enclosure are well controlled.

22. UNICOR should ensure the evaluation of heat exposures and implement hazard controls accordingly.

23. UNICOR should evaluate and appropriately control ergonomic hazards.

24. Also see hazard analysis recommendations in Section 6.3.

6.5 Environmental Compliance

25. Based on TCLP results from accumulated dust samples, UNICOR should treat dusts collected from cleaning, sweeping, or other recycling operations in the factory and associated facilities as hazardous waste, unless UNICOR performs testing that demonstrates otherwise.

26. The testing results from samples collected at the formerly leased 'Blue' and 'Gold' buildings should be provided to the building owners.

27. UNICOR and FCI Marianna should incorporate e-waste recycling requirements in the 2005 FCI Marianna Hazardous Materials Management policy/guidance or prepare a separate document with such information specifically for UNICOR recycling at FCI Marianna.

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ATTACHMENTS

ATTACHMENT 1

FCI Marianna Wipe/Bulk/TCLP Data Table

Samples Collected in E-Waste Recycling Areas of the FCI and FCP Factories (by FOH on 8/8/2007 - 8/9/2007)

Sample #	Sample Type	Building/Area	Surface/ Item	Description	Lead			Cadmium		
	W=Wipe; B=Bulk; TCLP=Toxic Characteristic Leaching Procedure				µg/ft^2	mg/kg	mg/l (extractable)	µg/ft^2	mg/kg	mg/l (extractable)
1	B	Breakdown (FCI)	Floor	Debris from sweeping		3700			670	
2	B	Reburbishment (FCI)	Floor	Debris from sweeping		420			100	
3	W	Reburbishment (FCI)	Floor	At sanding area	430			54		
4	W	Reburbishment (FCI)	Floor	At TV dissasembly line	320			11		
5	W	Reburbishment (FCI)	Metal cabinet	From top of yellow cabinet	240			19		
6	W	Breakdown (FCI)	Floor	At East Breakdown line	680			66		
7	W	Breakdown (FCI)	Floor	At East Compactor	76			27		
8	W	Breakdown (FCI)	Cabinet	Top of safety cabinet next to West Compactor	93			26		
9	W	Breakdown (FCI)	Floor	At West Breakdown line	81			39		
10	W	Breakdown (FCI)	Floor of Trailer	From floor of tractor trailer supplying bulk e-waste	110			9		
11	Water (TCLP)	Reburbishment (FCI)	Floor	Mop rinse			0.03			0.01
12a	B (TCLP)	eBay area in Main Warehouse (FPC)	Floor	Composite of dust from 3 fence post holes in floor			58			26
12b	B	eBay area in Main Warehouse (FPC)	Floor	Composite of dust from 3 fence post holes in floor		1100			390	
13	W	eBay area in Main Warehouse (FPC)	Metal	Light fixture	32			4		
14	W	eBay area in Main Warehouse (FPC)	Metal	Ventilation duct in center of room	490			150		
15	W	eBay area in Main Warehouse (FPC)	Metal	Ventilation duct at north wall	670			250		
16	B (TCLP)	Camp Loading Dock (FPC)	Floor of Trailer	Truck sweepings (debris) (TCLP)			0.09			0.06
17	B (TCLP)	Camp Loading Dock (FPC)	Floor of Trailer	Truck sweepings (debris) (TCLP)			0.07			0.01
18	W	Camp Warehouse (FPC)	Floor	Sorting & intake floor	26			1		
19	W	Camp Warehouse (FPC)	Counter top	Top of counter, laptop refinishing	30			1		
20	W	Camp Warehouse (FPC)	Cabinet top	Top of cabinet at wall storage	11			1		

ATTACHMENT 2

FCI Marianna Surface Wipe Data - Blue and Gold Buildings
Samples Collected 08/07/07

Sample #	Building Name	Description	Lead	Cadmium
			µg/ft²	µg/ft²
MXMTW-1	Gold Building	Top of duct (about 12' High)	750	100
MXMTW-2	Gold Building	Top of beam (about 20' high)	530	59
MXMTW-3	Gold Building	Top of duct	740	120
MXMTW-4	Gold Building	Top of duct	570	90
MXMTW-5	Gold Building	I-beam surface	330	37
MXMTW-6	Gold Building	Floor at base of beam 2	67	3
MXMTW-7	Gold Building	Floor at base of beam 4	69	3
MXMTW-8	Gold Building	Floor at base of beam 6	84	4
MXMTW-9	Gold Building	Floor at base of beam 8	91	6
MXMTW-10	Gold Building	I-beam	560	78
MXMTW-11	Gold Building	I-beam	310	38
MXMTW-12	Gold Building	Duct	660	120
MXMTW-13	Gold Building	Top of duct	830	150
MXMTW-14	Gold Building	Top of duct	840	150
MXMTW-15	Gold Building	I- beam	470	60
MXMTW-16	Gold Building	Ductwork at beam	760	100
MXMTW-21	Blue Building	On center I-beam (about 20' high)	1400	91
MXMTW-22	Blue Building	On center I-beam (about 20' high)	2200	99
MXMTW-23	Blue Building	On center I-beam (about 20' high)	3900	60
MXMTW-24	Blue Building	On center I-beam (about 20' high)	1500	79
MXMTW-25	Blue Building	Floor - S/W corner, about 24' from each wall	81	4
MXMTW-26	Blue Building	Floor - N/E corner, about 24' from each wall	16	2
MXMTW-27	Blue Building	Floor - N/W corner, about 24' from each wall	110	19
MXMTW-28	Blue Building	Floor - S/E corner, about 24' from each wall	100	13
MXMTW-29	Blue Building	On I-beam, S side of building, between E wall and center line	830	74
MXMTW-30	Blue Building	Top of Dayton heater nearest S/E corner	1700	480
MXMTW-31	Blue Building	Top of Dayton heater, North on E. wall	1300	350
MXMTW-32	Blue Building	Top of Dayton heater, center on East wall	1700	750
MXMTW-33	Blue Building	Support between garage doors	920	230
MXMTW-34	Blue Building	Beam	1100	210
MXMTW-35	Blue Building	Upper wall beam along W wall, about 1/3 toward S end	1100	120
MXMTW-36	Blue Building	Upper wall beam along W wall, about 2/3 toward S end	1100	130

ATTACHMENT 3

FCI Marianna TCLP Results - Blue and Gold Buildings
Samples Collected 08/07/07

Sample #	Sample Type W=Wipe B=Bulk	Building Name	Surface/Item	Description	Area Wiped (Sq. Ft.)	Lead mg/l (extractable)	Cadmium mg/l (extractable)
MXMTS-1	W	Blue Building	Soil	Test for lead and run-off metals	0.35	<0.1	<0.01
MXBTS-1	W	Blue Building	Soil	Test for lead and run-off metals	0.35	<0.1	<0.01
MXMTS-2	W	Blue Building	Soil	Test for lead and run-off metals	0.35	<0.1	<0.01
MXMTS-3	W	Blue Building	Soil	Test for lead and run-off metals	0.35	<0.1	<0.01
MXMTS-4	W	Blue Building	Soil	Test for lead and run-off metals	0.35	<0.1	0
MXMTS-5	W	Blue Building	Soil	Test for lead and run-off metals	0.35	<0.1	0
MXMTB-1	B	Gold Building	Dust pile	Pile nearest garage doors (south side)	0.35	<0.1	0.01
MXMTB-2	B	Gold Building	Dust pile	Pile in center of building	0.00	<0.1	0.03
MXMTB-3	B	Gold Building	Dust pile	Pile @ north end of building	0.00	0.14	0.16
MXMTB-4	Filter	Gold Building	Filter on swamp cooler	Pieces of filter	0.00	0.13	0.23

ENCLOSURES

ENCLOSURE 1

CONTROL TECHNOLOGY AND EXPOSURE ASSESSMENT FOR ELECTRONIC RECYCLING OPERATIONS, UNICOR MARIANNA FEDERAL CORRECTIONAL INSTITUTION MARIANNA, FLORIDA

REPORT DATE:
October 2008

REPORT NUMBER:
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SITES SURVEYED:	UNICOR Recycling Operations Federal Correctional Institution Marianna, Florida
NAICS:	562920
SURVEY DATE:	August 8 - 9, 2007
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EXECUTIVE SUMMARY

Researchers from the National Institute for Occupational Safety and Health (NIOSH) conducted a study of the recycling of electronic components at the Federal Prison Industries, Inc. (FPI) facilities (aka, UNICOR) in Marianna, Florida, in August, 2007 to assess worker exposures to metals and other occupational hazards, including heat, associated with these operations.

The electronics recycling operations at Marianna can be organized into four production processes: a) receiving and sorting, b) disassembly, c) glass breaking operations, and d) packaging and shipping. A fifth operation, cleaning and maintenance, was also addressed but is not considered a production process per se. It is known that lead, cadmium, and other metals are used in the manufacturing of electronic components and pose a risk to workers involved in recycling of electronic components if the processes are not adequately controlled or the workers are not properly trained and provided appropriate personal protective clothing and equipment.

Methods used to assess worker exposures to metals during this evaluation included: personal breathing zone sampling for airborne metals and particulate; surface wipe sampling to assess surface contamination; and bulk material samples to determine the composition of settled dust. Samples were analyzed for 31 metals with five selected elements (barium, beryllium, cadmium, lead and nickel) given emphasis. Heat exposures were determined using wet bulb globe temperature monitors.

The results of air sampling conducted during the August visit indicated no overexposures of workers to metals above the most stringent occupational exposure limits during the routine and non-routine operations evaluated during that site visit. The highest exposures to metals (as determined by both arithmetic and geometric means) occurred to workers in the Federal Prison Camp (FPC) glass breaking operation while changing filters, while workers in the Federal Prison Camp (FPC) UNICOR factory had the highest exposure to airborne particulate during routine production operations. The results of two of those samples were affected by unanticipated events. In one instance, a worker touched the inlet of the cassette with her glove and some lint was sucked onto the filter. In the other, a worker unloading a truck reported that toner spilled onto her from surplus equipment she was unloading. When those two samples (which did not exceed allowable limits) are not considered, the particulate concentrations are well below levels of concern. When those two samples are not included in the analyses, the FPC glass breakers had the highest particulate exposures. These occurred during the filter change operation.

Exposures to airborne metals during the filter change-out maintenance operation were higher than exposures during other operations in the FPC but were below the most stringent occupational exposure limits. Total airborne particulate levels were higher during this operation than elsewhere, when the two samples described above are disregarded. Total particulate concentrations during routine glass-breaking operations ranged from <71 $\mu g/m^3$ (140 minute sample) for a breaker to 891 $\mu g/m^3$ (147 minute sample) for a feeder. During the filter change operation, they ranged from 4,912 $\mu g/m^3$ (57 minute sample) for a worker working inside the glass-breaking booth to 274 $\mu g/m^3$ (45 minute sample) for a worker outside the booth. All airborne particulate measurements representing potential exposures during routine and non-routine operations were, however, below applicable occupational exposure limits (e.g., the OSHA PEL of 15 mg/m^3 (15000 $\mu g/m^3$), 8-hr TWA for total particulate).

Although beryllium is used in consumer electronics and computer components, such as disk drive arms (beryllium-aluminum), electrical contacts, switches, and connector plugs (copper-beryllium) and printed wiring boards [Willis and Florig 2002, Schmidt 2002], beryllium in this study was not detected at levels above the detection limit of the analytical method. Most of the recycling activities at this facility resemble typical maintenance activities on consumer products (e.g., personal computers), such as opening cases and removing components. Willis and Florig [2002] noted that most beryllium "in consumer products is used in ways that are not likely to create beryllium exposures during use and maintenance." This may account for the results seen at this facility. Other e-recycling activities that include further processing, such as shredding of the components, may produce higher exposures to beryllium but shredding does not occur at this facility.

Samples collected during routine daily glass breaking operations showed that the highest exposure was less than 10% of the OSHA PEL for lead of 50 $\mu g/m^3$ 8 hr TWA (4.5 $\mu g/m^3$ 8hr TWA for a 109 minute sample). The highest lead exposure measured during the filter change operation was 12.5 $\mu g/m^3$ 8 hr TWA for a 57 minute sample. The highest cadmium result during routine glass breaking was 2.0 $\mu g/m^3$ 8hr TWA for a 143 minute sample, less than half the OSHA PEL of 5 $\mu g/m^3$ 8hr TWA. During the filter change operation, the highest cadmium concentration was 1.4 $\mu g/m^3$, 8hr TWA, for a 57 minute sample. Samples collected on disassembly workers in the FCI factory area and on workers in the FPC factory area were well below levels of concern for cadmium, lead and nickel. Unless specified, the results of the samples presented are for the duration of sample and not calculated on an 8 hour time-weighted average basis.

Lead, cadmium and other heavy metals were detected in the surface wipe and bulk dust samples. There are few established standards available for wipe samples with which to compare these data. Some of the surfaces tested for lead indicated levels exceeding the most stringent criteria. The wipe sample results can not be used to determine when the contamination occurred. They only represent the surface contamination present at the time the sample was collected.

Environmental heat monitoring and estimates of work rate indicated that some workers in this facility were exposed to heat stress (e.g., above the ACGIH® TLV®) or at risk of heat stress (e.g., exceeding the ACGIH® Action Limit) during this survey period. The locations where heat stress was noted included the glass breaking operation (breakers, feeders, and outside workers) and the warehouse (truck crew), while a risk of heat stress was noted in the warehouse (other workers), FCI-disassembly and FCI-Refurbish.

Recommendations resulting from this study include:

- The implementation of a site specific health and safety program at Marianna that includes a heat stress program.
- The respiratory protection program for this facility should be evaluated to ensure that it complies with OSHA regulations.
- Attention should be focused on practices to prevent accidental ingestion of lead and other metals, such as housekeeping to reduce surface contamination and hand washing to prevent hand-to-mouth transfer of contaminants.
- Management should evaluate the feasibility of providing and laundering work clothing for all workers in the recycling facility.
- Change rooms should be equipped with separate storage facilities for work clothing and for street clothes to prevent cross-contamination.
- All UNICOR operations should be evaluated from the perspective of health, safety and the environment in the near future.

A comprehensive program is needed within the Bureau of Prisons to assure both staff and inmates a safe and healthy workplace.

I. INTRODUCTION

Researchers from the National Institute for Occupational Safety and Health (NIOSH) conducted a study of exposures to metals and other occupational hazards associated with the recycling of electronic components at the Federal Prison Industries (aka, UNICOR) in Marianna, Florida*. The principal objectives of this study were:

1. To measure full-shift, personal breathing zone exposures to metals including barium, beryllium, cadmium, lead and nickel.

2. To evaluate contamination of surfaces in the work areas that could create dermal exposures or allow re-entrainment of metals into the air.

3. To identify and describe the control technology and work practices used in operations associated with occupational exposures to beryllium, as well as to determine additional controls, work practices, substitute materials, or technology that can further reduce occupational exposures to beryllium and other metals.

4. To evaluate the use of personal protective equipment in operations involved in the recycling of electronic components.

Other objectives such as a preliminary evaluation of heat exposures and visual observations of undocumented hazards, were secondary to those listed above but are discussed in this document.

An evaluation was conducted August 8 - 9, 2007, by NIOSH researchers from the Engineering and Physical Hazards Branch, Division of Applied Research and Technology, Cincinnati, Ohio. During this evaluation, two full shifts of environmental monitoring were conducted for the duration of routine plant operations, and monitoring was also conducted during non-routine operations, such as cleaning and maintenance as described in Section II (Process Description) and Section III (Sampling and Analytical Methods).

Computers and their components contain a number of hazardous substances. Among these are "platinum in circuit boards, copper in transformers, nickel and cobalt in disk drives, barium and cadmium coatings on computer glass, and lead solder on circuit boards and video screens" [Chepesiuk 1999]. The Environmental Protection Agency (EPA) notes that "In addition to lead, electronics can contain chromium, cadmium, mercury, beryllium, nickel, zinc, and brominated flame retardants" [EPA 2008]. Schmidt [2002] linked these and other substances to their use and location in the "typical" computer: lead used to join metals (solder) and for radiation protection, is present in the cathode ray tube (CRT) and printed wiring board (PWB). Aluminum, used in structural components and for its conductivity, is present in the housing, CRT, PWB, and connectors. Gallium is used in semiconductors; it is present in the PWB. Nickel is used in structural components and for its magnetivity; it is found in steel housing, CRT and PWB. Vanadium functions as a red-phosphor emitter; it is used in the CRT. Beryllium, used for its thermal conductivity, is found in the PWB and in connectors. Chromium, which has decorative and hardening properties, may be a component of steel used in the housing. Cadmium, used in Ni-Cad batteries and as a blue-green phosphor emitter, may be found in the housing, PWB and CRT. Cui and

* This report documents the study conducted at Marianna, Florida. Other NIOSH DART field studies were conducted at Federal correctional facilities in Lewisburg, Pennsylvania and Elkton, Ohio.

Forssberg [2003] note that cadmium is present in components like SMD chip resistors, semiconductors, and infrared detectors. Mercury may be present in batteries and switches, thermostats, sensors and relays [Schmidt 2002, Cui and Forssberg 2003], found in the housing and PWB. Arsenic, which is used in doping agents in transistors, may be found in the PWB [Schmidt 2002].

Lee et al. [2004] divided the personal computer into three components, the main machine, monitor, and keyboard. They further divided the CRT of a color monitor into the "(1) panel glass (faceplate), (2) shadow mask (aperture), (3) electronic gun (mount), (4) funnel glass and (5) deflection yoke. Lee et al. [2004] note that panel glass has a high barium concentration (up to 13%) for radiation protection and a low concentration of lead oxide. The funnel glass has a higher amount of lead oxide (up to 20%) and a lower barium concentration. They analyzed a 14-in Philips color monitor by electron dispersive spectroscopy and reported that the panel contained silicon, oxygen, potassium, barium and aluminum in concentrations greater than 5% by weight, and titanium, sodium, cerium, lead, zinc, yttrium, and sulfur in amounts less than 5% by weight. Analysis of the funnel glass revealed greater than 5% silicon, oxygen, iron and lead by weight, and less than 5% by weight potassium, sodium, barium, cerium, and carbon. Finally, Lee et al. [2004] noted that the four coating layers are applied to the inside of the panel glass, including a layer of three fluorescent colors (red, blue and green phosphors) that contain various metals, and a layer of aluminum film to enhance brightness.

The reports referenced in the two preceding paragraphs cite the potential hazards of electronic waste by listing the constituents of electronic components. However, they do not cite any data on emissions or occupational exposures that resulted from recycling work practices. German investigators [BIA 2001, Berges 2008a] broke 72 cathode-ray tubes using three techniques (pinching off the pump port, pitching the anode with a sharp item, and knocking off the cathode) in three experiments performed on a test bench designed to measure emissions from the process. In contrast to the reports of potential hazards cited above, neither lead nor cadmium was detected in the total dust, with one exception, where lead was detected at a concentration of 0.05 mg/cathode ray tube during one experiment wherein the researchers released the vacuum out of 23 TVs by pinching off the pump port [BIA 2001, Berges 2008b]. They described this result as "sufficiently low that a violation of the German atmospheric limit value of 0.1 mg/m^3 need not generally be anticipated" [BIA 2001]. The researchers noted that "the working conditions must be organized such that skin contact with and oral intake of the dust are excluded" [BIA 2001].

There are very few articles documenting actual occupational exposures among electronics recycling workers. Sjödin et al. [2001] and Pettersson-Julander et al. [2004] have reported potential exposures of electronics recycling workers to flame retardants while they dismantled electronic products. Recycling operations in the Marianna facility are limited to disassembly and sorting tasks, with the exception of breaking CRTs and stripping insulation from copper wiring. Disassembly and sorting probably poses less of a potential hazard to workers than tasks that disrupt the integrity of the components, such as shredding or desoldering PWBs.

The process of greatest concern was the glass breaking operation (GBO, described below) that releases visible emissions into the workroom atmosphere. Material safety data sheets and other information on components of CRTs broken in this operation listed several metals, including lead, cadmium, beryllium and nickel. In addition, Federal Occupational Health (FOH) investigators expressed a particular interest in those metals and barium because of whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium, at electronics recycling operations overseen by Federal Prison Industries (UNICOR) at a number of BOP facilities around the country.

Due to the location and time of the evaluation at this facility, the potential for heat stress was also evaluated at the Marianna recycling operation. This information was presented to the Bureau of Prisons and FOH in an earlier report dated September 26, 2007 and is included as part of this report.

II. PROCESS DESCRIPTION

The recycling of electronic components at the Marianna Federal Correctional Institution (FCI) is done in two separate buildings: 1) the main factory located within the FCI main compound; and 2) the Federal Prison Camp (FPC) located approximately a quarter mile to the south on the same property. Diagrams of these work areas are shown in Figures I and II, respectively, with an enlargement of the GBO in Figure III. These figures provide the layout of the work process, although workers often moved throughout the various areas in the performance of their tasks. The population of the UNICOR FCI facility was approximately 205 workers and of the FPC approximately 86 workers.

The recycling of electronic components at this facility can be organized into four production processes: a) receiving and sorting, b) disassembly, c) glass breaking operations, and d) packaging and shipping. A fifth operation, cleaning and maintenance, will also be addressed but is not considered a production process per se.

Incoming materials destined for recycling are received at a warehouse where they are examined and sorted. A truck crew loads and unloads semi-trailers at the loading dock in the warehouse area. They unloaded two trailers on August 8 and loaded two and unloaded two on August 9. During this evaluation it appeared that the bulk of the materials received were computers, either desktop or notebooks, or related devices such as printers. Some items, notably notebook computers, could be upgraded and resold, and these items were sorted out for that task.

After electronic memory devices (e.g., hard drives, discs, etc.) were removed and degaussed or shredded, computer central processing units (CPUs), servers and similar devices were sent for disassembly; monitors and other devices (e.g., televisions) that contain CRTs were separated and sent for disassembly and removal of the CRT. Printers, copy machines and any device that could potentially contain toner, ink, or other expendables were segregated and inks and toners were removed prior to being sent to the disassembly area.

In the disassembly process external cabinets, usually plastic, were removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing were removed and sorted by grade for further treatment if necessary. Components such as circuit boards or chips that may have value or may contain precious metals such as gold or silver were removed and sorted. With few exceptions each of the workers in the main factory will perform all tasks associated with the disassembly of a piece of equipment into the mentioned components with the use of powered and un-powered hand tools (primarily screwdrivers and wrenches), with a few workers collecting the various parts and placing them into the proper collection bin. Work tasks included removing screws and other fasteners from cabinets, unplugging or clipping electrical cables, removing circuit boards, and using whatever other methods necessary to break these devices into their component parts. Essentially all components currently are sold for some type of recycling.

The third production process to be evaluated was the GBO where CRTs from computer monitors and TVs were sent for processing. This was an area of primary interest in this evaluation due to concern from staff, review of process operations and materials involved, and observations during an initial walk-through. This was the only process where local exhaust ventilation was utilized or where respiratory protection was in universal use. Workers in other locations would wear eye protection and occasionally would voluntarily wear a disposable respirator. Workers in the GBO wore personal protective equipment (PPE) based upon their assigned work.

Two outside workers moved inventory for feeders and breakers. One wore a tee-shirt, work pants and cloth gloves; the other wore a short-sleeve work shirt, work pants and cloth gloves. Two feeders removed CRTs from large (Gaylord) boxes and placed them on a roller conveyor for the breakers. Feeders wore spun-bonded olefin coveralls over tee-shirts and work pants, shoe covers, Kevlar® sleeve guards, and cloth work gloves with rubberized palms and fingers. Two breakers broke the funnel and panel glass. The breakers wore loose-fitting hood-type powered air-purifying respirators (PAPRs), (MB14-72 PAPR w/ Super Top Hood, Woodsboro, MD, Global Secure Safety), spun-bonded olefin coveralls over work pants and tee-shirts, shoe covers over work boots, cloth work gloves over rubber gloves, and Kevlar® sleeve guards. The PPE is kept in lockers against a wall in the GBO, opposite the glass-breaking booth. When the breakers are finished breaking glass, they clean the floor, first with brooms and then with a high-efficiency particulate air (HEPA) vacuum cleaner. The breakers leave the booth in their coveralls and PAPR, use another HEPA vacuum cleaner on their coveralls before removing them, then remove and dispose of their coveralls, remove their PAPRs and leave the work area. Shoes are HEPA-vacuumed before exiting the GBO (visitors are offered shoe covers). Battery chargers for the PAPRs are located on a bookcase against the wall adjacent to the glass-breaking booth in the staging area.

CRTs that had been removed from their cases were trucked to this process area in large boxes. These are staged by the outside workers using a pallet jack. The CRTs are lifted by hand from Gaylord boxes by the feeders and placed on a roller conveyor through an opening on the side of the glass breaking enclosure. The breakers roll the CRTs onto an angle-iron grate for breaking (see Figure IV). Each breaker stands on an elevated platform facing the grate, which is positioned in front of the local-exhaust ventilation unit described by the manufacturer as a reverse flow horizontal filter module (HFM). As the CRT moved from left to right in the booth the electron gun was removed by tapping with a hammer to break it free from the tube, then a series of hammer blows was used to break the funnel glass and allow it to fall through the grate into large Gaylord boxes (cardboard boxes approximately 3 feet tall designed to fit on a standard pallet) positioned below the grate. This was done at the first (left) station in Figure V. The CRT was moved to the second (right) station where any internal metal framing or lattice was removed before the panel glass was broken with a hammer and also allowed to fall into a Gaylord box. During the two days of sampling 293 and 258 CRTs were broken. Various sources on-site stated that "normal production" was approximately 300 CRTs per day. The work shift in the GBO was abbreviated due to the environmental heat on both days, and was further shortened on August 9 to allow time for the filter change procedure. Given the shortened work schedule, the production rate (number of CRTs broken) on the days of sampling was not thought to be lower than expected for a typical day. No count was made by the survey team regarding the number of color vs. monochrome monitors broken.

The HFMs were designed and manufactured by Atmos-Tech Industries (model HFM24-ST/RF/SP, Ocean City, NJ). Each unit is equipped with a bank of 35% efficient pleated pre-filters and a HEPA filter, a direct-drive 1200 cfm fan with a ½ horsepower motor, and a control panel with a minihelic pressure gauge and variable speed control. Air enters through the pre-filters in the front of the unit, passes through the HEPA filter, and is discharged into the room through a grille at the back of the unit. A frame attached to the front of each unit supports 24-in long plastic strip curtains on the front and sides. The top is enclosed with a sheet of ¼-inch clear polycarbonate plastic. The prefilters are held in place by a metal grille. Glass breaking is performed on top of an angle-iron grate inside the area enclosed by the strip curtains. Figure V shows the left-hand HFM, number 1.

The final production process, packing and shipping, returned the various materials segregated during the disassembly and glass breaking processes to the warehouse to be sent to contracted purchasers of those individual materials. To facilitate shipment some bulky components such as plastic cabinets or metal frames were placed in a hydraulic bailer to be compacted for easier shipping. Other materials were boxed or containerized and removed for subsequent sale to a recycling operation.

In addition to monitoring routine daily activities in the four production processes described above, environmental monitoring was conducted to evaluate exposures during the replacement of filters in the local exhaust ventilation system used for the GBO. This is a maintenance operation that occurs at approximately monthly intervals during which the two sets of filters in this ventilation system are removed and replaced. This operation was of particular interest because of concern expressed by management and workers and also because of elevated exposures documented in previous similar operations. Two workers in spun-bonded olefin coveralls, gloves and PAPRs remove both sets of filters, clean the system, and replace the filters. They are assisted by two additional workers who wear spun-bonded olefin coveralls and gloves while working outside the glass breaking enclosure. The filter change is a maintenance operation that occurs at approximately monthly intervals during which the ventilation system is shut down and all filters are removed and replaced. Initially the exhaust system components, including the accessible surfaces of the filters, are vacuumed with a HEPA vacuum. Then the filters are removed and bagged for disposal, and the area inside the filter housing is vacuumed. New filters are inserted to replace the old ones, the LEV system is reassembled, and any residual dust is HEPA vacuumed.

III. SAMPLING AND ANALYTICAL METHODS

Air sampling techniques

Methods used to assess worker exposures in this workplace evaluation included: personal breathing zone sampling for airborne metals and total particulate; surface wipe sampling to assess surface contamination; and bulk material samples to determine the composition of settled dust. Material safety data sheets and background information on CRTs and other processes in this operation listed several metals, including lead, cadmium, beryllium and nickel. Additionally, FOH personnel expressed specific interest in barium due to whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium, at electronics recycling operations overseen by Federal Prison Industries (UNICOR) at a number of BOP facilities around the country.

Personal breathing zone and general area airborne particulate samples were collected and analyzed for metals and airborne particulate. Samples were collected for as much of the work shift as possible, at a flow rate of 3 liters/minute (L/min) using a calibrated battery-powered sampling pump (Model 224, SKC Inc., Eighty Four, PA) connected via flexible tubing to a 37-mm diameter filter (0.8 μm pore-size mixed cellulose ester filter) in a 3-piece, clear plastic cassette sealed with a cellulose shrink band. These samples were subsequently analyzed for metals using inductively coupled plasma spectroscopy (ICP) according to NIOSH Method 7300 [NIOSH 1994] with modifications. It is possible to determine both airborne particulate as well as metals on the same sample by using a pre-weighed filter (for total particulate samples) and then post-weighing that filter to determine weight gain before digesting for metals analysis.

This analytical technique produces a measure for dust and a measure of 31 elements, including the five of particular interest mentioned above, and that information is appended to this report. Because Method 7300 is an elemental analysis, the laboratory report describes the amount of the element present in each sample (µg/sample) as the element. The method does not distinguish among the compounds which may have contained the element in the sample.

Because there is evidence that the presence of an ultrafine component increases the toxicity for chronic beryllium disease and possibly other toxic effects, information on the aerosol size distribution was collected to assist in evaluation of the potential exposure [McCawley et al. 2001]. An aerodynamic particle sizer (APS model 3321, TSI Instruments, Shoreview, MN) was used to collect this information on a real time basis with data transfer directly to a laptop computer. The number concentration [number of particles/cubic centimeter (cm^3)] of particles of various sizes was counted over the range from 0.5 to 20 µm a using time-of-flight technique. The sampler was placed inside of the glass-breaking enclosure.

Bulk sampling and analysis
Bulk material samples were collected by gathering a few grams of settled dust or material of interest and transferring this to a glass collection bottle for storage and shipment. These samples were analyzed for metals using NIOSH Method 7300 [NIOSH 1994] modified for bulk digestion.

Surface contamination technique
Surface wipe samples were collected using Ghost™ Wipes for metals (Environmental Express, Mt. Pleasant, SC) and Palintest® Dust Wipes for Be (Gateshead, United Kingdom) to evaluate surface contamination. These wipe samples were collected in accordance with ASTM Method D 6966-03 [ASTM 2002], with a disposable paper template with a 10-cm by 10-cm square opening. The templates were held in place by hand or taped in place, to prevent movement during sampling. Wipes were placed in sealable test tube containers for storage until analysis. Ghost Wipes™ were sent to the laboratory to be analyzed for metals according to NIOSH Method 7303 [NIOSH 1994]. Palintest wipes were analyzed for beryllium using the Quantech Fluorometer (Model FM109515, Barnstead International, Dubuque, Iowa) for spectrofluorometric analysis by NIOSH Method 9110 [NIOSH 1994].

Observations regarding work practices and use of personal protective equipment were recorded. Information was obtained from conversations with the workers and management to determine if the sampling day was a typical workday to help place the sampling results in proper perspective.

Heat Exposure Measurements
Measurements to determine heat exposure were made with a QUESTemp° 34 datalogging thermal environment monitor (Quest Technologies, Oconomowoc, WI). This device was capable of measuring wet-bulb, dry-bulb and globe temperatures and calculating the Wet Bulb Globe Temperature Index $(WBGT)_{out}$ (for solar load, not used for this evaluation), $WBGT_{in}$ (for no solar load), and humidity. The $WBGT_{in}$ (indoors or outdoors with no solar load) is the sum of 0.7 times the Natural Wet-Bulb (NWB) Temperature and 0.3 times the Globe Temperature (GT), expressed by the equation:

$$WBGT_{in} = 0.7\ NWB + 0.3\ GT$$

Where NWB is measured using a natural (static) wet-bulb thermometer and GT is measured using a black globe thermometer. Measurements were stored electronically in the instrument and downloaded to a computer at the end of the work day.

Local Exhaust Ventilation Characterization Methods
Several methods were used to evaluate the local exhaust ventilation system. These methods included measuring air velocity at the face of each of the HFMs inside the glass-breaking area, and measuring air velocities at the plastic curtains enclosing the glass-breaking grate in front of each HFM. In addition, a smoke tracer was used to confirm the direction of the airflow and effect of secondary airflows on hood performance. A Velocicalc Plus Model 8388 thermal anemometer (TSI Incorporated, St. Paul, MN) was used to measure air speeds at the face of each HFM and just inside the enclosing plastic strip curtain. A Wizard Stick smoke device (Zero Toys, Inc., Concord, MA) was used to visualize air flow.

The face velocity tests were performed by dividing the face of the HFM into 12 rectangles of equal area and measuring the velocity at the center of each. Face velocities were taken at each center point averaged over a period of 30 seconds, using a 5-second time averaging setting on the instrument. The metal grid in front of the pre-filters was used to support the edge of the probe and the researcher stood to one side to avoid obstructing air flow. To measure the velocities achieved by the control at each center point, the anemometer probe was held perpendicular to the air flow direction at those points. The same measurements were repeated at the front edge of the plastic strip curtains enclosing the area immediately in front of each HFM to determine the capture velocity at that point.

Smoke was released around the periphery of the hood and in the interior of the hood to qualitatively evaluate the capture and determine areas of concern. By releasing smoke at points in and around the hood, the path of the smoke, and thus any airborne material potentially released at that point, could be qualitatively determined.

IV. OCCUPATIONAL EXPOSURE LIMITS AND HEALTH EFFECTS

In evaluating the hazards posed by workplace exposures, NIOSH investigators use mandatory and recommended occupational exposure limits (OELs) for specific chemical, physical, and biological agents. Generally, OELs suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects*. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the exposure limit. Combined effects are often not considered in the OEL. Also, some substances can be absorbed by direct contact with the skin and mucous membranes in addition to being inhaled, thus contributing to the overall exposure. Finally, OELs may change over the years as new information on the toxic effects of an agent become available.

* On March 20, 1991, the Supreme Court decided the case of International Union, United Automobile, Aerospace & Agricultural Implement Workers of America, UAW v. Johnson Controls, Inc., 111 S. Ct. 1196, 55 EPD 40,605. It held that Title VII forbids sex-specific fetal protection policies. Both men and women must be protected equally by the employer.

Most OELs are expressed as a time-weighted average (TWA) exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday[†]. Some chemical substances and physical agents have recommended short-term exposure limits (STEL) or ceiling values where there are health effects from higher exposures over the short-term. Unless otherwise noted, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during a workday, and the ceiling limit is an exposure that should not be exceeded at any time, even instantaneously.

In the U.S., OELs have been established by Federal agencies, professional organizations, state and local governments, and other entities. Some OELs are mandatory, legal limits; others are recommendations. The U.S. Department of Labor Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) [29 CFR 1910 (general industry); 29 CFR 1926 (construction industry); and 29 CFR 1915, 1917 and 1918 (maritime industry)] are legal limits that are enforceable in workplaces covered under the Occupational Safety and Health Act and in Federal workplaces under Executive Order 12196 [NARA 2008]. NIOSH Recommended Exposure Limits (RELs) are recommendations that are made based on a critical review of the scientific and technical information available on the prevalence of hazards, health effects data, and the adequacy of methods to identify and control the hazards. Recommendations made through 1992 are available in a single compendium [NIOSH 1992]; more recent recommendations are available on the NIOSH Web site (http://www.cdc.gov/niosh). NIOSH also recommends preventive measures (e.g., engineering controls, safe work practices, personal protective equipment, and environmental and medical monitoring) for reducing or eliminating the adverse health effects of these hazards. The NIOSH Recommendations have been developed using a weight of evidence approach and formal peer review process. Other OELs that are commonly used and cited in the U.S. include the Threshold Limit Values (TLVs)® recommended by the American Conference of Governmental Industrial Hygienists (ACGIH)®, a professional organization [ACGIH 2008]. ACGIH® TLV®s are considered voluntary guidelines for use by industrial hygienists and others trained in this discipline "to assist in the control of health hazards." Workplace Environmental Exposure Levels (WEELs) are recommended OELs developed by the American Industrial Hygiene Association (AIHA), another professional organization. WEELs have been established for some chemicals "when no other legal or authoritative limits exist" [AIHA 2007].

Employers should understand that not all hazardous chemicals have specific OSHA PELs and for many agents, the legal and recommended limits mentioned above may not reflect the most current health-based information. However, an employer is still required by OSHA to protect their employees from hazards even in the absence of a specific OSHA PEL. In particular, OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, NIOSH investigators encourage employers to make use of other OELs when making risk assessment and risk management decisions to best protect the health of their employees. NIOSH investigators also encourage the use of the traditional hierarchy of controls approach to eliminating or minimizing identified workplace hazards. This includes, in preferential order, the use of: (1) substitution or elimination of the hazardous agent, (2) engineering controls (e.g., local exhaust ventilation, process enclosure, dilution ventilation) (3) administrative controls (e.g., limiting time of exposure, employee

[†] OSHA PELs, unless otherwise noted, are TWA concentrations that must not be exceeded during any 8-hour workshift of a 40-hour work-week [NIOSH 1997]. NIOSH RELs, unless otherwise noted, are TWA concentrations for up to a 10-hour workday during a 40-hour workweek [NIOSH 1997]. ACGIH® TLVs®, unless otherwise noted, are TWA concentrations for a conventional 8-hour workday and 40-hour workweek [ACGIH 2008]

training, work practice changes, medical surveillance), and (4) personal protective equipment (e.g., respiratory protection, gloves, eye protection, hearing protection).

Both the OSHA PELs and ACGIH® TLV®s address the issue of combined effects of airborne exposures to multiple substances [29 CFR 1910.1000(d)(1)(i), ACGIH 2008]. ACGIH® [2008] states:
When two or more hazardous substances have a similar toxicological effect on the same target organ or system, their combined effect, rather than that of either individually, should be given primary consideration. In the absence of information to the contrary, different substances should be considered as additive where the health effect and target organ or system is the same. That is, if the sum of

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots \frac{C_n}{T_n} \qquad \text{Eqn. 1}$$

exceeds unity, the threshold limit of the mixture should be considered as being exceeded (where C_1 indicates the observed atmospheric concentration and T_1 is the corresponding threshold limit…).

A. Exposure Criteria for Occupational Exposure to Airborne Chemical Substances

The OELs for the five primary contaminants of interest, in micrograms per cubic meter (µg/m³), are summarized in Table 1 and additional information related to those exposure limits is presented below.

Table 1: Occupational Exposure Limits for Five Metals of Primary Interest (µg/m³)

	Barium (Ba)	Beryllium (Be)	Cadmium (Cd)	Lead (Pb)	Nickel (Ni)
REL	500 TWA	0.5 TWA	Lowest Feasible Concentration	50 TWA	15 TWA
PEL	500 TWA	2 TWA 5 (30 minute ceiling) 25 (peak exposure never to be exceeded)	5 TWA	50 TWA	1000 TWA
TLV®	500 TWA	2 TWA 10 (STEL)	10 (total) TWA 2 (respirable) TWA	50 TWA	1500 TWA (elemental) 100 TWA (soluble inorganic compounds) 200 TWA (insoluble inorganic compounds

This subset of five metals has been selected for consideration through the body of this report because their presence was noted on MSDSs or other information pertaining to CRTs and other processes at this facility (beryllium, cadmium, lead and nickel) or due to the interest expressed in barium exposures by FOH personnel due to whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium, at electronics recycling operations overseen by Federal Prison Industries (UNICOR) at a number of BOP facilities around the country.

The occupational exposure limits of all 31 metals quantified in this work are listed in Appendix A. Note that these limits refer to the contaminant as the element (e.g., the TLV®s, beryllium and compounds, as Be; cadmium and compounds, as Cd [ACGIH 2008]). Additionally, the OEL for dust is presented here to place those air sampling results in perspective.

Occupational Exposure Criteria for Barium (Ba)
The current OSHA PEL, NIOSH REL, and ACGIH® TLV® is 0.5 mg/m^3 as a TWA for airborne barium exposures (barium and soluble compounds, except barium sulfate, as barium) [29 CFR 1910.1000, NIOSH 2005, ACGIH 2008]. There is no AIHA WEEL for barium [AIHA 2007]. Skin contact with barium, and many of its compounds, may cause local irritation to the eyes, nose, throat and skin, and may cause dryness and cracking of the skin and skin burns after prolonged contact [Nordberg 1998].

Occupational Exposure Criteria for Beryllium (Be)
The OSHA general industry standard sets a beryllium PEL of 2 µg/m^3 for an 8-hour TWA, a ceiling concentration of 5 µg/m^3, not to exceed 30 minutes and a maximum peak concentration of 25 µg/m^3, not to be exceeded for any period of time [29 CFR 1910.1000]. The NIOSH REL for beryllium is 0.5 µg/m^3 for up to a 10-hour work day, during a 40-hour workweek [NIOSH 2005]. The current TLV® is an 8-hr TWA of 2 µg/m^3, and a STEL of 10 µg/m^3 [ACGIH 2008]. The ACGIH® published a notice of intended changes for the beryllium TLV® to 0.05 µg/m^3 TWA and 0.2 µg/m^3 STEL based upon studies investigating both chronic beryllium disease and beryllium sensitization [ACGIH 2008]. There is no AIHA WEEL for beryllium [AIHA 2007]. Beryllium has been designated a known human carcinogen by the International Agency for Research on Cancer [IARC 1993].

Occupational Exposure Criteria for Cadmium (Cd)
The OSHA PEL for cadmium is 5 µg/m^3 as a TWA [29 CFR 1910.1027]. Exposure at or above half that value, the Action Level of 2.5 µg/m^3 TWA, requires several actions of the employer. These include providing respiratory protection if requested [29 CFR 1910.1027(g)(1)(v)], medical surveillance if currently exposed more than 30 days per year [1910.1027(l)(1)(i)(A)], and medical surveillance if previously exposed unless potential aggregated cadmium exposure did not exceed 60 months [1910.1027(l)(1)(i)(b)]. Initial examinations include a medical questionnaire and biological monitoring of cadmium in blood (CdB), cadmium in urine (CdU), and Beta-2-microglobulin in urine (β2-M) [29 CFR 1910.1027 Appendix A]. An employee whose biological testing results during both the initial and follow-up medical examination are elevated above the following trigger levels must be medically removed from exposure to cadmium at or above the action level: (1) CdU level: above 7 µg/g creatinine, or (2) CdB level: above 10 µg/liter of whole blood, or (3) β2-M level: above 750 µg/g creatinine and (a) CdU exceeds 3 µg/g creatinine or (b) CdB exceeds 5 µg/liter of whole blood [OSHA 2004].

The ACGIH® TLV® for cadmium and compounds as cadmium is 10 µg/m^3 as a TWA, and 2 µg/m^3 TWA for the respirable fraction of airborne cadmium and compounds, as cadmium [ACGIH 2008]. The ACGIH® also published a Biological Exposure Index® that recommends that cadmium blood level be controlled at or below 5 µg/L and urine level to be below 5 µg/g creatinine [ACGIH 2008]. There is no AIHA WEEL for cadmium [AIHA 2007].

In 1976, NIOSH recommended that exposures to cadmium in any form should not exceed a concentration greater than 40 µg/m^3 as a 10-hour TWA or a concentration greater than 200 µg/m^3 for any 15-minute period, in order to protect workers against kidney damage and lung disease. In 1984, NIOSH issued a Current Intelligence Bulletin, which recommended that cadmium and its compounds be regarded as potential occupational carcinogens based upon evidence of lung cancer among a cohort of workers exposed in a smelter [NIOSH 1984]. NIOSH recommends that exposures be reduced to the lowest feasible concentration [NIOSH 2005]. This NIOSH REL was developed using a previous NIOSH policy for carcinogens (29 CFR 1990.103). The current NIOSH policy for carcinogens was adopted in September 1995. Under the previous policy, NIOSH usually recommended that exposures to carcinogens be limited to the “lowest feasible concentration,” which was a nonquantitative value. Under the previous policy, most quantitative RELs for carcinogens were set at the limit of detection (LOD) achievable when the REL was originally established. From a practical standpoint, NIOSH testimony provided in 1990 on OSHA's proposed rule on occupational exposure to cadmium noted that, "NIOSH research suggests that the use of innovative engineering and work practice controls in new facilities or operations can effectively contain cadmium to a level of 1 $\mu g/m^3$. Also, most existing facilities or operations can be retrofitted to contain cadmium to a level of 5 $\mu g/m^3$ through engineering and work practice controls" [NIOSH 1990]. Early symptoms of cadmium exposure may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or cough. Short-term exposure effects of cadmium inhalation include cough, chest pain, sweating, chills, shortness of breath, and weakness. Short-term exposure effects of ingestion may include nausea, vomiting, diarrhea, and abdominal cramps [NIOSH 1989]. Long-term exposure effects of cadmium may include loss of the sense of smell, ulceration of the nose, emphysema, kidney damage, mild anemia, an increased risk of cancer of the lung, and possibly of the prostate [NIOSH 1989, Thun et al. 1991, Goyer 1991].

Occupational Exposure Criteria for Lead (Pb)

The OSHA PEL for lead is 50 $\mu g/m^3$ (8-hour TWA), which is intended to maintain worker blood lead level (BLL) below 40 µg/deciliter (dL). Medical removal is required when an employee's BLL reaches 50 µg/dL [29 CFR 1910.1025]. The NIOSH REL for lead (8-hour TWA) is 0.050 mg/m^3; air concentrations should be maintained so that worker blood lead remains less than 0.060 mg Pb/100 g of whole blood [NIOSH 2005]. At BLLs below 40 µg/dL, many of the health effects would not necessarily be evident by routine physical examinations but represent early stages in the development of disease. In recognition of this, voluntary standards and public health goals have established lower exposure limits to protect workers and their children. The ACGIH® TLV® for lead in air is 50 $\mu g/m^3$ as an 8-hour TWA, with worker BLLs to be controlled to ≤ 30 µg/dL. A national health goal is to eliminate all occupational exposures that result in BLLs >25 µg/dL [DHHS 2000]. There is no AIHA WEEL for lead [AIHA 2007].

Occupational exposure to lead occurs via inhalation of lead-containing dust and fume and ingestion from contact with lead-contaminated surfaces. Symptoms of lead poisoning include weakness, excessive tiredness, irritability, constipation, anorexia, abdominal discomfort (colic), fine tremors, and "wrist drop" [Saryan and Zenz 1994, Landrigan et al. 1985, Proctor et al. 1991a]. Overexposure to lead may also result in damage to the kidneys, anemia, high blood pressure, impotence, and infertility and reduced sex drive in both genders. In most cases, an individual's BLL is a good indication of recent exposure to and current absorption of lead [NIOSH 1978].

Occupational Exposure Criteria for Nickel (Ni)

The NIOSH REL for nickel metal and other compounds (as nickel) is 15 $\mu g/m^3$ based on its designation as a potential occupational carcinogen [NIOSH 2005]. The ACGIH® TLV® for insoluble inorganic compounds of nickel is 200 $\mu g/m^3$ (inhalable fraction). For soluble inorganic nickel compounds the TLV® is 100 $\mu g/m^3$ (inhalable fraction). The TLV® for elemental nickel is 1,500 $\mu g/m^3$ (inhalable fraction) [ACGIH 2008]. The OSHA PEL for nickel is 1,000 $\mu g/m^3$ TWA [29 CFR 1910.1000]. Metallic nickel compounds cause allergic contact dermatitis [Proctor et al. 1991b]. NIOSH considers nickel a potential occupational carcinogen [NIOSH 2005]. There is no AIHA WEEL for nickel [AIHA 2007].

Occupational Exposure Criteria for Dust

The maximum allowable exposure to airborne particulate not otherwise regulated is established by OSHA at 15 mg/m^3 for total and 5 mg/m^3 for the respirable portion [29 CFR 1910.1000]. A more stringent recommendation of 10 mg/m^3 inhalable and 3 mg/m^3 respirable is presented by the ACGIH® which feels that "even biologically inert insoluble or poorly soluble particulate may have adverse health effects" [ACGIH 2008]. There is no AIHA WEEL for these substances [AIHA 2007].

B. Surface Contamination Criteria

Occupational exposure criteria have been discussed above for airborne concentrations of several metals. Surface wipe samples can provide useful information in two circumstances; first, when settled dust on a surface can contaminate the hands and then be ingested when transferred from hand to mouth; and second, if the surface contaminant can be absorbed through the skin and the skin is in frequent contact with the surface [Caplan 1993]. Although some OSHA standards contain housekeeping provisions which address the issue of surface contamination by mandating that surfaces be maintained as free as practicable of accumulations of the regulated substances, there are currently no surface contamination criteria included in OSHA standards [OSHA 2008].‡ The health hazard from these regulated substances results principally from their inhalation and to a smaller extent from their ingestion; those substances are by and large "negligibly" absorbed through the skin [Caplan 1993]. NIOSH RELs do not address surface contamination either, nor do ACGIH® TLV®s or AIHA WEELs. Caplan [1993] stated that "There is no general quantitative relationship between surface contamination and air concentrations..." He also noted that, "Wipe samples can serve a purpose in determining if surfaces are as 'clean as practicable'. Ordinary cleanliness would represent totally insignificant inhalation dose; criteria should be based on surface contamination remaining after ordinarily thorough cleaning appropriate for the contaminant and the surface." With those caveats in mind, the following paragraphs present guidelines that help to place the results of the surface sampling conducted at this facility in perspective.

Surface Contamination Criteria for Five Metals of Primary Interest

Surface Contamination Criteria for Lead

Federal standards have not been adopted that identify an exposure limit for lead contamination of surfaces in the industrial workplace. However, in a letter dated January 13. 2003 [Fairfax 2003], OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace [29 CFR 1926.62(h)(1), 1926.62(i)(2)(i) and 1926(i)(4)(ii)] interpreted the level of lead-contaminated dust allowable on workplace surfaces as follows: a) All surfaces shall be maintained as 'free as practicable' of accumulations of lead, b) The employer shall provide clean change areas for employees whose airborne exposure to lead is above the permissible exposure limit, c) The employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination, d) The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of HUD's acceptable decontamination level of 21.5 µg/100 cm^2 (200 µg/square foot [ft^2]) for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas, e) In situations where employees are in direct contact with lead-contaminated surfaces, such as, working surfaces or floors in change rooms, storage facilities, lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 21.5 µg/100 cm^2 (200 µg/ft^2) level, and f) For other surfaces, OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of lead contamination meets the definition of "practicable." OSHA notes that "the term 'practicable' was used in the standard, as each workplace will have to address different challenges to ensure that lead-surface contamination is kept to a minimum. It is OSHA's view that a housekeeping program which is as rigorous as 'practicable' is necessary in many jobs to keep airborne lead levels below

‡ OSHA has referenced a Department of Housing and Urban Development (HUD) lead criteria in documents related to its enforcement of the lead standard [Fairfax 2003].

permissible exposure conditions at a particular site" [Fairfax 2003]. Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of lead dust does not become a source of employee lead exposures. OSHA has stated that any method that achieves this end is acceptable.

In the United States, standards for final clearance following lead abatement were established for public housing and facilities related to children. However, no criteria have been recommended for other types of buildings, such as commercial facilities. One author has suggested criteria based upon lead-loading values. Lange [2001] proposed a clearance level of 108 µg/100 cm^2 (1000 µg/ft^2) for floors of non-lead free buildings and 118 µg/100 cm^2 (1100 µg/ft^2) for lead-free buildings, and states that "no increase in BLL should occur for adults associated or exposed within a commercial structure" at the latter level. These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions such as: a) Lead uptake following ingestion is 35% absorption of lead in the gastrointestinal system, b) Fingers have a total "touch" area of 10 cm^2 and 100% of the entire presumed lead content on all 10 fingers is taken up, c) The average 'normal' environmental lead dose (from 'uncontaminated food/water/air) is 20 µg per day, d) The weight of the exposed person is 70 kg, and e) Daily lead excretion is limited to an average of 48 µg. Lange [2001] notes that "use of the proposed values would provide a standard for non-child-related premises (e.g. commercial, industrial, office)…" but cautions that, "Further investigation is warranted to evaluate exposure and subsequent dose to adults from surface lead."

Surface Contamination Criteria for Beryllium
A useful guideline is provided by the U.S. Department of Energy, where DOE and its contractors are required to conduct routine surface sampling to determine housekeeping conditions wherever beryllium is present in operational areas of DOE/NNSA facilities. Those facilities must maintain removable surface contamination levels that do not exceed 3 µg/100 cm^2 during non-operational periods. The DOE also has release criteria that must be met before beryllium-contaminated equipment or other items can be released to the general public or released for use in a non-beryllium area of a DOE facility. These criteria state that the removable contamination level of equipment or item surfaces does not exceed the higher of 0.2 µg/100 cm^2 or the level of beryllium in the soil in the area of release. Removable contamination is defined as "beryllium contamination that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing."

Surface Contamination Criteria for Cadmium
Like lead and beryllium, cadmium poses serious health risks from exposure. Cadmium is a known carcinogen, is very toxic to the kidneys, and can also cause depression. However, OSHA, NIOSH, AIHA and ACGIH® have not recommended criteria for use in evaluating wipe samples. The OSHA Cadmium standard [29 CFR 1910.1027] mandates that "All surfaces shall be maintained as free as practicable of accumulations of cadmium," that, "all spills and sudden releases of material containing cadmium shall be cleaned up as soon as possible," and that, "surfaces contaminated with cadmium shall, wherever possible, be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne."

Surface Contamination Criteria for Nickel
NIOSH, OSHA, AIHA and ACGIH® have not established occupational exposure limits for nickel on surfaces.

Surface Contamination Criteria for Barium
NIOSH, OSHA, AIHA and ACGIH® have not established occupational exposure limits for barium on surfaces.

C. Heat Stress Evaluation Criteria

Section 19 of the Occupational Safety and Health Act of 1970 (the Act) identifies federal agency safety program and responsibilities and, through its implementing regulations, requires agency heads to furnish federal employees places and conditions of employment "that are free from recognized hazards that are causing or are likely to cause death or serious physical harm" [29 CFR 1960.8]. In addition, Executive Order 12196 expands on the responsibilities originating from the Act and requires agency heads to "[a]ssure prompt abatement of unsafe or unhealthy working conditions." In circumstances where such conditions cannot be abated, the agency must develop a plan that identifies a timetable for abatement and a summary of interim steps to protect employees. Employees exposed to the conditions also must be informed of the provisions of the plan.

The criteria OSHA uses to determine overexposures to heat stress were developed by the NIOSH and the ACGIH®. Factors taken into consideration in evaluating heat stress include environmental and metabolic heat (judged as the work rate) of the worker; the clothing and personal protective equipment worn; and the cycle of work and recovery. The assumptions made for the purposes of this report are that all workers have been acclimatized under heat-stress conditions similar to those anticipated for a minimum of 2 weeks and that there is adequate water and salt intake.

As described in the ACGIH® Documentation of Threshold Limit Values [ACGIH 2007], Light work is illustrated as, "Sitting with light manual work with hands or hands and arms and driving. Standing with some light arm work and occasional walking." The Moderate work category, considered to be the predominant rate observed at Marianna, is defined by the ACGIH® TLV® as, "Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work, or light pushing and pulling. Normal walking." The example of Heavy work given in the ACGIH® TLV® as, "Intense arm and trunk work, carrying, shoveling, manual sawing; pushing and pulling heavy loads; and walking at a fast pace." Very Heavy work is exemplified by, "Very intense activity at fast to maximum pace."

Because the evaporation of sweat from the skin is the predominant heat removal mechanism for workers, any clothing or PPE that impedes that evaporation needs to be considered in an evaluation of heat stress. Accepted clothing for heat stress evaluation using the TLV® WBGT criteria is traditional long sleeve work shirt and pants. This is essentially the level of clothing worn by all workers at the Marianna facility. Therefore an adjustment for clothing beyond such a summer work uniform; a Clothing Adjustment Factor – [CAF]), should be made for workers in the GBO, due primarily to their use of spun-bonded olefin coveralls [ACGIH 2007, Bernard 2005].

NIOSH Recommended Exposure Limits
The NIOSH RELs for Heat Stress for acclimatized workers are shown in Figure VI [NIOSH 1986]. NIOSH recommends controlling total heat exposures so that unprotected, healthy acclimatized workers are not exposed to combinations of metabolic and environmental heat that exceed the applicable RELs. The recommended limits are for healthy workers who are physically and medically fit for the level of activity required by their work and are wearing the traditional one layer work clothing of not more than long-sleeved work shirts and pants (or equivalent). The limits may not provide adequate protection to workers wearing clothing with lower air or vapor permeability or insulation values that exceed those of

traditional work clothing. NIOSH recommends that no worker be exposed to combinations of metabolic and environmental heat exceeding the applicable ceiling limit unless provided with and properly using adequate heat-protective clothing.

NIOSH [1986] recommends reducing the REL and RAL by 2 ºC (3.8 ºF) when the worker is wearing a two-layer clothing system, and lowering the REL and RAL by 4 ºC (7.2 ºF) when a "partially air and/or vapor impermeable ensemble or heat reflective or protective leggings, gauntlets, etc. are worn." However, the NIOSH document notes that those suggested corrections are scientific judgments that were not substantiated by controlled experimental studies or prolonged experience in industrial settings.

Threshold Limit Value and Action Level

The above work rate and clothing factors can be used, in combination with the hourly work / rest regimen of exposed workers, to find the permissible maximum WBGT heat exposure limit (expressed in °C) from the table of TLV®s.

Table 2: Heat Stress TLV®s and Action Limit WBGT Values [ACGIH 2007]

Allocation of Work in a Cycle of Work and Recovery	TLV® (WBGT values in °C)				Action Limit (WBGT values in °C)			
	Light	**Moderate**	**Heavy**	**Very Heavy**	**Light**	**Moderate**	**Heavy**	**Very Heavy**
75% to 100%	31.0	28.0	—	—	28.0	25.0	—	—
50% to 75%	31.0	29.0	27.5	—	28.5	26.0	24.0	—
25% to 50%	32.0	30.0	29.0	28.0	29.5	27.0	25.5	24.5
0% to 25%	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

Assessment of exposures in relation to the stress and strain TLV®s is a step-by-step process, once exposures and working conditions have been assessed. The first step is to ascertain whether or not a CAF is available. There is a CAF for polyolefin coveralls of 1.0 ºC (1.8 ºF) WBGT. The TLV®s note that "the recommended adjustment factors are based on a worker wearing a single layer coverall over modesty clothing" (e.g., shorts and tee-shirt, or perhaps the tee-shirts and work pants worn by the workers in the GBO).

If there is a CAF available, one should determine whether or not the screening criteria for the Action Limit (above) are exceeded, and if they are, then determine if the screening criteria for the TLV® (above) are exceeded (if the Action Limit criteria are not exceeded, continue to monitor work conditions). If the screening criteria for the TLV® are exceeded, a detailed analysis is recommended, including obtaining a task analysis that includes a time-weighted average of the "Effective WBGT" (the environmental WBGT plus the CAF) and the metabolic rate.

The next step is to review the results of the detailed analysis. If the detailed analysis indicates that the Action Limit is exceeded, but the TLV® is not (or the workers are acclimatized), then general controls should be implemented and monitoring of conditions continued. General controls include [ACGIH 2007]:

• Provide accurate verbal and written instructions, annual training programs, and other information about heat stress and strain
• Encourage drinking small volumes (approximately 1 cup) of cool, palatable water (or other acceptable fluid replacement drink) about every 20 minutes

• Permit self-limitation of exposures and encourage co-worker observation to detect signs and symptoms of heat strain in others
• Counsel and monitor those who take medications that may compromise normal cardiovascular, blood pressure, body temperature regulation, renal, or sweat gland functions; and those who abuse or are recovering from the abuse of alcohol or other intoxicants
• Encourage healthy life-styles, ideal body weight and electrolyte balance
• Adjust expectations of those returning to work after absence from hot exposure situations and encourage consumption of salty foods (with approval of physician if on a salt-restricted diet)
• Consider preplacement medical screening to identify those susceptible to systemic heat injury
• Monitor the heat stress conditions and reports of heat-related disorders

If the detailed analysis reveals that the "exposure exceeds the limits for acclimatized workers," the ACGIH® [2007] recommends that physiological monitoring (e.g., core body temperature, heart rate monitoring) as "the only alternative to demonstrate that adequate protection is provided." If physiological monitoring indicates that employees are experiencing excessive heat strain (the overall bodily response to heat stress), then job-specific controls should be implemented. These include [ACGIH 2007}:

• Consider engineering controls that reduce the metabolic rate, provide general air movement, reduce process heat and water vapor release, and shield radiant heat sources, among others
• Consider administrative controls that set acceptable exposure times, allow sufficient recovery, and limit physiological strain
• Consider personal protection that is demonstrated effective for the specific work practices and conditions at the location

Finally, ACGIH® [2007] notes that a program to manage heat stress is required when heat stress levels exceed the Action Limit or workers utilize clothing ensembles that limit heat loss, and that in either case, general controls should be utilized to protect workers.

V. RESULTS AND DISCUSSION

The work described here was conducted in August, 2007 at the Marianna FCI and FPC, UNICOR Recycling Factory electronic components recycling operations. During this testing air, surface wipe, bulk dust and heat data were collected in locations where the electronics recycling operations were taking place or had taken place in the past. The primary purposes of this evaluation were to estimate the potential exposures of inmates and/or staff to toxic substances and heat encountered during the recycling of electronic components, and to recommend remedial measures to reduce exposures if necessary.

A statistical summary of air sampling results is presented in Table 3, and results of personal breathing zone and area air sampling are shown in Table 4. Surface wipe sample results are contained in Table 5; bulk material sample results are presented in Table 6; environmental heat measurements are shown in Table 7; and estimated work rates and metabolic heat values are given in Table 8. Table 9 provides the results of the ventilation evaluation in the GBO. As mentioned in Section III above, all samples were analyzed for 31 metals due to the parameters of the analytical method. While the data in these tables present the results of just the five metals of primary interest in this evaluation, results of all analyses are contained in the appendices. These data indicate levels well below the OELs of those other metals, even when results for combined exposures as calculated by Equation 1 are considered.

A. Bulk Material Sample Results
Five bulk material samples of dust from locations within the GBO were collected in August 2007. These samples were analyzed for metals, and the results are presented in Table 6 for the metals of primary interest. The one metal present in all five samples in significant concentration is lead, which ranged from 2,200 to 35,000 mg/kg (0.22% to 3.5%). Nickel was measured at 0.2% in one sample. No beryllium was detected in these bulk samples. The entire data set (all 31 metals) is presented in Appendix B at the end of this report.

B. Surface Wipe Sample Results
The surface wipe sample results collected during the visit in the electronic recycling operations at the Marianna FCI are summarized below and in Table 5, and the entire surface wipe sample data set is contained in Appendix C. Results of spectrofluorometric analysis for beryllium only confirmed ICP measurements and are not repeated in the tables.

It is noteworthy that many of the cadmium wipe samples collected from work surfaces described as "rubber" or "mat(t)" have many of the highest levels of surface contamination, although the data were not analyzed for statistical significance since this technique is considered semi-quantitative. As Table 5 indicates, the majority of these mats were used as table coverings in the work area. The higher cadmium levels may indicate that these surfaces are more difficult to clean and retain dust, or they may be indicative of the operations taking place at those work stations. In either case, using cardboard or another disposable covering on top of the mats and discarding the covering after every shift would address the issue of contamination of these surfaces.

FCI Recycling Factory
Wipe samples taken in the UNICOR electronic recycling factory did not indicate levels of barium on work surfaces at levels of concern as discussed in Section IV above in the surface contamination subsection. The highest barium concentration detected was 80 $\mu g/100\ cm^2$. No beryllium was detected in samples from the recycling factory; the limit of detection was 0.07 $\mu g/100\ cm^2$. Many of the surfaces tested for lead indicated levels exceeding the OSHA-referenced HUD criteria of 21.5 $\mu g/100\ cm^2$, including two in the breakdown area that contained 110 and 140 $\mu g/100\ cm^2$. While there are no criteria for evaluating cadmium surface contamination, 3 of 23 of the cadmium measurements were 19 $\mu g/100\ cm^2$ or greater, with a range from less than the limit of detection of 0.1 $\mu g/100\ cm^2$ to 65 $\mu g/100\ cm^2$. The highest level of nickel surface contamination was 68 $\mu g/100\ cm^2$.

FPC
Three surfaces were wiped to measure surface metal contamination in the camp (Table 5) and one produced the highest levels of barium, cadmium and lead seen (320, 360, and 5100 $\mu g/100\ cm^2$ respectively) and 52 µg of nickel/100 cm^2. This was a sample of accumulated dust collected on top of an electrical conduit attached to the back wall to the left of HFM-1 inside the containment area. This indicates insufficient cleaning in this area of airborne dust that escaped capture by the local exhaust system. It should be noted that the denominator (100 cm^2) is an approximation for this sample, which was collected from a rounded surface where a template could not be used. The other two samples here were well below the suggested maximum levels. However, one was obtained from the door of a locker used to store PPE, and the other was collected on top of the bookcase used to charge the PAPR battery packs, indicating that some contamination is present in these clean areas. This is confirmed by the results of the bulk sample of settled dust collected from on top of a locker in the GBO (Table 6).

C. Air Sample Results

Air measurements were collected during both routine and non-routine operations in the areas identified, including the GBO. Data presented here and in Table 4 are for the duration of the samples rather than for an 8-hour time weighted average since the concentrations of contaminants are so low in most cases. Measurements made during the filter change operation are presented at the bottom of Table 4 and discussed separately below since this was not a routine production operation. The full data set of all 31 metals is presented in Appendix D.

FCI Recycling Factory

Eighteen samples were collected in the UNICOR recycling factory for airborne metals during the August, 2007 study. These data can be identified by date in Table 4, but the magnitudes of the exposures were not generally different by date. Measurements during routine operations revealed that barium concentrations ranged between <0.05 and 0.26 $\mu g/m^3$ and were below occupational exposure limits. Beryllium levels also were all below the limit of detection. The minimal detectable concentration (limit of detection/sample volume) varied with sample volume, most being <0.03 $\mu g/m^3$. Cadmium, lead and nickel, likewise, were found at low levels ranging up to 0.091, 0.54, and 0.19 $\mu g/m^3$, respectively. Lead was the metal found in highest quantity, but only 6 samples were above the limit of detection and the highest was approximately 1% of the occupational exposure limits of 50 $\mu g/m^3$. Airborne particulate concentrations ranged up to 717 $\mu g/m^3$ (<0.1 to 0.7 mg/m^3).

FPC Recycling operations

Airborne metal concentrations in the FPC, in operations other than glass breaking, were generally lower than those in the FCI. Fourteen samples collected principally in trucking and breakdown operations were well below the most stringent occupational exposure limit. Two samples in this series were compromised. In one instance, an employee touched the inlet with her work glove and some lint was captured by the sampler. In the second, an employee was unloading recyclables and toner spilled on her front; some toner entered the sampling cassette. Airborne lead levels were all below the limit of detection when those two samples are excluded. No beryllium was detected in any of the samples. Nickel results were also less than the limit of detection, with the exception of one of the compromised samples. Barium and cadmium ranged up to 0.42 and 0.24 $\mu g/m^3$ respectively, when the compromised samples are ignored. Airborne total particulate concentrations ranged from <60 to 887 $\mu g/m^3$ when the compromised samples are excluded.

FPC Glass Breaking Room – Routine Production

While exposures in the GBO were of specific interest and anticipated to be higher than in other production processes, no detectable levels of beryllium or nickel were found in the twelve samples collected at the Marianna facility during the two days this process was monitored. Airborne levels of barium, cadmium and lead ranged up to 2.1, 6.8 and 20 $\mu g/m^3$, respectively. None of the samples exceeded the relevant occupational exposure limits as 8-hr TWAs (e.g., 6.8 $\mu g/m^3$ of cadmium in a 143 minute sample results in an 8-hr TWA of 2.0 $\mu g/m^3$). This cadmium result approached, but did not exceed, the OSHA Action Level. Particulate measurements ranged up to 891 $\mu g/m^3$. These results indicate that the HFMs do an effective job in controlling the breakers' exposures to levels below relevant occupational exposure criteria. The feeders' exposures indicate that their jobs should be reviewed to determine the source of their airborne exposures to determine if it originates from material handling or from dust escaping the enclosed booth area. When the results of sampling conducted during routine operations in the GBO are reviewed, the reader should recall that the GBO was operating on a shortened schedule due to the hot conditions.

FPC Glass Breaking Room – Non-Routine Filter Cleaning and Maintenance Operations
The filter change operation in the GBO, discussed in the Process Description (Section II), was the task of most concern regarding exposures of workers to toxic metals. As noted above, the filter change is a maintenance operation that occurs at approximately monthly intervals during which the ventilation system is shut down and all filters are removed and replaced. During this operation, two workers in spun-bonded olefin coveralls, gloves and PAPRs remove both sets of filters, clean the system, and replace the filters. They are assisted by two additional workers who wear spun-bonded olefin coveralls and gloves while working outside the glass breaking enclosure. The exhaust system components, including the accessible surfaces of the filters, are first HEPA vacuumed. The filters are then removed and bagged for disposal, and the area inside the filter housing is vacuumed. New filters are inserted to replace the old ones, the LEV system is reassembled, and any residual dust is HEPA vacuumed.

Air sampling preformed during this operation revealed that barium concentrations ranged from 1.0 to 16 $\mu g/m^3$. No beryllium or nickel was detected. Cadmium ranged from 0.74 to 12 $\mu g/m^3$ (0.069 to 1.4 $\mu g/m^3$ 8-hr TWA), and again lead was the metal found in the highest concentration, ranging from 5.6 to 105 $\mu g/m^3$ (0.53 to 12 $\mu g/m^3$ 8-hr TWA). Airborne total particulate measurements ranged from 270 to 5,000 $\mu g/m^3$.

Results of particle size measurements from the Aerodynamic Particle Sizer inside the enclosed area in the GBO are presented in Figure VII. These data indicate a low level of particle concentration (particles/cm^3) can be achieved during glass breaking through the use of local exhaust ventilation. As one would expect, the maximum particle number concentration occurred during the filter change operation on August 9. Our APS data show that the particle concentration during filter changing can reach approximately 325 particles/cm^3 in the 0.6 – 0.7 µm size range, with the number of particles in the larger particle size near 3 µm increasing to more than 150 particles/cm^3. Filter changing produced the highest particle counts, while routine daily cleaning produced higher number concentrations than routine glass-breaking operations. However, results indicated that none of the tasks were especially dusty when compared to other industrial environments and tasks [Alexander et al. 1999, Kuhlbusch et al. 2004, Evans et al. 2008].

D. Heat Measurement Results

The heat measurement data collected on August 8 and 9, 2007, are presented in Table 7. Measurements of indoor wet bulb globe temperature ($WBGT_{in}$) were calculated for one hour increments and are presented for each of the two days of the testing at that facility. Included are the heat stress data obtained in the various locations tested in both FCI and FPC. The GBO operation was limited to the morning because of the summer heat. However, no work-rest regimen was in place at any of the Marianna operations.

Having observed work at all Marianna locations evaluated, work rates in the FCI and FPC were determined as shown in Table 8. The metabolic heat values are taken from the ACGIH® TLV® documentation [ACGIH 2007]. They represent midpoints in the range of metabolic rates for the categories of work. Because all workers were not working at the same rate, even though they were assigned the same jobs, some tasks were given overlapping classifications.

Comparison of the Results with the NIOSH REL
Using the plot in Figure 7, entering a Metabolic Heat value of 300 Watts (W) and entering a WBGT value of 32.8 °C (adding the NIOSH clothing adjustment of 4 °C to the measured WBGT value of 28.8 °C) for the breakers, shows that the REL for continuous work (60 minutes/hour) was exceeded for the breakers during their first hour of work on August 8. Since that hour represented their minimum measured heat

exposure, the breakers' exposures exceeded the REL for continuous work for all of the measured periods. The feeders' estimated metabolic heat equaled or exceeded that of the breakers (e.g., they lifted and carried CRTs, while the breakers slid them and used breaking tools) and they shared the same environmental heat exposure and wore spun-bonded olefin coveralls over their work clothes. Therefore, the feeders were also exposed above the REL on both sampling days. Using the plot in Figure 7 and entering a metabolic heat value of 240 W (the average work rate for the outside workers in the GBO) on the horizontal axis and an unadjusted WBGT value of 28.8 °C, shows that the outside workers in the GBO were at or slightly over the REL for continuous work for that period, and likely exceeded the REL for continuous work during the period from 9:00 am to 10:00 am on August 9, when the WBGT value was 30.4 °C.

Using the same procedure, entering a metabolic heat value of 240 W for all FCI workers and hourly TWA WBGT values that ranged from 28.3 °C to 29 °C on August 8 and from 29.2 °C to 30.4 °C, the FCI workers' heat exposures approached or exceeded the REL for continuous work for several periods on both days. Using the plot in Figure 7, the WBGT values in Table 7, and a metabolic heat value of 300 W for the truck crew shows that their exposures approached or exceeded the REL for continuous work on both days as well. Only the other warehouse workers experience heat exposures that were below the REL for continuous work on both days, based on an estimated metabolic heat of 180 W and a maximum 1-hr TWA of 29.4 °C WBGT.

Comparison of the Results with the ACGIH® TLV®

Adjusting the TLV® and Action Limit values in Table 2 by a CAF reduction of 1°C for workers wearing spun-bonded olefin coveralls and comparing the results in Table 7 with those values utilizing the work rates noted above indicates that some of the tasks performed by workers at this facility result in exceeding recommended heat stress values under the conditions measured on August 8 and 9, 2007.

Specifically, the breakers' measured WBGT values of 28.8 °C and 29.7 °C on August 8 and 29.7 °C and 30.4 °C on August 9 exceeded the CAF-adjusted TLV® of 27 °C for moderate work performed continuously (45-60 minutes out of every hour), and it should be noted that the WBGT monitor was placed outside of the plastic enclosure wherein the breakers worked (because 4 of 6 GBO workers work outside this enclosure). The WBGT value may have been higher inside the enclosure due to heat generated by the electric motors in the HFMs. The same measured WBGT values represented the feeders' environmental heat exposures. Their moderate to heavy work also resulted in WBGT exposures in excess of the CAF-adjusted TLV®s of 27 °C for continuous moderate work and 26.5 °C for heavy work for a work cycle of 50% to 75% work in an hour. The filter change operation WBGT measurement of 31.2 °C on August 9 also exceeded the CAF-adjusted TLV® for continuous light work of 30 °C. No CAF adjustment is required for workers in other tasks, who wore typical summer work clothing.

For the outside workers in the GBO , the measured WBGT values of 28.8 °C and 29.7 °C on August 8 and 29.7 °C and 30.4 °C on August 9 and light to moderate work rates result in exposures that exceeded the TLV® for continuous moderate work and the Action Limit for continuous light work. Reviewing the WBGT values measured in the Warehouse on August 8 reveals that they ranged from 28.1 °C to 28.5 °C, while WBGT measurements on August 9 in the Warehouse ranged from 28.6 °C to 29.4 °C. Those values exceed the Action Limit for continuous light work of 28.0 °C. The WBGT monitor in the Warehouse was placed on the wooden reception counter at the loading dock entrance in an attempt to measure the exposures of both the warehouse workers and the crew unloading trucks. The truck crew workers exposures also exceeded the TLV® of 28 °C for continuous moderate work. WBGT temperatures measured in the FCI –Refurbish area ranged from 28.3 °C to 29.1 °C on August 8, and from 29.2 °C to

30.3 ºC on August 9, exceeding the Action Limit for continuous light work. Finally, measured WBGT values in the FCI-Disassembly area ranged from 28.4 ºC to 29.4 ºC on August 8, and from 29.3 ºC to 30.4 ºC on August 9. These measurements exceeded the Action Limit for continuous light work.

E. Local Exhaust System Measurements

The tests described above were conducted with the variable speed control on both units set at 100%. The minihelic gauges on the left-hand HFM (s/n 11023-1) and on the right-hand HFM (s/n 11023-2) read 1.2 and 1.3 inches, respectively. The results of the velocity measurements are presented in Table 9. The average face velocity measured at HFM-1 (the one on the left when facing them from the front, s/n 11023-1) was 0.66 meters/second (m/sec) (130 feet/minute [fpm]); the average capture velocity at the edge of the front curtains was 0.37 m/sec (73 fpm). The average face velocity measurement was in close agreement with the manufacturer's test report of 0.66 m/sec (130 fpm) measured at the face of the HEPA filter with the fan operating at 100% capacity. However, the manufacturer's readings only varied from 0.64 to 0.68 m/sec (125 to 133 fpm) versus 0.35 to 1.07 m/sec (68 to 210 fpm) measured during this testing. The average face velocity measured at HFM-2 was 0.54 m/sec (106 fpm); the average capture velocity measured at the edge of the curtains in front of the unit was 0.40 m/sec (78 fpm). The manufacturer's test of the new unit reported an average face velocity of 0.76 m/sec (150 fpm) at the face of the HEPA filter (range 0.71-0.81 m/sec [140-160 fpm]). There were some gaps visible between the prefilters on both HFMs and there was a gap between HFM-2 and the angle-iron grate. The gaps between the prefilters may shorten the service life of the HEPA filter by allowing larger particles to reach it. The measurements of the face and capture velocity show that better capture is achieved in the central portion of both workstations; performance drops off considerably outside of the center part of the enclosure. These gaps may also account for the distribution of face velocities noted (some of which differed by more than 20% from the mean value) as air was exhausted through the gaps, flowing around, rather than through, the prefilters. The gap between the grate and the HFM may decrease the effectiveness of the HFM by increasing the distance from the face to the glass-breaking operation and may allow broken glass to escape collection and land on the floor resulting in an additional hazard and a longer clean-up time. Smoke released showed the air tended to flow into the enclosed area in front of each HFM as expected.

Both HFMs are in an area enclosed by plastic curtains on two sides and a building wall on the other two sides. The curtain enclosing the front of the area is composed of plastic strips. The side curtain is a continuous plastic sheet, except for a cut out framed in wood that allows the attending inmates to pass material to the tube breakers via a roller conveyor. The area in enclosed on top by plastic as well.

The HFMs discharge into the enclosure (rather than to the outside of the building, for example) recirculating the filtered air into the workplace. Since the air is recirculated, the enclosure is not under negative pressure with regard to the rest of the glass breaking facility. The American National Standards Institute and the American Industrial Hygiene Association note that recirculation of air from industrial exhaust systems into workroom air can result in hazardous air contaminant concentrations in the facility if not designed properly [ANSI/AIHA 2007]. They recommend performing an evaluation of the process and the toxicity of the materials used in the process before recirculating air to the workplace [ANSI/AIHA 2007]. That standard emphatically states "under no circumstances shall workroom air consist of 100% recirculated air." According to the ANSI/AIHA standard., the recirculation of exhaust air streams that contain highly toxic substances (as defined by the OSHA Hazard Communication Standard) requires the use of a continuous monitoring device for the contaminant in the exhaust stream; however a continuous monitoring of the pressure drop across the redundant filter may be acceptable if filter testing upon installation reveals the presence of no more than 10% of the acceptable concentration of the contaminant in the discharge ductwork [ANSI/AIHA 2007]. There are no continuous monitoring devices installed on these HFMs. While the samples collected during this evaluation were not collected in the discharge ductwork, the measured occupational exposures were very low. Monitoring of the pressure drop across the HEPA filter may be an acceptable means of monitoring filter loading and detecting any leaks. There are manometers installed on both HFMs.

Exhausting the HFMs to the outside of the building could create negative pressure within the glass-breaking booth with respect to the rest of the building to help contain airborne contaminants generated by that operation and eliminate the recirculation of exhaust air. Addition of tempered make-up air would cool the workers; the volume of makeup air supplied should be balanced with the exhaust volume to maintain the desired negative pressure. However, since the HFMs are not designed to exhaust externally, the manufacturer should be consulted before any modifications are attempted.

The OSHA lead standard includes requirements for the design and evaluation of mechanical exhaust systems in workplaces where the OSHA PEL of 50 $\mu g/m^3$ [29 CFR 1910.1025]. These include a requirement to perform measurements at least every 3 months (and within 5 days of any change that might impact upon exposure) which demonstrate the effectiveness of the system in controlling exposure, such as capture velocity, duct velocity, or static pressure. Where exhaust air is recirculated into the workplace, that regulation also requires the use of a high efficiency filter with reliable back-up filter and the use of controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails. The OSHA cadmium standard includes similar requirements and adds a requirement to utilize procedures to minimize employee exposure to cadmium when maintenance of ventilation systems and changing of filters is being conducted. However, none of the air samples revealed lead or cadmium exposures above the OSHA PEL in the GBO, so these requirements do not apply here.

VI. CONCLUSIONS AND RECOMMENDATIONS

The primary purpose of sampling is to determine the extent of employee exposures and the adequacy of protection. Sampling also permits the employer to evaluate the effectiveness of engineering and work practice controls and informs the employer whether additional controls need to be installed. Values that exceed OELs indicate that additional controls are necessary. This study focused on the evaluation of airborne exposures and heat stress, with additional data collected on surface contamination. Measurements of environmental heat indicate exposures above safe levels for the work loads and work schedules. The results of air sampling during this August 2007 survey found that lead, cadmium, and other metals are generated and released during the recycling operations at this facility. No exposures to airborne metals or particulate were found that exceeded the OSHA Action Level for these substances during routine production or during non-routine operations, such as the monthly filter change operation. When the results of sampling conducted during routine operations in the GBO are reviewed, the reader should remember that the GBO was operating on a shortened schedule due to the hot conditions.

Although the whistleblower was concerned about beryllium and literature that pertains to e-waste recycling report that beryllium is present in electronic components, none was detected in air, wipe, or bulk samples collected at this facility. One explanation for this is based on the work of Willis and Florig [2002]. They note that beryllium "in consumer products is used in ways that are not likely to create beryllium exposures during use and maintenance." The recycling operations (except the GBO) involve disassembly of electronics and sorting of the components. While some breakage occurs during the disassembly process, the components likely to contain beryllium are not subject to further processing that might create the potential for beryllium exposures.

Recommendations are presented below to assure the continued safe conditions at Marianna Federal Correctional facility. While no overexposures were documented in air samples, the feeders' exposures during routine glass breaking operations require further scrutiny to determine the source of their airborne exposures. Many wipe samples in the FCI revealed levels of concern, notably those that exceeded the OSHA criteria for lead of 21.5 μg/100 cm^2, as well as samples for cadmium and nickel that produced results up to 66 μg of cadmium /100 cm^2 and 70 μg of nickel/100 cm^2. Modifications can be made to assure continued exposure control and to improve operations in general.

When reviewing the work practices for the inmates working in the GBO, one is struck by the approaches taken to worker protection. A typical work area where exposure levels dictate the use of protective clothing includes an outer change area where workers can remove and store their street clothing and don their work clothing and personal protective equipment before entering the work area (Figure VII). As Figure VII illustrates, in a typical facility where protective clothing is required, workers exit the work area through a "decon" area (e.g., where they vacuum the outer surface of their clothes) upon completion of their work, and then enter a separate, "dirty" locker area, where their soiled work clothes are removed and placed in receptacles for cleaning or disposal. The workers then pass through a shower area, and then enter the clean locker area, where they change into their street clothes again. In some cases (e.g., asbestos removal), respirators are worn into the shower and not removed until the exterior surfaces are rinsed.

In the Marianna GBO, air sampling revealed that the use of protective clothing, respirators or change rooms is not required by the OSHA lead or cadmium standards, since the PEL is not exceeded. However, management has chosen to require the use of respirators and protective clothing. At the time of this evaluation, the workers wore their prison uniforms into the work area and donned disposable spun-bonded olefin coveralls on top of them. Thus, their prison uniforms may become contaminated by their work, and the workers may be at risk of heat illness through their use of the outer garments. In addition, respirators and clean protective clothing are stored in lockers in the work area, where they are at risk of contamination. Since this facility already provides uniforms; a second set could be provided for workers in the GBO, collected, segregated and laundered separately and in accordance with good practices and applicable regulations. Using a different colored uniform for use in the GBO would aid in the segregation of work uniforms from "street clothes." Using a separate uniform inside the GBO and discontinuing the use of spun-bonded olefin coveralls over the normal prison uniform would improve heat loss and reduce the level of heat stress while protecting the workers from the environment.

Heat Stress Recommendations

The following additional recommendations are based on NIOSH, and ACGIH® recognized methods and/or procedures which can be used to reduce heat stress hazards at the Marianna FCI and FCP workplaces:

BOP should institute measures immediately to ensure compliance with the ACGIH® heat stress criteria in preparation for next summer. If UNICOR is not presently able to ensure such compliance, it should suspend glass breaking operations at Marianna during hot weather until a heat stress program can be developed and implemented to offset the potential health problems and/or consequences that may result from glass breaking activities and the elevated temperatures found during this investigation. If the BOP has an equally effective alternative to achieving compliance other than the development of a heat stress plan and the interim suspension of GBO, it should promptly notify the OIG.

1. Based upon the exposures to hot environments documented in this report, the site-specific health and safety program at Marianna must include a heat stress section, which includes, as a minimum:

a. Procedures that will be used to determine environmental and metabolic heat. NIOSH [1986] recommends establishing a WBGT or environmental profile for each hot work area during winter and summer months to help determine when to implement engineering and/or work practice controls. Additional measurements should be made to aid in the implementation decision when the profile indicates that excessive heat should be anticipated or if a heat wave is forecast.

b. Both routine and non-routine work practices should be carefully observed to estimate the metabolic heat associated with each job or task. Procedures for obtaining those estimates can be found in NIOSH [1986] and ACGIH [2007] publications.

c. NIOSH [1986] recommends instituting a medical surveillance program for all workers who may be exposed to heat stress above recommended limits, including preplacement and periodic examinations. The recommended content of the examinations and other relevant information can be found in that reference.

2. Engineering controls are the preferred method to reduce and/or eliminate occupational stressors in the workplace; therefore, cooling methods, such as air conditioning systems should be investigated to reduce the heat load in this work place. Portable air conditioners may be used in the trailers while the trailer crews are working, if monitoring shows their use is warranted.

3. In lieu of implementing engineering controls, work/rest schedules can be utilized to control worker exposure to heat stress. Provisions for a work/rest regimen should be established so that exposure time to high temperatures and/or the work rate is decreased. For example, a measured hourly TWA WBGT of 29 ºC and a moderate work load dictates a work rest schedule of 30 to 45 minutes work per hour [ACGIH 2008]. In addition, the BOP needs to reassess its current use of PPE (i.e., the use of spun-bonded olefin, PAPRs, gloves, etc.) and consider adding personal cooling devices, such as, cooling vest or packs for workers in the GBO.

4. An initial and periodic training program should be implemented, informing employees about the hazards of heat stress, predisposing factors and how to recognize heat-related illness signs and symptoms, potential health effects, first aid procedures, precautions for work in hot environments and preventing heat-induced illnesses, worker responsibilities, and other elements [NIOSH 1986].

5. An acclimation program should be implemented for new employees <u>or</u> employees returning to work from absences of three or more days.

6. Specific procedures should be developed for heat-related emergency situations, including provisions that first aid be administered immediately to employees displaying symptoms of heat related illness.

7. Workers should be permitted to drink water at liberty.

8. The ACGIH [2007] recommends the following general controls for limiting heat strain. Consult the documentation of the Heat Stress and Strain TLV for further information.

- Provide accurate verbal and written instructions, annual training programs, and other information about heat stress and strain
- Encourage drinking small volumes (approximately 1 cup) of cool, palatable water (or other acceptable fluid replacement drink) about every 20 minutes
- Permit self-limitation of exposures and encourage co-worker observation to detect signs and symptoms of heat strain in others
- Counsel and monitor those who take medications that may compromise normal cardiovascular, blood pressure, body temperature regulation, renal, or sweat gland functions; and those who abuse or are recovering from the abuse of alcohol or other intoxicants
- Encourage healthy life-styles, ideal body weight and electrolyte balance
- Adjust expectations of those returning to work after absence from hot exposure situations and encourage consumption of salty foods (with approval of physician if on a salt-restricted diet)
- Consider preplacement medical screening to identify those susceptible to systemic heat injury
- Monitor the heat stress conditions and reports of heat-related disorders

9. If the detailed analysis required by the TLV® reveals that the "exposure exceeds the limits for acclimatized workers," the ACGIH® [2007] recommends that physiological monitoring (e.g., core body temperature, heart rate monitoring) as "the only alternative to demonstrate that adequate protection is provided." If physiological monitoring indicates that employees are experiencing excessive heat strain (the overall bodily response to heat stress), then job-specific controls should be implemented. These include [ACGIH 2007]:

- Consider engineering controls that reduce the metabolic rate, provide general air movement, reduce process heat and water vapor release, and shield radiant heat sources, among others
- Consider administrative controls that set acceptable exposure times, allow sufficient recovery, and limit physiological strain
- Consider personal protection that is demonstrated effective for the specific work practices and conditions at the location

10. It is strongly recommended that the current version of the documentation of the ACGIH® TLV®s be referenced to assist in adding additional specific information when preparing a site-specific heat stress program for the Marianna facilities. Examples would be on a thorough understanding of the various clothing ensembles worn throughout the year (especially during the warmer seasons) and the role that PPE (i.e., the use of spun-bonded olefin suits, hoods, gloves, etc.) may play on the effects of heat stress. Additional emphasis should be placed on the TLV® Guidelines for Limiting Heat Strain and the Guidelines for Heat Stress Management. It is also recommended that that additional material on heat stress be investigated, such as OSHA's Heat Stress Card (OSHA Publication 3154). This and other relevant materials can be found on OSHA's web page (http://www.osha.gov/SLTC/heatstress/index.html).

Based on the data presented in this report, the following recommendations are made. These recommendations are divided into four categories, described as ventilation controls in the GBO, programmatic issues, procedural issues, and housekeeping issues.

Ventilation controls in the GBO:

1. The HFM ventilation controls maintain airborne metal and dust exposures in the GBO booth to concentrations below allowable limits. Typically, respirators would not be required in an environment where occupational exposures are below allowable limits. However, the PAPRs probably provide some heat stress relief by blowing air past the workers' heads. Their use should be continued.
2. There is currently no ventilation system supplying air to the GBO. The air in the breaking booth is filtered and recirculated by the HFMs. ANSI and AIHA [2007] recommend that "under no circumstances shall workroom air consist of 100% recirculated air." Providing tempered and filtered outside air would satisfy that recommendation and provide some relief from heat stress. However, any air supply system should be designed carefully. Adding a supply of air to the breaking booth without any exhaust would create a positive pressure in the booth and spread potentially contaminated air to the rest of the GBO. Ideally, a tempered air supply to the GBO would be balanced with exhaust air to create a slight negative pressure in the breaking booth with regard to the rest of the GBO. Depending on the source of their exposures, this pressure differential could result in lower exposures for the feeders. Consult with a qualified engineer and the HFM manufacturer to determine the best way to achieve this using the existing HFMs if possible. The addition of a change room should also be taken into account.
3. According to the ANSI/AIHA [2007] standard, the recirculation of exhaust air streams that contain highly toxic substances (as defined by the OSHA Hazard Communication Standard) requires the use of a continuous monitoring device for the contaminant in the exhaust stream; however a continuous monitoring of the pressure drop across the redundant filter may be acceptable. There

are no continuous monitoring devices present on the HFMs. However, there are pressure gauges mounted on the side of each unit. Consult with the manufacturer to determine if these are installed in order to monitor pressure drop across the HEPA filter and to determine what settings should lead to filter change (high pressure across the filter) or process shut down (low pressure setting). A visual or audio warning device should be added that would signal the worker if the HFM stops working or if the pressure drop across the filter exceeds the manufacturer's recommended settings.

Programmatic issues:

1. Training of workers should be scheduled and documented in the use of techniques for dust suppression, the proper use of local ventilation, personal protection equipment (e.g., coveralls, respirators, gloves) and hazard communication, housekeeping and personal hygiene practices. Written programs should be prepared and the programs implemented and updated as required to ensure that workers receive training in hazard communication, respiratory protection, working in hot environments, an the use of personal protective equipment.
2. The respiratory protection program for this facility should be evaluated for this operation in order to ensure that it complies with OSHA regulation 1910.134, especially with regard to cleaning and storage practices. BOP should also be aware of the fact that the respirator manufacturer Global Secure PAPR is going through bankruptcy, and their approvals will likely soon be listed as 'Obsolete", meaning the manufacturer no longer supports them with replacement parts. If OEM replacement parts are needed and can't be purchased, the respirator will no longer be usable as a NIOSH approved device.
3. Frequently while conducting the on-site work, NIOSH researchers observed tasks being conducted in a manner which appeared to be biomechanically taxing, such as workers lifting large CRTs from Gaylord boxes and placing them on the roller conveyor in the GBO. Tasks should be evaluated to determine if there are awkward postures or lifting techniques that may result in repetitive stress trauma and if modifications in procedures or equipment would provide benefit to this workplace.
4. Heat stress should be periodically re-evaluated during hot weather (e.g., the summer months).
5. All UNICOR operations, including but not limited to recycling should be evaluated from the perspective of health, safety and the environment in the near future.
6. A program should be established within the Bureau of Prisons to assure that these issues are adequately addressed by competent, trained and certified health and safety professionals. While a written program to address these issues is necessary at each facility, adequate staffing with safety and health professionals is required to ensure its implementation. One indication of adequate staffing is provided by the United States Navy, which states "Regions/Activities with more than 400 employees shall assign, at a minimum, a full time safety manager and adequate clerical support" [USN 2005]. That document also provides recommended hazard-based staffing levels for calculating the "number of professional personnel needed to perform minimum functions in the safety organization."
7. A comprehensive program is needed within the Bureau which provides sufficient resources, including professional assistance, to assure each facility the assets needed to assure both staff and inmates a safe and healthy workplace.

Procedural issues:

8. The use of an alternative method (e.g., static pressure drop) should be investigated to determine frequency of filter change. The manufacturer of this system may have guidelines in this regard.
9. Workers performing the filter change operation should continue to utilize respiratory protection as part of a comprehensive respiratory protection program. The PAPRs used provide adequate protection for the modified filter change operation.

10. Because the facility already provides uniforms to its workers, management should evaluate the feasibility of providing and laundering work clothing for all workers in the recycling facility, instead of the current practice of providing disposable clothing for glass breaking workers only. Contaminated work clothing must be segregated from other clothes and laundered in accordance with applicable regulations. Use of different colored uniforms for work and "street" clothes would aid in the segregation process.
11. While levels of airborne contaminants were below acceptable limits (e.g., the OSHA PELs for lead and cadmium), best practices and the current use of protective clothing in the GBO suggest that change rooms should be modified to provide showers and separate storage facilities for protective work clothing and equipment and for street clothes that prevent cross-contamination. The use of properly constructed change rooms as described above would restrict any contamination to the work area and keep it out of residential areas of the facility.
12. The use of alternative methods to break cathode-ray tubes should be investigated by Marianna management. Lee et al. [2004] present different methods to separate panel glass from funnel glass in CRT recycling (sec 2.1) and for removing the coatings from the glass (sec 2.2). The hot wire and vacuum suction methods (supplemented with local exhaust ventilation) described by Lee et al. may produce fewer airborne particulates than breaking the glass with a hammer. The authors [Lee et al. 2004] describe a commercially-available method in which an electrically-heated wire is either manually or automatically wound around the junction of the panel and funnel glass, heating the glass. After heating the glass for the necessary time, cool (e.g., room temperature) air is directed at the surface, fracturing the glass-to-glass junction using thermal shock. The separated panel and funnel glass can then be sorted by hand. They also describe a method wherein a vacuum-suction device is moved over the inner surface of the panel glass to remove the loose fluorescent coating [Lee et al. 2004]. The vacuum used must be equipped with HEPA filtration. Industrial central vacuum systems are available; they may cost less in the long run than portable HEPA vacuum cleaners. These modifications may also reduce the noise exposure to glass breakers.
13. German authorities [BG/BIA 2001] have issued a set of best-practices for dismantling CRTs that should be reviewed for their applicability to these operations. Among those is a recommendation for the provision of washrooms and rooms with separate storage capabilities for street and work clothing.

Housekeeping:

14. Due to the levels of surface contamination of lead and other metals measured in the recycling facility, workers should wash their hands before eating, drinking, or smoking. While not observed here, remember that consumption of food, beverage or tobacco in the workplace should be prohibited to prevent accidental ingestion of hazardous substances.
15. Given the concentrations of lead and cadmium detected in the bulk dust samples, surface wipe samples, and air measurements, periodic industrial hygiene evaluations and facility inspections are recommended to confirm that exposures are maintained below applicable occupational exposure limits.
16. Daily and weekly cleaning of work areas by HEPA-vacuuming and wet mopping should be continued, taking care to assure no electrical or other safety hazard is introduced. The BG/BIA guidelines [2001] recommend daily cleaning of tables and floors with a type-H vacuum cleaner. Type H is the European equivalent of a HEPA vacuum, where the H class requires that the filter achieve 99.995% efficiency, where 90% of the test particles are smaller than 1.0 μm and pass the assembled appliance test, 99.995% efficiency where 10% of the particles are smaller than 1.0 μm, 22% below 2.0 μm, and 75% below 5.0 μm. High levels of lead surface contamination was

measured in some work areas, indicating the need for improved housekeeping practices in effect in all locations observed. Other practices not observed during the time of this evaluation, but which have been observed at other facilities should be discouraged; this includes the use of compressed air to clean parts or working surfaces.

17. The use of disposable coverings on work surfaces (e.g., cardboard from excess boxes) may aid housekeeping practices. Wipe sampling can be used initially to determine the frequency with which the coverings should be discarded. However, Marianna facility management must ensure that the contaminated coverings are disposed of properly.

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Table 3: Summary Statistics for Airborne Metal Measurements*
(Concentration units for means is μg/m^3)

	Ba	Be	Cd	Pb	Ni	Particulate
18 samples collected in the FCI UNICOR factory						
Arithmetic Mean (μg/m^3)	0.13	0.025	0.056	0.29	0.22	250
Arithmetic Standard Deviation (μg/m^3)	0.075	0.013	0.029	0.17	0.15	155
Geometric Mean (μg/m^3)	0.11	0.022	0.050	0.25	0.19	207
Geometric Standard Deviation (μg/m^3)	1.9	1.5	1.7	1.8	1.8	1.9
12 samples collected in the FPC UNICOR factory						
Arithmetic Mean (μg/m^3)	0.09	0.022	0.067	0.22	0.22	234
Arithmetic Standard Deviation (μg/m^3)	0.11	0.0078	0.058	0.078	0.078	304
Geometric Mean (μg/m^3)	0.067	0.022	0.055	0.22	0.22	140
Geometric Standard Deviation (μg/m^3)	2.0	1.3	1.8	1.3	1.3	2.6
12 samples collected in the FPC GBO						
Arithmetic Mean (μg/m^3)	0.80	0.037	1.1	6.1	0.37	435
Arithmetic Standard Deviation (μg/m^3)	0.74	0.0078	2.1	6.5	0.078	330
Geometric Mean (μg/m^3)	0.46	0.037	0.29	3.0	0.37	287
Geometric Standard Deviation (μg/m^3)	3.4	1.2	4.7	3.9	1.2	2.9
6 samples collected in the FPC GBO during filter change						
Arithmetic Mean (μg/m^3)	4.8	0.092	4.2	30	0.92	1567
Arithmetic Standard Deviation (μg/m^3)	5.7	0.013	4.2	38	0.13	1737
Geometric Mean (μg/m^3)	2.9	0.091	2.7	18	0.91	968
Geometric Standard Deviation (μg/m^3)	2.8	1.1	2.9	2.9	1.1	3.0

Where results were less than the limit of detection (LOD), the value LOD/$\sqrt{2}$ was used in calculating these statistics. These summary statistics exclude two samples collected in the FPC UNICOR factory that were compromised, MSMHF-9 and MSMHF-11. The employee who wore sample MSMHF-9 reported that toner "exploded" (spilled) as she unloaded recyclable components from a truck. This probably accounts for the high dust loading. The employee who wore sample MSMHF-11 touched the cassette inlet with her glove at 9:35 am. Some lint was transferred to the filter. This probably accounts for the high dust loading on this sample as well.

Table 4: Airborne Metal Measurements

Sample ID	Building	Date	Area / Personal	Sample Description	Sample Duration	Flow Rate	Ba	Be	Cd	Pb	Ni	Particulate
					Minutes	L/minute	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
The following 18 samples were collected in the FCI UNICOR factory												
MCMWF-5	FCI	8/8/07	P	Break down	251	3.0	0.15	<0.03	(0.052)	(0.54)	(0.19)	717
MCMWF-6	FCI	8/8/07	P	Orderly (moves Materials)	253	3.0	0.26	<0.03	(0.079)	<0.1	(0.11)	369
MCMWF-7	FCI	8/8/07	P	Bailer	253	3.0	0.21	<0.03	(0.047)	(0.17)	(0.13)	277
MCMWF-8	FCI	8/8/07	P	Refurbishing	241	3.0	0.077	<0.03	<0.03	<0.1	(0.089)	373
MCMWF-9	FCI	8/8/07	P	Refurbishing	245	3.0	(0.063)	<0.03	<0.03	(0.35)	(0.15)	218
MCMWF-10	FCI	8/8/07	P	Dismantling	239	3.0	0.11	<0.03	(0.052)	<0.1	<0.08	265
MCMHF-1	FCI	8/9/07	P	Orderly	217	3.0	0.26	<0.03	(0.091)	<0.3	<0.3	307
MCMHF-2	FCI	8/9/07	P	Bailer	207	3.0	0.19	<0.03	(0.069)	<0.3	<0.3	306
MCMHF-3	FCI	8/9/07	P	Separator	269	3.0	0.17	<0.02	(0.056)	(0.40)	<0.2	235
MCMHF-4	FCI	8/9/07	P	Orderly refurbish	123	3.0	<0.05	<0.05	<0.1	<0.5	<0.5	<81
MCMHF-5	FCI	8/9/07	P	Disassembly refurbish	94	3.0	<0.07	<0.07	<0.1	<0.7	<0.7	<106
MCMHF-6	FCI	8/9/07	P	Disassembly refurbish	235	3.0	0.14	<0.03	<0.06	(0.37)	<0.3	213
MCMHF-7	FCI	8/9/07	P	Orderly	271	3.0	0.12	<0.03	<0.05	<0.2	<0.2	185
MCMHF-8	FCI	8/9/07	P	Disassembler	275	3.1	0.18	<0.02	<0.05	<0.2	<0.2	282
MCMHF-9	FCI	8/9/07	P	Disassembler	240	3.0	0.21	<0.03	<0.06	(0.44)	<0.3	333
MCMHF-10	FCI	8/9/07	P	Disassembly refurbish	237	3.0	(0.055)	<0.03	<0.06	<0.3	<0.3	(122)
MCMHF-11	FCI	8/9/07	P	Orderly refurbish	250	3.0	(0.039)	<0.03	<0.05	<0.3	<0.3	(76)
MCMHF-12	FCI	8/9/07	P	Disassembly refurbish	72	3.0	<0.09	<0.09	<0.2	<0.9	<0.9	<140
The following 14 samples were collected in the FPC UNICOR factory												
MSMWF-5	Camp	8/8/07	P	Lead truck crew	220	3.0	(0.055)	<0.03	<0.06	<0.3	<0.3	(102)
MSMWF-6	Camp	8/8/07	P	Dock unload/load	212	3.1	(0.041)	<0.03	<0.06	<0.3	<0.3	(117)
MSMWF-7	Camp	8/8/07	P	Truck work, sweeping	105	3.0	<0.06	<0.06	<0.1	<0.6	<0.6	<95
MSMWF-8	Camp	8/8/07	P	Truck crew, sweep/unload	206	3.0	(0.042)	<0.03	<0.07	<0.3	<0.3	178
MSMWF-11	Camp	8/8/07	P	Breakdown CPUs	166	3.0	0.42	<0.04	<0.08	<0.4	<0.4	<60
MSMWF-12	Camp	8/8/07	P	Breakdown CPUs	263	3.0	(0.063)	<0.03	<0.05	<0.3	<0.3	(110)
MSMHF-7	Camp	8/9/07	P	Truck crew	256	3.0	(0.049)	<0.03	(0.089)	<0.3	<0.3	872

< quantity less than the limit of detection. Parentheses indicate quantity between the limit of detection and limit of quantitation. †The employee who wore sample MSMHF-9 reported that toner "exploded" (spilled) as she unloaded recyclable components from a truck. *The employee who wore sample MSMHF-11 touched the cassette inlet with her glove at 9:35 am. Some lint was transferred to the filter. These incidents probably account for the high dust loading on both samples.

Table 4: Airborne Metal Measurements (continued)

Sample ID	Building	Date	Area / Personal	Sample Description	Sample Duration	Flow Rate	Ba	Be	Cd	Pb	Ni	Particulate
					Minutes	L/minute	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
MSMHF-8	Camp	8/9/07	P	Truck crew	297	3.0	(0.064)	<0.02	0.24	<0.2	<0.2	887
MSMHF-9	Camp	8/9/07	P	Truck crew	245	3.0	0.20	<0.03	0.49	(0.42)	<0.3	9,524†
MSMHF-10	Camp	8/9/07	P	Fork lift driver	254	3.0	(0.033)	<0.03	<0.05	<0.3	<0.3	(101)
MSMHF-11	Camp	8/9/07	P	CPU disassembly	301	3.0	1.6	<0.02	0.14	1.1	0.84	14,396*
MSMHF-12	Camp	8/9/07	P	CPU disassembly	251	3.0	(0.060)	<0.03	<0.05	<0.3	<0.3	(62)
MSMHF-13	Camp	8/9/07	P	CPU disassembly	207	3.0	(0.069)	<0.03	<0.06	<0.3	<0.3	(108)
MSMHF-14	Camp	8/9/07	P	CPU disassembly	269	3.0	0.16	<0.03	<0.05	<0.2	<0.2	161
The following 12 samples were collected in the FPC GBO												
MSMWF-1	Camp	8/8/07	P	Feeder	143	3.0	0.65	<0.05	6.8	3.7	<0.5	513
MSMWF-2	Camp	8/8/07	P	Feeder	140	3.0	0.69	<0.05	3.8	5.2	<0.5	619
MSMWF-3	Camp	8/8/07	P	Outside person	137	3.0	(0.11)	<0.05	(0.22)	<0.5	<0.5	<73
MSMWF-4	Camp	8/8/07	P	Outside person	135	3.0	(0.079)	<0.05	(0.21)	(0.57)	<0.5	(116)
MSMWF-9	Camp	8/8/07	P	Breaker, Front Side (left)	91	3.0	1.5	<0.07	0.59	12	<0.7	806
MSMWF-10	Camp	8/8/07	P	Breaker, Back Side (right)	88	3.0	0.42	<0.08	<0.2	(2.4)	<0.8	(140)
MSMHF-1	Camp	8/9/07	P	Outside person	150	3.0	0.49	<0.04	<0.09	3.1	<0.4	311
MSMHF-2	Camp	8/9/07	P	Outside person	148	3.0	(0.097)	<0.05	<0.09	(0.68)	<0.5	(173)
MSMHF-3	Camp	8/9/07	P	Feeder	147	2.9	2.1	<0.05	(0.18)	15	<0.5	891
MSMHF-4	Camp	8/9/07	P	Feeder	144	3.0	1.3	<0.05	(0.13)	8.8	<0.5	694
MSMHF-5	Camp	8/9/07	P	Breaker front side	109	3.0	2.0	<0.06	0.70	20	<0.6	856
MSMHF-6	Camp	8/9/07	P	Breaker back side	140	3.0	(0.13)	<0.05	<0.1	(1.0)	<0.5	<71
The following 6 samples were collected in the FPC GBO during filter change												
MSMHF-17	Camp	8/9/07	P	Filter change back, inside booth	45	3.0	5.0	<0.1	5.3	29	<1	1,704
MSMHF-19	Camp	8/9/07	P	Filter change front, inside booth	57	3.0	16	<0.1	12	105	<1	4,912
MSMHF-20	Camp	8/9/07	P	Filter change outside booth	62	3.0	1.6	<0.1	1.7	9.7	<1	753
MSMHF-21	Camp	8/9/07	P	Filter change outside booth	58	2.9	3.6	<0.1	4.4	22	<1	1,427
MSMHF-22	Camp	8/9/07	P	Filter change outside booth	47	3.0	1.3	<0.1	1.1	8.5	<1	(333)
MSMHF-23	Camp	8/9/07	P	Filter change outside booth	45	3.0	1.0	<0.1	(0.74)	(5.6)	<1	(274)

Table 5: Wipe Sample Results

SAMPLE I. D.	DATE	DESCRIPTION	Ba	Be	Cd	Pb	Ni
			Results in μg/100 cm²				
SAMPLES TAKEN FROM THE FCI FACTORY							
MCMWG – 1	8/8/07	Cleaning area, table top where workers cleaning monitors	1.8	<0.07	0.49	5.6	2.7
MCMWG – 2	8/8/07	Table top near repair worker	15	<0.07	3.0	35	17
MCMWG – 3	8/8/07	Table top near breakdown worker, laminate surface	5.1	<0.07	1.1	37	3.9
MCMWG – 4	8/8/07	Table top near breakdown worker, surface is floor-mat material	16	<0.07	65	46	25
MCMWG – 5	8/8/07	Table top near breakdown worker, rough wood surface	8.9	<0.07	5.1	34	39
MCMWG – 6	8/8/07	Table top near testing worker, vinyl surface	5.9	<0.07	1.5	11	7.2
MCMWG – 7	8/8/07	Table top near sander, vinyl surface	20	<0.07	2.2	23	24
MCMWG – 8	8/8/07	Table top near worker doing copper stripping, Masonite surface	2.0	<0.07	0.73	14	3.7
MCMWG – 9	8/8/07	Table top near breakdown worker, rubber mat surface	2.6	<0.07	0.91	46	3.7
MCMHG – 1	8/9/07	Table top in breakdown area, rubber matt surface	18	<0.07	22	110	28
MCMHG – 2	8/9/07	Table top in breakdown area, smooth wood surface	0.60	<0.07	0.82	3.6	1.5
MCMHG – 3	8/9/07	Inside of Gaylord box containing small boards	1.0	<0.07	0.60	1.8	2.5
MCMHG – 4	8/9/07	Inside bailer in disassembly area	0.38	<0.07	(0.16)	2.5	1.2
MCMHG – 5	8/9/07	Rubber matt surface in breakdown area	21	<0.07	4.1	85	14
MCMHG – 6	8/9/07	Smooth wood surface in breakdown area	15	<0.07	3.0	17	7.3
MCMHG – 7	8/9/07	Smooth wood surface in breakdown area	80	<0.07	19	88	19
MCMHG – 8	8/9/07	Rough wood surface in breakdown area	11	<0.07	1.9	72	11
MCMHG – 9	8/9/07	Rough wood surface in breakdown area	62	<0.07	2.9	140	18
MCMHG – 10	8/9/07	Smooth work surface in copper stripping area	3.4	<0.07	0.54	9.8	2.7
MCMHG – 11	8/9/07	Top of sanding table in refurbish area, rubber surface	53	<0.07	3.0	33	68
MCMHG – 12	8/9/07	Table top for refurbishing large assemblies, very rough wood surface	1.4	<0.07	1.0	5.3	5.1
MCMHG – 13	8/9/07	Inside box containing "Frames with boards"	(0.16)	<0.07	<0.07	1.1	<0.3
MCMHG – 14	8/9/07	Smooth wood surface, disassembly operation in refurbish area	7.4	<0.07	1.1	36	3.9
SAMPLES TAKEN FROM THE CAMP FACILITY							
MSMWG – 1	8/8/07	Top of bookcase outside breaking area	1.3	<0.07	1.2	8.4	(0.75)
MSMWG – 2	8/8/07	Locker in GB area (top, under handle)	0.25	<0.07	0.31	2.9	(0.32)
MSMWG – 3	8/8/07	Top of conduit inside containment on interior wall	320	<0.07	360	5100	52

< Indicates a value less than the limit of detection. Numbers in parentheses indicate a result between the LOD and LOQ.

Table 6: Composition of Bulk Dust Samples from the Glass Breaking Operation

SAMPLE I. D.	DATE	SAMPLE DESCRIPTION	Ba	Be	Cd	Pb	Ni
MSMWB – 1	8/8/07	Bulk from filter in shop vac used for general cleaning	1000	<0.2	170	2200	1800
MSMWB – 2	8/8/07	Bulk from Nilfisk vac used outside containment area	890	<0.2	(1.3)	35000	7.7
MSMWB – 3	8/8/07	Bulk from Nilfisk vac used inside containment area	82	<0.2	(0.98)	2300	2.1
MSMWB – 4	8/8/07	Settled dust on top of locker	570	<0.2	130	2500	610
MSMHB – 1	8/9/07	Floor sweeping outside of curtained area during filter change using broom to sweep floor	470	<0.2	260	10000	31

All samples were taken from glass breaking room at the camp facility. Concentrations are in mg/kg. < indicates a value less than the limit of detection. A value in parentheses indicates a result between the limit of detection and limit of quantitation.

Table 7: Wet Bulb Globe Temperature Measurements, Marianna Federal Correctional Facility

Heat Stress Data – August 8, 2007		
Location	Times	Hourly TWA* $WBGT_{in}$ °C (°F)
Camp – Glass Breaking Room	8:52 a.m. to 9:52 a.m.	28.8 (83.8)
	9:53 a.m. to 10:45 a.m.	29.7 (85.5)
Camp – Warehouse	9:41 a.m. to 10:41 a.m.	28.1 (82.6)
	10:42 a.m. to 11:42 a.m.	28.4 (83.1)
	11:43 a.m. to 12:43 p.m.	28.5 (83.3)
	12:44 p.m. to 1:44 p.m.	28.5 (83.3)
	1:45 p.m. to 2:45 p.m.	28.2 (82.8)
FCI – Refurbish	10:24 a.m. to 11:24 a.m.	28.3 (82.9)
	11:25 a.m. to 12:25 p.m.	28.9 (84.0)
	12:26 p.m. to 1:26 p.m.	29.1 (84.4)
	1:27 p.m. to 2:27 p.m.	29.1 (84.4)
	2:28 p.m. to 3:28 p.m.	28.8 (83.8)
FCI – Disassembly	10:31 a.m. to 11:31 a.m.	28.4 (83.1)
	11:32 a.m. to 12:32 p.m.	29.0 (84.2)
	12:33 p.m. to 1:33 p.m.	29.1 (84.4)
	1:34 p.m. to 2:34 p.m.	29.4 (84.9)
	2:35 p.m. to 3:35 p.m.	29.2 (84.6)

Heat Stress Data – August 9, 2007		
Location	Times	Hourly TWA* $WBGT_{in}$ °C (°F)
Camp – Glass Breaking Room	7:59 a.m. to 8:59 a.m.	29.7 (85.5)
	9:00 a.m. to 10:00 a.m.	30.4 (86.8)
Glass Breaking Room during Filter Change	12:35 p.m. to 1:35 p.m.	31.2 (88.2)
Camp –Warehouse	8:44 a.m. to 9:44 a.m.	28.6 (83.5)
	9:45 a.m. to 10:45 a.m.	29.3 (84.8)
	10:46 a.m. to 11:46 a.m.	29.4 (84.9)
	11:47 a.m. to 12:47 p.m.	29.3 (84.7)
	12:48 p.m. to 1:48 p.m.	29.2 (84.5)
FCI – Refurbish	9:35 a.m. to 10:35 a.m.	29.2 (84.6)
	10:36 a.m. to 11:36 a.m.	29.6 (85.2)
	11:37 a.m. to 12:37 p.m.	29.7 (85.5)
	12:38 p.m. to 1:38 p.m.	29.7 (85.5)
	1:39 p.m. to 2:39 p.m.	30.1 (86.1)
	2:40 p.m. to 3:40 p.m.	30.3 (86.5)
FCI – Disassembly	9:04 a.m. to 10:04 a.m.	29.3 (84.7)
	10:05 a.m. to 11:05 a.m.	29.6 (85.3)
	11:06 a.m. to 12:06 p.m.	29.9 (85.9)
	12:07 p.m. to 1:07 p.m.	30.0 (86.0)
	1:08 p.m. to 2:08 p.m.	30.2 (86.4)
	2:09 p.m. to 3:09 p.m.	30.4 (86.8)

*Time weighted average

Table 8: Estimated Work Rates

Location	Task	Work Rate	Metabolic Heat (Watts)
FCI	All tasks	Light/moderate	180/300
FPC	Unloading trucks	Moderate	300
	Warehouse work	Light	180
	GBO* helpers	Light/moderate	180/300
	GBO feeders	Moderate/heavy	300/415
	GBO breakers	Moderate	300

Table 9: Air Velocity Measurements for HFM 1 and HFM 2

FACE VELOCITY MEASUREMENTS

HFM 1

1.07 (210)	0.81(160)	0.79 (155)
0.71 (140)	0.61(120)	0.66 (130)
0.48 (95)	0.76(150)	0.48 (95)
0.46 (90)	0.81(160)	0.35 (68)

HFM 2

0.69 (135)	1.02 (200)	0.76 (150)
0.53 (105)	0.66 (130)	0.64 (125)
0.30 (60)	0.48 (95)	0.15 (30)
0.51 (100)	0.36 (70)	0.36 (70)

CAPTURE VELOCITY MEASUREMENTS

HFM 1

0.19 (38)	0.35 (69)	0.14 (27)
0.18 (35)	0.89 (175)	0.23 (45)
0.43 (85)	0.93 (184)	0.11 (21)
0.15 (30)	0.71 (140)	0.15 (30)

HFM 2

0.17 (33)	0.80 (157)	0.27 (53)
0.18 (36)	0.81 (160)	0.25 (50)
0.20 (39)	0.55 (108)	0.24 (47)
0.64 (125)	0.50 (99)	0.16 (31)

Units in meters/second (feet/min)

Appendix A
Occupational Exposure Criteria for Metal/Elements

TABLE 2. EXPOSURE LIMITS, CAS #, RTECS

Element (Symbol)	CAS #	RTECS	Exposure Limits, mg/m³ (Ca = carcinogen) OSHA	NIOSH	ACGIH
Silver (Ag)	7440-22-4	VW3500000	0.01 (dust, fume, metal)	0.01 (metal, soluble)	0.1 (metal) 0.01 (soluble)
Aluminum (Al)	7429-90-5	BD0330000	15 (total dust) 5 (respirable)	10 (total dust) 5 (respirable fume) 2 (salts, alkyls)	10 (dust) 5 (powders, fume) 2 (salts, alkyls)
Arsenic (As)	7440-38-2	CG0525000	varies	C 0.002, Ca	0.01, Ca
Barium (Ba)	7440-39-3	CQ8370000	0.5	0.5	0.5
Beryllium (Be)	7440-41-7	DS1750000	0.002, C 0.005	0.0005, Ca	0.002, Ca
Calcium (Ca)	7440-70-2	–	varies	varies	varies
Cadmium (Cd)	7440-43-9	EU9800000	0.005	lowest feasible, Ca	0.01 (total), Ca 0.002 (respir.), Ca
Cobalt (Co)	7440-48-4	GF8750000	0.1	0.05 (dust, fume)	0.02 (dust, fume)
Chromium (Cr)	7440-47-3	GB4200000	0.5	0.5	0.5
Copper (Cu)	7440-50-8	GL5325000	1 (dust, mists) 0.1 (fume)	1 (dust) 0.1 (fume)	1 (dust, mists) 0.2 (fume)
Iron (Fe)	7439-89-6	NO4565500	10 (dust, fume)	5 (dust, fume)	5 (fume)
Potassium (K)	7440-09-7	TS6460000	–	--	–
Lanthanum	7439-91-0	–	–	–	–
Lithium (Li)	7439-93-2	–	–	--	–
Magnesium (Mg)	7439-95-4	OM2100000	15 (dust) as oxide 5 (respirable)	10 (fume) as oxide	10 (fume) as oxide
Manganese (Mn)	7439-96-5	OO9275000	C 5	1; STEL 3	5 (dust) 1; STEL 3 (fume)
Molybdenum (Mo)	7439-98-7	QA4680000	5 (soluble) 15 (total insoluble)	5 (soluble) 10 (insoluble)	5 (soluble) 10 (insoluble)
Nickel (Ni)	7440-02-0	QR5950000	1	0.015, Ca	0.1 (soluble) 1 (insoluble, metal)
Phosphorus (P)	7723-14-0	TH3500000	0.1	0.1	0.1
Lead (Pb)	7439-92-1	OF7525000	0.05	0.05	0.05
Antimony (Sb)	7440-36-0	CC4025000	0.5	0.5	0.5
Selenium (Se)	7782-49-2	VS7700000	0.2	0.2	0.2
Tin (Sn)	7440-31-5	XP7320000	2	2	2
Strontium (Sr)	7440-24-6	–	–	–	–
Tellurium (Te)	13494-80-9	WY2625000	0.1	0.1	0.1
Titanium (Ti)	7440-32-6	XR1700000	–	–	–
Thallium (Tl)	7440-28-0	XG3425000	0.1 (skin) (soluble)	0.1 (skin) (soluble)	0.1 (skin)
Vanadum (V)	7440-62-2	YW240000	–	C 0.05	–
Tungsten	7440-33-7	–	5	5 10 (STEL)	5 10 (STEL)
Yttrium (Y)	7440-65-5	ZG2980000	1	N/A	1
Zinc (Zn)	7440-66-6	ZG8600000	–	–	–
Zirconium (Zr)	7440-67-7	ZH7070000	5	5, STEL 10	5, STEL 10

Appendix B
Metallic Composition of Bulk Dust Samples from the Glass Breaking Operation
Concentrations are in mg/kg
Please see Table 6 for sample dates and descriptions.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MSMWB-1	MSMWB-2	MSMWB-3	MSMWB-4	MSMHB-1
Al	3900	120	54	5000	410
Sb	110	<3	<3	100	(8.3)
As	<7	<7	<7	<7	<7
Ba	1000	890	82	570	470
Be	<0.2	<0.2	<0.2	<0.2	<0.2
Cd	170	(1.3)	(0.98)	130	260
Ca	18000	770	150	26000	700
Cr	53	1.9	2.3	87	23
Co	5.2	<0.2	<0.2	18	0.63
Cu	210	28	3.5	320	52
Fe	9200	1100	800	18000	4300
La	<0.1	<0.1	<0.1	2.3	(0.12)
Pb	2200	35000	2300	2500	10000
Li	(3.2)	(0.14)	<0.09	(15)	0.44
Mg	1800	72	16	3800	77
Mn	220	290	4.6	370	50
Mo	4.2	(1.1)	<0.4	6.0	(0.42)
Ni	1800	7.7	2.1	610	31
P	790	(33)	<10	2800	57
K	2700	190	190	3700	400
Se	<20	<20	<20	<20	<20
Ag	13	0.30	<0.08	1.8	<0.08
Sr	130	32	18	150	140
Te	<2	<2	<2	(3.5)	(4.0)
Tl	<5	(6.8)	(8.5)	(9.7)	<5
Sn	67	<4	<4	65	(7.9)
Ti	44	2.8	1.0	58	3.2
V	6.5	(0.10)	<0.1	15	<0.1
Y	2100	19	31	2300	5800
Zn	5900	4500	390	7700	13000
Zr	(2.0)	(20)	<2	(2.6)	(3.8)

Appendix C

Metallic Composition of Wipe Samples

Concentrations are in $\mu g/100\ cm^2$

Please see Table 5 for sample dates and descriptions.

<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MCMWG - 1	MCMWG - 2	MCMWG - 3	MCMWG - 4	MCMWG - 5	MCMWG - 6	MCMWG - 7	MCMWG - 8	MCMWG - 9	MCMHG - 1	MCMHG - 2	MCMHG - 3	MCMHG - 4
As	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ba	1.8	15	5.1	16	8.9	5.9	20	2.0	2.6	18	0.60	1.0	0.38
Be	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Cd	0.49	3.0	1.1	65	5.1	1.5	2.2	0.73	0.91	22	0.82	0.60	(0.16)
Cr	1.1	6.0	2.7	8.2	12	2.4	4.7	2.3	3.2	9.8	(0.89)	(0.56)	(0.56)
Co	(0.18)	2.5	(0.25)	0.98	1.1	0.34	0.79	2.0	1.1	1.2	<0.09	(0.15)	(0.10)
Cu	5.1	35	12	68	130	14	36	14	51	83	3.3	3.3	2.2
Fe	58	567	137	667	3197	187	447	267	167	2297	21	49	95
La	<0.05	0.34	(0.077)	<0.05	1.3	(0.082)	0.37	(0.14)	(0.11)	0.87	<0.05	<0.05	(0.058)
Pb	5.6	35	37	46	34	11	23	14	46	110	3.6	1.8	2.5
Mn	1.8	18	4.4	22	110	7.0	15	35	22	35	(0.35)	1.4	1.8
Mo	<0.2	0.66	<0.2	2.9	2.2	<0.2	(0.34)	(0.22)	<0.2	0.71	<0.2	<0.2	<0.2
Ni	2.7	17	3.9	25	39	7.2	24	3.7	3.7	28	1.5	2.5	1.2
P	<6	301	13	22	<6	53	<6	<6	<6	<6	<6	<6	<6
Se	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Ag	0.16	0.76	0.29	9.7	5.2	0.28	0.32	(0.10)	0.26	3.7	(0.069)	(0.068)	<0.04
Sr	0.50	3.8	2.3	3.4	3.8	1.1	1.7	0.91	0.78	2.7	0.47	0.48	(0.36)
Te	<0.5	(0.72)	<0.5	<0.5	(0.51)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tl	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Sn	<3	19	32	44	39	(5.4)	13	11	95	190	(3.1)	<3	(3.6)
V	<0.05	0.29	(0.12)	(0.13)	(0.14)	<0.05	<0.05	<0.05	(0.076)	(0.13)	<0.05	<0.05	<0.05
Y	(0.065)	1.3	0.91	2.9	0.41	0.20	0.51	(0.11)	0.19	1.4	(0.056)	<0.04	<0.04
Zn	108	638	348	598	728	178	178	138	558	708	218	138	98
Zr	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Appendix C (Continued)
Metallic Composition of Wipe Samples
Concentrations are in µg/100 cm^2
Please see Table 5 for sample dates and descriptions.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MCMHG - 5	MCMHG - 6	MCMHG - 7	MCMHG - 8	MCMHG - 9	MCMHG - 10	MCMHG - 11	MCMHG - 12	MCMHG - 13	MCMHG - 14	MSMWG - 1	MSMWG - 2	MSMWG - 3
As	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ba	21	15	80	11	62	3.4	53	1.4	(0.16)	7.4	1.3	0.25	320
Be	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Cd	4.1	3.0	19	1.9	2.9	0.54	3.0	1.0	<0.07	1.1	1.2	0.31	360
Cr	6.7	2.7	6.5	4.1	10	2.7	9.3	2.1	(0.25)	2.0	(0.33)	(0.39)	13
Co	36	(0.14)	1.3	0.87	19	(0.22)	1.5	(0.17)	<0.09	(0.098)	<0.09	(0.11)	0.59
Cu	94	18	43	19	77	31	95	21	1.3	13	1.5	(0.8)	29
Fe	1897	157	887	501	1897	1797	527	267	7.3	177	10	1.7	1297
La	0.58	(0.055)	0.90	0.29	0.92	0.55	0.24	(0.13)	<0.05	(0.071)	<0.05	<0.05	1.5
Pb	85	17	88	72	140	9.8	33	5.3	1.1	36	8.4	2.9	5100
Mn	44	3.0	49	110	450	110	24	12	0.51	14	<0.1	<0.1	22
Mo	(0.27)	0.70	2.9	<0.2	<0.2	<0.2	(0.39)	(0.28)	<0.2	<0.2	<0.2	<0.2	(0.47)
Ni	14	7.3	19	11	18	2.7	68	5.1	<0.3	3.9	(0.75)	(0.32)	52
P	<6	<6	12	<6	<6	<6	20	<6	<6	<6	<6	<6	80
Se	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Ag	1.1	0.30	1.6	0.58	9.3	(0.066)	0.55	4.3	<0.04	0.58	<0.04	<0.04	1.2
Sr	2.4	1.2	4.7	1.7	2.6	0.94	2.8	0.79	(0.32)	1.8	0.91	0.72	170
Te	3.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tl	<2	<2	<2	<2	<2	(2.2)	<2	<2	<2	<2	<2	<2	<2
Sn	170	27	62	120	160	(4.1)	19	(4.0)	<3	43	<3	<3	12
V	(0.092)	(0.054)	(0.080)	0.21	0.56	<0.05	(0.14)	<0.05	<0.05	(0.073)	<0.05	<0.05	0.33
Y	0.14	(0.11)	1.1	3.3	2.0	(0.11)	0.45	(0.054)	<0.04	0.27	1.0	0.49	810
Zn	628	278	698	488	1298	488	308	148	91.3	378	118	148	3098
Zr	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Appendix D
Metallic Composition of Airborne Dust Samples
Concentrations are in μg/m³
Please see Table 4 for sample dates, description, duration and flow rate.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MCMWF-5	MCMWF-6	MCMWF-7	MCMWF-8	MCMWF-9	MCMWF-10
Aluminum	2.8	2.6	2.4	(1.8)	(1.5)	(1.3)
Antimony	<0.5	<0.5	<0.5	<0.6	<0.5	<0.6
Arsenic	<1	<1	<1	<1	<1	<1
Barium	0.15	0.26	0.21	0.077	(0.063)	0.11
Beryllium	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Cadmium	(0.052)	(0.079)	(0.047)	<0.03	<0.03	(0.052)
Calcium	17	17	12	9.1	7.8	8.1
Chromium	(0.24)	(0.13)	(0.18)	<0.1	<0.1	(0.22)
Cobalt	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Copper	(0.29)	(0.33)	(0.17)	<0.1	0.53	(0.20)
Iron	5.4	5.9	6.1	3.5	2.3	4.2
Lanthanum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	(0.54)	<0.1	(0.17)	<0.1	(0.35)	<0.1
Lithium	<0.009	<0.009	<0.009	<0.01	<0.01	<0.01
Magnesium	1.3	1.1	0.96	1.2	0.53	0.67
Manganese	0.15	0.21	0.11	(0.093)	(0.12)	(0.13)
Molybdenum	<0.052	<0.08	<0.08	<0.08	<0.08	<0.08
Nickel	(0.19)	(0.11)	(0.13)	(0.089)	(0.15)	<0.08
Phosphorus	<4	<4	<4	<4	<4	<4
Potassium	1.6	1.0	0.82	(0.33)	(0.40)	(0.39)
Selenium	<3	<3	<3	<3	<3	<3
Silver	<0.03	<0.03	<0.03	<0.03	<0.3	(0.050)
Strontium	0.077	0.066	0.057	0.050	0.039	0.049
Tellurium	<0.4	<0.4	<0.4	(0.44)	<0.4	<0.4
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.6
Tin	<0.5	<0.5	<0.5	<0.5	<0.5	<0.6
Titanium	(0.065)	0.076	(0.054)	(0.044)	<0.03	(0.045)
Vanadium	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Yttrium	<0.008	<0.03	<0.03	<0.01	<0.02	<0.02
Zinc	7.7	6.1	5.7	5.8	3.4	2.9
Zirconium	(0.20)	(0.16)	<0.1	<0.1	<0.1	<0.1

Appendix D (Continued)
Metallic Composition of Airborne Dust Samples
Concentrations are in μg/m^3
Please see Table 4 for sample dates, description, duration and flow rate.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MCMHF-1	MCMHF-2	MCMHF-3	MCMHF-4	MCMHF-5	MCMHF-6
Aluminum	(2.2)	<1	(1.4)	<2	<2	(1.8)
Antimony	<0.5	<0.5	<0.4	<0.8	<1	<0.4
Arsenic	<2	<2	<1	<3	<4	<1
Barium	0.26	0.19	0.17	<0.05	<0.07	0.14
Beryllium	<0.03	<0.03	<0.02	<0.05	<0.07	<0.03
Cadmium	(0.091)	(0.069)	(0.056)	<0.1	<0.1	<0.06
Calcium	14	9.5	12	<5	<7	(6.5)
Chromium	<0.2	<0.2	<0.1	<0.3	<0.4	<0.1
Cobalt	<0.06	<0.06	<0.05	<0.1	<0.1	<0.06
Copper	<0.3	<0.3	<0.2	<0.5	<0.7	<0.3
Iron	(4.6)	(3.5)	(4.7)	<5	<7	<3
Lanthanum	<0.01	<0.01	<0.01	<0.02	<0.03	<0.01
Lead	<0.3	<0.3	(0.40)	<0.5	<0.7	(0.37)
Lithium	<0.02	<0.02	<0.01	<0.03	<0.04	<0.01
Magnesium	<1	<1	<1	<2	<3	<1
Manganese	0.20	(0.12)	0.16	<0.08	<0.1	(0.13)
Molybdenum	(0.18)	<0.2	<0.1	<0.3	<0.4	<0.1
Nickel	<0.3	<0.3	<0.2	<0.5	<0.7	<0.3
Phosphorus	<5	<5	<4	<8	<11	<4
Potassium	1.0	(0.74)	0.90	<0.3	<0.4	(0.55)
Selenium	<5	<5	<4	<8	<11	<4
Silver	(0.022)	(0.018)	(0.012)	<0.03	<0.04	(0.017)
Strontium	(0.052)	(0.042)	(0.042)	<0.03	<0.04	(0.030)
Tellurium	<0.5	<0.5	<0.4	<0.8	<1	<0.4
Thallium	(0.77)	<0.6	<0.5	<1	<1	<0.6
Tin	<0.8	(0.82)	<0.6	<1	<2	<0.7
Titanium	(0.037)	(0.032)	(0.059)	<0.05	<0.07	<0.03
Vanadium	(0.031)	<0.02	<0.01	<0.03	<0.04	(0.014)
Yttrium	(0.014)	0.27	<0.01	0.20	<0.03	<0.01
Zinc	4.9	5.2	5.6	1.1	(0.74)	6.2
Zirconium	(0.18)	<0.2	<0.1	<0.3	<0.4	<0.1

Appendix D (Continued)
Metallic Composition of Airborne Dust Samples
Concentrations are in µg/m^3
Please see Table 4 for sample dates, description, duration and flow rate.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MCMHF-7	MCMHF-8	MCMHF-9	MCMHF-10	MCMHF-11	MCMHF-12
Aluminum	(1.0)	(1.3)	(2.5)	<1	<0.9	<3
Antimony	(0.42)	<0.4	<0.4	<0.4	<0.4	<1
Arsenic	<1	<1	<1	<1	<1	<5
Barium	0.12	0.18	0.21	(0.055)	(0.039)	<0.09
Beryllium	<0.03	<0.02	<0.03	<0.03	<0.03	<0.09
Cadmium	<0.05	<0.05	<0.06	<0.06	<0.05	<0.2
Calcium	7.1	11	15	(3.0)	<3	<9
Chromium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5
Cobalt	<0.05	<0.05	<0.06	<0.06	<0.05	<0.2
Copper	<0.2	<0.2	<0.3	<0.3	<0.3	<0.9
Iron	(3.9)	(2.6)	(6.3)	<3	<3	<9
Lanthanum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.04
Lead	<0.2	<0.2	(0.44)	<0.3	<0.3	<0.9
Lithium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05
Magnesium	<1	<0.9	<1	<1	<1	<4
Manganese	(0.11)	(0.086)	0.22	(0.089)	(0.041)	<0.1
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5
Nickel	<0.2	<0.2	<0.3	<0.3	<0.3	<0.9
Phosphorus	<4	<4	<4	<4	<4	<14
Potassium	(0.43)	1.2	1.5	(0.27)	<0.1	<0.5
Selenium	<4	<4	<4	<4	<4	<14
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05
Strontium	(0.022)	(0.041)	(0.047)	<0.01	<0.01	<0.05
Tellurium	<0.4	<0.4	<0.4	<0.4	<0.4	(2.1)
Thallium	<0.5	<0.5	<0.6	<0.6	<0.5	<2
Tin	<0.6	<0.6	(0.75)	<0.7	<0.7	<2
Titanium	<0.03	<0.02	(0.061)	<0.03	<0.03	<0.09
Vanadium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05
Yttrium	<0.01	0.075	<0.01	(0.066)	<0.01	<0.04
Zinc	3.4	5.6	7.9	2.5	0.77	<0.4
Zirconium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5

Appendix D (Continued)
Metallic Composition of Airborne Dust Samples
Concentrations are in µg/m^3
Please see Table 4 for sample dates, description, duration and flow rate.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MSMWF-1	MSMWF-2	MSMWF-3	MSMWF-4	MSMWF-5	MSMWF-6
Aluminum	(2.8)	(4.3)	<2	<2	<1	<1
Antimony	<0.7	<0.7	<0.7	<0.7	<0.5	<0.5
Arsenic	<2	<2	<2	<2	<2	<2
Barium	0.65	0.69	(0.11)	(0.079)	(0.055)	(0.041)
Beryllium	<0.05	<0.05	<0.05	<0.05	<0.03	<0.03
Cadmium	6.8	3.8	(0.22)	(0.21)	<0.06	<0.06
Calcium	28	36	<5	<5	(3.6)	(4.3)
Chromium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt	<0.09	<0.1	<0.1	<0.1	<0.06	<0.06
Copper	<0.5	<0.5	<0.5	<0.5	<0.3	<0.3
Iron	(8.2)	(9.8)	<5	<5	(3.9)	<3
Lanthanum	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01
Lead	3.7	5.2	<0.5	(0.57)	<0.3	<0.3
Lithium	<0.02	<0.02	<0.02	<0.03	<0.02	<0.02
Magnesium	<2	<2	<2	<2	<1	<1
Manganese	(0.17)	(0.16)	<0.07	<0.07	<0.05	<0.05
Molybdenum	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel	<0.5	<0.5	<0.5	<0.5	<0.3	<0.3
Phosphorus	<7	<7	<7	<7	<5	<5
Potassium	2.3	3.1	<0.2	<0.2	(0.18)	(0.20)
Selenium	<7	<7	<7	<7	<5	<5
Silver	(0.023)	<0.02	<0.02	<0.03	<0.02	<0.02
Strontium	0.19	0.29	(0.027)	<0.03	<0.02	<0.02
Tellurium	<0.7	(0.88)	<0.7	(0.94)	<0.5	<0.5
Thallium	<0.9	<1	<1	<1	<0.6	<0.6
Tin	<1	(1.3)	<1	<1	<0.8	<0.8
Titanium	<0.05	<0.05	<0.05	<0.05	<0.03	<0.03
Vanadium	<0.002	<0.02	<0.02	<0.03	<0.02	<0.02
Yttrium	2.1	2.3	0.36	0.17	<0.01	<0.01
Zinc	49	36	2.7	2.0	0.70	(0.43)
Zirconium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Appendix D (Continued)
Metallic Composition of Airborne Dust Samples
Concentrations are in µg/m^3
Please see Table 4 for sample dates, description, duration and flow rate.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MSMWF-7	MSMWF-8	MSMWF-9	MSMWF-10	MSMWF-11	MSMWF-12
Aluminum	<2	<1	<3	<3	<1	<0.9
Antimony	<1	<0.5	<1	<1	<0.6	<0.4
Arsenic	<3	<2	<4	<4	<2	<1
Barium	<0.06	(0.042)	1.5	0.42	0.42	(0.063)
Beryllium	<0.06	<0.03	<0.07	<0.08	<0.04	<0.03
Cadmium	<0.1	<0.07	0.59	<0.2	<0.08	<0.05
Calcium	<6	(3.6)	23	<8	<4	<3
Chromium	<0.3	<0.2	<0.4	<0.4	<0.2	<0.1
Cobalt	<0.1	<0.07	<0.1	<0.2	<0.08	<0.05
Copper	<0.6	<0.3	<0.7	<0.8	<0.4	<0.3
Iron	<6	(3.6)	<7	<8	<4	<3
Lanthanum	<0.03	<0.02	<0.03	<0.03	<0.02	<0.01
Lead	<0.6	<0.3	12	(2.4)	<0.4	<0.3
Lithium	<0.03	<0.02	<0.04	<0.04	<0.02	<0.01
Magnesium	<3	<1	<3	<3	<2	<1
Manganese	<0.1	<0.05	<0.1	<0.1	<0.06	<0.04
Molybdenum	<0.3	<0.2	<0.4	<0.4	<0.2	<0.1
Nickel	<0.6	<0.3	<0.7	<0.8	<0.4	<0.3
Phosphorus	<10	<5	<11	<11	<6	<4
Potassium	<0.3	(0.23)	3.4	(0.46)	(0.24)	<0.1
Selenium	<10	<5	<11	<11	<6	<4
Silver	<0.03	<0.02	<0.04	<0.04	<0.02	<0.01
Strontium	<0.03	<0.02	0.59	(0.12)	(0.026)	<0.01
Tellurium	<1	<0.5	<1	<1	<0.6	<0.4
Thallium	<1	<0.6	<1	<2	<0.8	<0.5
Tin	<2	<0.8	<2	<2	<1	<0.6
Titanium	<0.06	<0.03	<0.07	<0.08	<0.04	<0.03
Vanadium	<0.03	<0.02	<0.04	<0.04	<0.02	<0.01
Yttrium	0.28	<0.02	26	7.5	1.2	0.11
Zinc	(0.86)	0.63	66	16	3.8	0.96
Zirconium	<0.3	<0.2	<0.4	<0.4	<0.2	<0.1

Appendix D (Continued)
Metallic Composition of Airborne Dust Samples
Concentrations are in $\mu g/m^3$
Please see Table 4 for sample dates, description, duration and flow rate.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MSMHF-1	MSMHF-2	MSMHF-3	MSMHF-4	MSMHF-5	MSMHF-6
Aluminum	(2.7)	<2	8.9	(5.3)	(5.2)	<2
Antimony	<0.7	<0.7	<0.7	<0.7	<0.9	<0.7
Arsenic	<2	<2	<2	<2	<3	<2
Barium	0.49	(0.097)	2.1	1.3	2.0	(0.13)
Beryllium	<0.04	<0.05	<0.05	<0.05	<0.06	<0.05
Cadmium	<0.09	<0.09	(0.18)	(0.13)	0.70	<0.1
Calcium	(9.3)	(5.4)	33	32	19	<5
Chromium	<0.2	<0.2	<0.2	<0.2	<0.3	<0.2
Cobalt	<0.09	<0.09	<0.09	<0.09	<0.1	<0.1
Copper	<0.4	<0.5	<0.5	<0.5	<0.6	<0.5
Iron	(5.1)	<5	16	(8.3)	(8.9)	<5
Lanthanum	<0.02	<0.02	<0.02	<0.02	<0.03	<0.02
Lead	3.1	(0.68)	15	8.8	20	(1.0)
Lithium	<0.02	<0.02	<0.02	<0.02	<0.03	<0.02
Magnesium	<2	<2	(2.3)	<2	<2	<2
Manganese	(0.10)	<0.07	(0.19)	(0.18)	<0.09	<0.07
Molybdenum	<0.2	<0.2	<0.2	<0.2	<0.3	<0.2
Nickel	<0.4	<0.5	<0.5	<0.5	<0.6	<0.5
Phosphorus	<7	<7	<7	<7	<9	<7
Potassium	1.4	(0.45)	5.9	3.7	4.3	<0.2
Selenium	<7	<7	<7	<7	<9	<7
Silver	<0.02	<0.02	<0.02	<0.02	<0.03	<0.02
Strontium	(0.067)	(0.025)	0.33	0.23	0.73	(0.055)
Tellurium	<0.7	<0.7	<0.7	(1.3)	<0.9	(0.86)
Thallium	<0.9	<0.9	<0.9	<0.9	<1	<1
Tin	<1	(1.3)	<1	<1	<2	<1
Titanium	<0.04	<0.05	<0.05	<0.05	<0.06	<0.05
Vanadium	<0.02	<0.02	<0.02	<0.02	<0.03	<0.02
Yttrium	8.0	0.60	52	23	37	1.7
Zinc	17	2.0	84	49	80	3.8
Zirconium	<0.2	<0.2	<0.2	<0.2	<0.3	<0.2

Appendix D (Continued)
Metallic Composition of Airborne Dust Samples
Concentrations are in $\mu g/m^3$
Please see Table 4 for sample dates, description, duration and flow rate.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MSMHF-7	MSMHF-8	MSMHF-9	MSMHF-10	MSMHF-11	MSMHF-12
Aluminum	(1.0)	(1.7)	3.9	<0.9	27	<0.9
Antimony	<0.4	<0.3	(0.52)	<0.4	(0.43)	<0.4
Arsenic	<1	<1	<1	<1	<1	<1
Barium	(0.049)	(0.064)	0.20	(0.033)	1.6	(0.060)
Beryllium	<0.03	<0.02	<0.03	<0.03	<0.02	<0.03
Cadmium	(0.089)	0.24	0.49	<0.05	0.14	<0.05
Calcium	(4.4)	7.9	16	<3	177	<3
Chromium	0.19	0.12	5.0	<0.1	0.48	<0.1
Cobalt	<0.05	<0.05	0.30	<0.05	<0.04	<0.05
Copper	<0.3	<0.2	<0.3	<0.3	1.7	<0.3
Iron	208	168	2449	(3.9)	48	<3
Lanthanum	0.082	0.081	0.97	<0.01	<0.01	<0.01
Lead	<0.3	<0.2	(0.42)	<0.3	1.1	<0.3
Lithium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	<1	(1.1)	9.9	<1	13	<1
Manganese	2.5	2.8	27	(0.051)	0.91	(0.15)
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	<0.3	<0.2	<0.3	<0.3	0.84	<0.3
Phosphorus	<4	<3	<4	<4	(8.7)	<4
Potassium	(0.23)	(0.34)	0.78	<0.1	45	<0.1
Selenium	<4	<3	<4	<4	<3	<4
Silver	<0.01	<0.01	<0.01	<0.01	0.099	<0.01
Strontium	<0.01	(0.039)	(0.054)	<0.01	0.47	<0.01
Tellurium	<0.4	<0.3	(0.50)	<0.4	<0.3	<0.4
Thallium	<0.5	<0.4	<0.5	<0.5	<0.4	<0.5
Tin	<0.7	<0.6	(0.69)	<0.7	<0.6	<0.7
Titanium	<0.03	<0.02	(0.050)	<0.03	0.85	<0.3
Vanadium	<0.01	<0.01	<0.01	<0.01	(0.027)	<0.01
Yttrium	<0.01	0.32	(0.050)	<0.01	0.097	<0.01
Zinc	2.3	3.0	20	0.51	24	1.3
Zirconium	<0.1	<0.1	<0.1	<0.1	(1.0)	<0.1

Appendix D (Continued)
Metallic Composition of Airborne Dust Samples
Concentrations are in $\mu g/m^3$
Please see Table 4 for sample dates, description, duration and flow rate.
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	MSMHF-13	MSMHF-14	MSMHF-17	MSMHF-19
Aluminum	<1	<0.9	(7.1)	30
Antimony	<0.5	<0.4	<2	<2
Arsenic	<2	<1	<7	<6
Barium	(0.069)	0.16	5.0	16
Beryllium	<0.03	<0.03	<0.1	<0.1
Cadmium	<0.06	<0.05	5.3	12
Calcium	<3	(4.6)	<15	47
Chromium	<0.2	<0.01	<0.7	<0.6
Cobalt	<0.06	<0.05	(0.36)	0.82
Copper	<0.3	<0.3	<1	<1
Iron	<3	(3.6)	<15	41
Lanthanum	<0.01	<0.01	<0.07	(0.056)
Lead	<0.3	<0.2	29	105
Lithium	<0.02	<0.01	<0.07	<0.06
Magnesium	<1	<1	<6	<5
Manganese	<0.05	(0.048)	<0.2	(0.35)
Molybdenum	<0.2	<0.1	<0.7	<0.6
Nickel	<0.3	<0.2	<1	<1
Phosphorus	<5	<4	<22	<18
Potassium	<0.2	(0.38)	5.6	23
Selenium	<5	<4	<22	<18
Silver	<0.02	<0.01	<0.07	<0.06
Strontium	<0.02	(0.012)	2.1	7.6
Tellurium	<0.5	<0.4	<2	<2
Thallium	<0.6	<0.5	<3	<2
Tin	<0.8	<0.6	<4	<3
Titanium	<0.03	<0.03	<0.1	(0.23)
Vanadium	<0.02	<0.01	<0.07	<0.06
Yttrium	<0.01	<0.01	200	438
Zinc	2.3	3.6	467	1053
Zirconium	<0.2	<0.1	<0.7	<0.6

Appendix D (Continued)
Metallic Composition of Airborne Dust Samples
Concentrations are in μg/m^3
Please see Table 4 for sample dates, description, duration and flow rate.
<indicates a result less than the limit of detection. Values in parentheses represent results between the limit of detection and limit of quantitation.

	MSMHF-20	MSMHF-21	MSMHF-22	MSMHF-23
Aluminum	<4	(6.5)	<5	<5
Antimony	<2	<2	<2	<2
Arsenic	<5	<6	<7	<7
Barium	1.6	3.6	1.3	1.0
Beryllium	<0.1	<0.1	<0.1	<0.1
Cadmium	1.7	4.4	1.1	(0.74)
Calcium	<11	(12)	<14	<15
Chromium	<0.5	<0.6	<0.7	<0.7
Cobalt	<0.2	(0.24)	<0.3	<0.3
Copper	<1	<1	<1	<1
Iron	<11	<12	<14	<15
Lanthanum	<0.05	<0.05	<0.06	<0.07
Lead	9.7	22	8.5	(5.6)
Lithium	<0.05	<0.06	<0.07	<0.07
Magnesium	<4	<5	<6	<6
Manganese	<0.2	<0.2	<0.2	<0.2
Molybdenum	<0.5	<0.6	<0.7	<0.7
Nickel	<1	<1	<1	<1
Phosphorus	<16	<18	<21	<22
Potassium	(2.5)	4.8	(1.3)	(1.2)
Selenium	<16	<18	<21	<22
Silver	<0.05	<0.06	<0.07	<0.07
Strontium	0.81	1.5	0.57	0.49
Tellurium	<2	<2	<2	<2
Thallium	<2	<2	<3	<3
Tin	<3	<3	<4	<4
Titanium	<0.1	<0.1	<0.1	<0.1
Vanadium	<0.05	<0.06	<0.07	<0.07
Yttrium	51	131	38	24
Zinc	124	333	92	59
Zirconium	<0.5	<0.6	<0.7	<0.7

Figure I: Marianna FCI UNICOR Factory Floor Plan

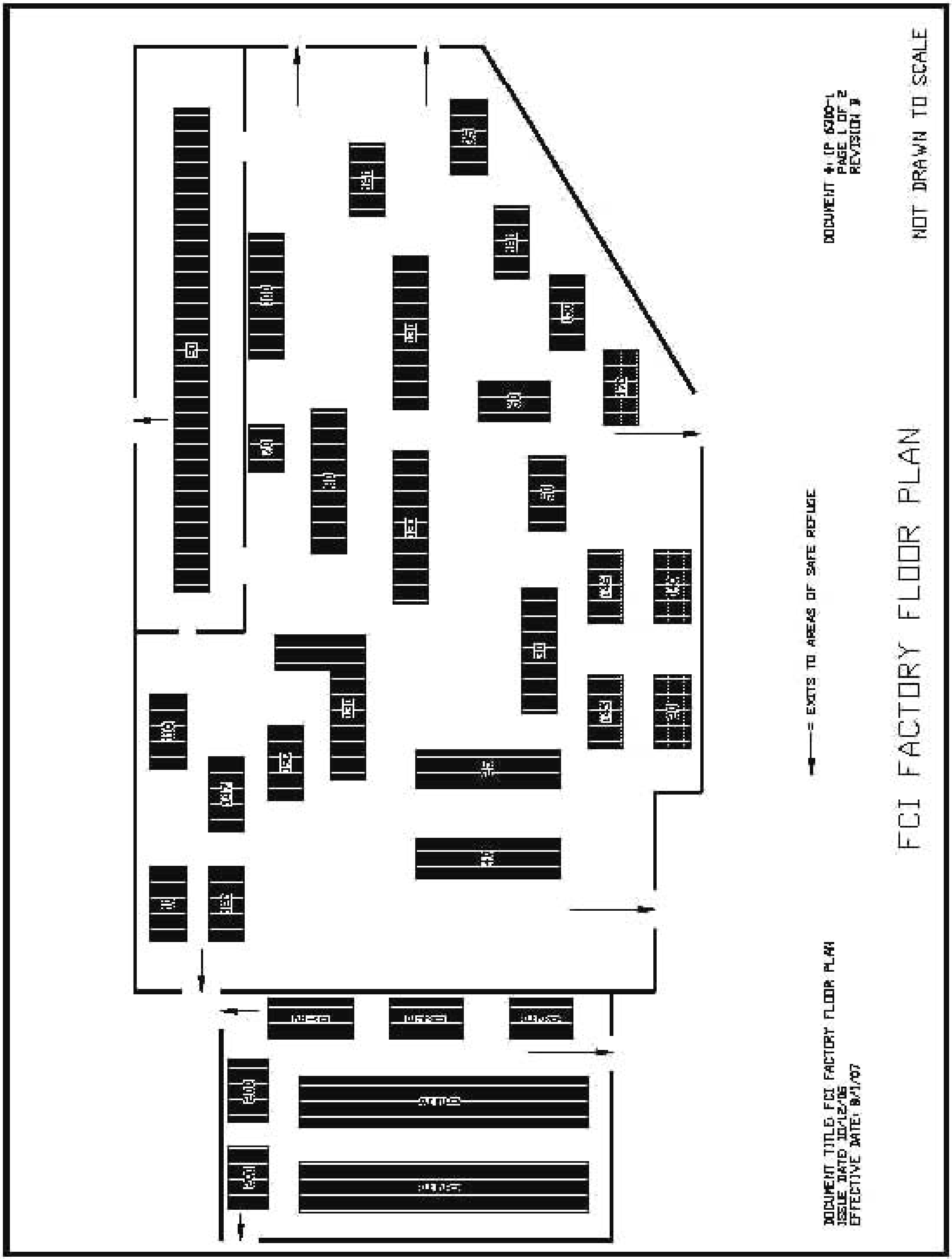


Figure II: Marianna FPC UNICOR Factory Floor Plan

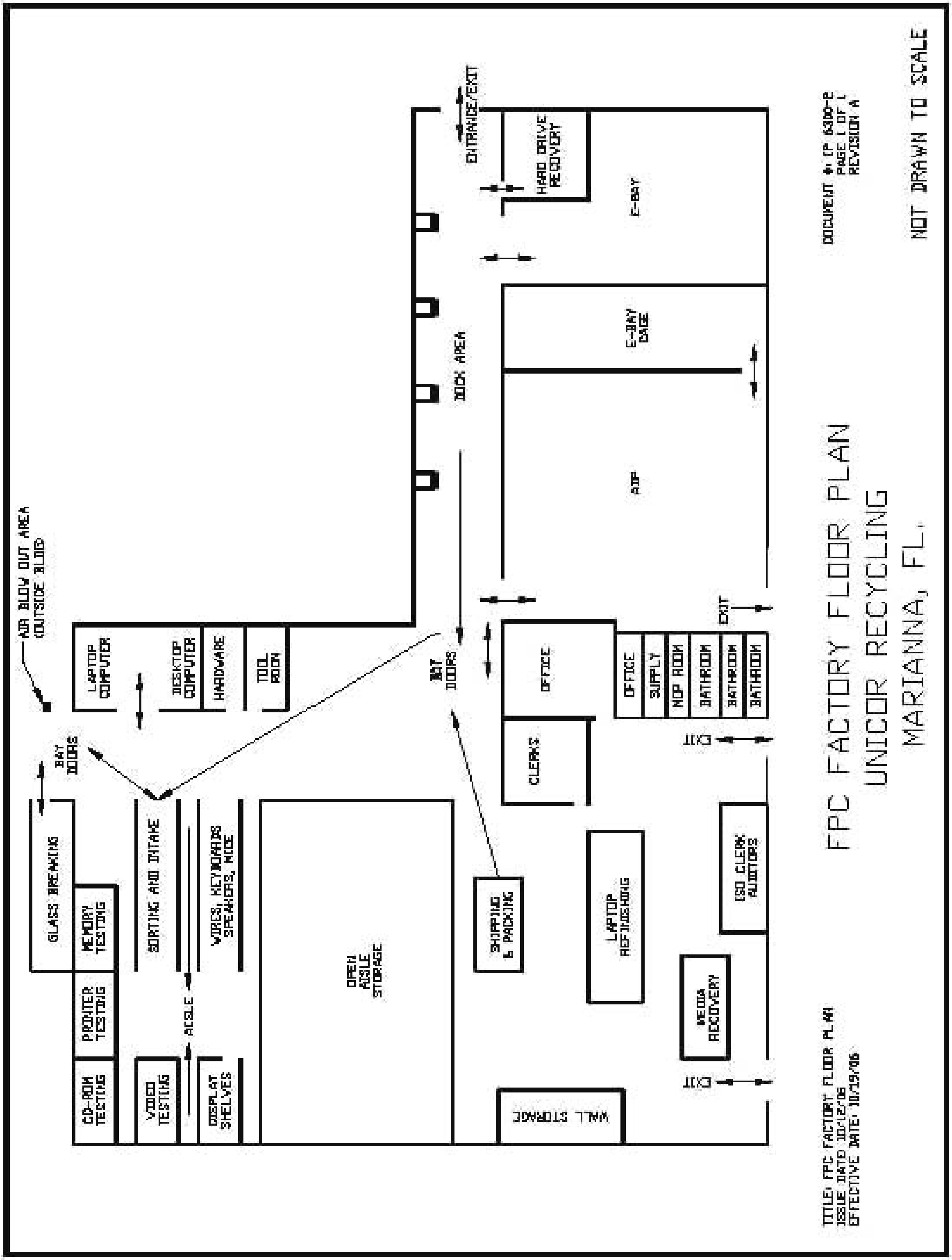


Figure III: Marianna FPC Glass Breaking Area

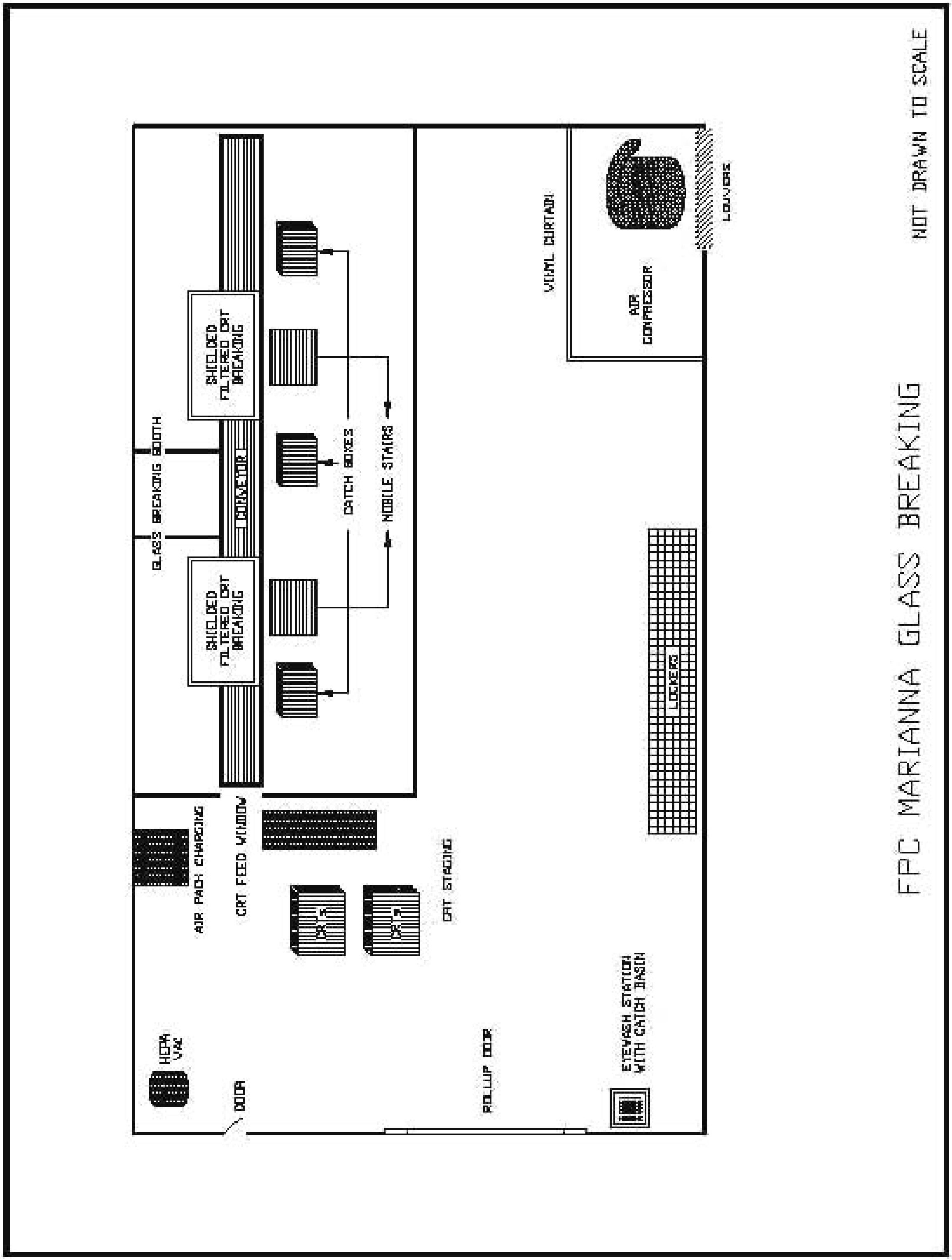


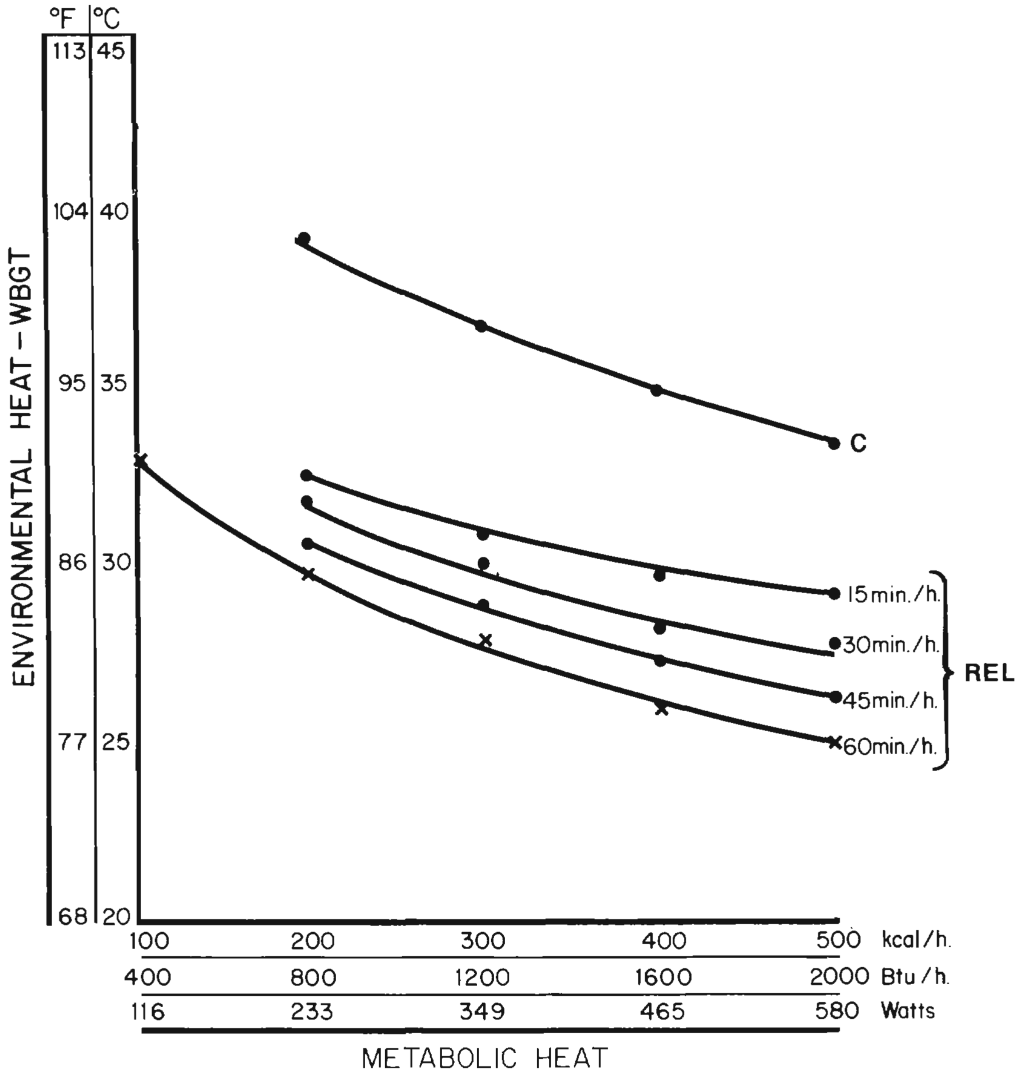
Figure IV: Marianna FPC Glass Breaking Booth
(Includes box of CRTs on hand truck below window in plastic curtain)

Worker feeds CRTs from box at left into enclosure where glass is broken. Two horizontal flow modules (HFMs) are visible in the enclosed area. Those units collect and filter air and recirculate the filtered air into the enclosure. The booth is enclosed on two sides by concrete block walls and on two sides by plastic curtains. It is enclosed on top by plastic. There is no mechanical ventilation in the GBO besides the HFMs

Figure V: Marianna FPC Glass Breaking Booth Work Stations
(Plastic curtain pulled to the left to show first work station)

Worker takes CRT from left, removes gun, breaks funnel glass, and passes to right where second worker breaks panel glass. The horizontal flow modules (HFMs) collect and filter the air and recirculate the filtered air inside the booth. The booth is enclosed on four sides and on top. There is no mechanical ventilation in the GBO besides the HFMs inside the booth.

Figure VI: NIOSH Recommended Heat-Stress Exposure Limits for Heat-Acclimatized Workers [NIOSH 1986]



C = Ceiling Limit

***for "standard worker" of 70 kg (154 lbs) body weight and 1.8 m^2 (19.4 ft^2) body surface.**

Figure VII: Recommended Layout of Typical Facility where Protective Clothing is Required [DOD 1987].

Note the arrows showing the movement of the workers to segregate contaminated equipment and clothing from clean items. Workers shower before re-entering clean locker rooms after removing contaminated clothing.

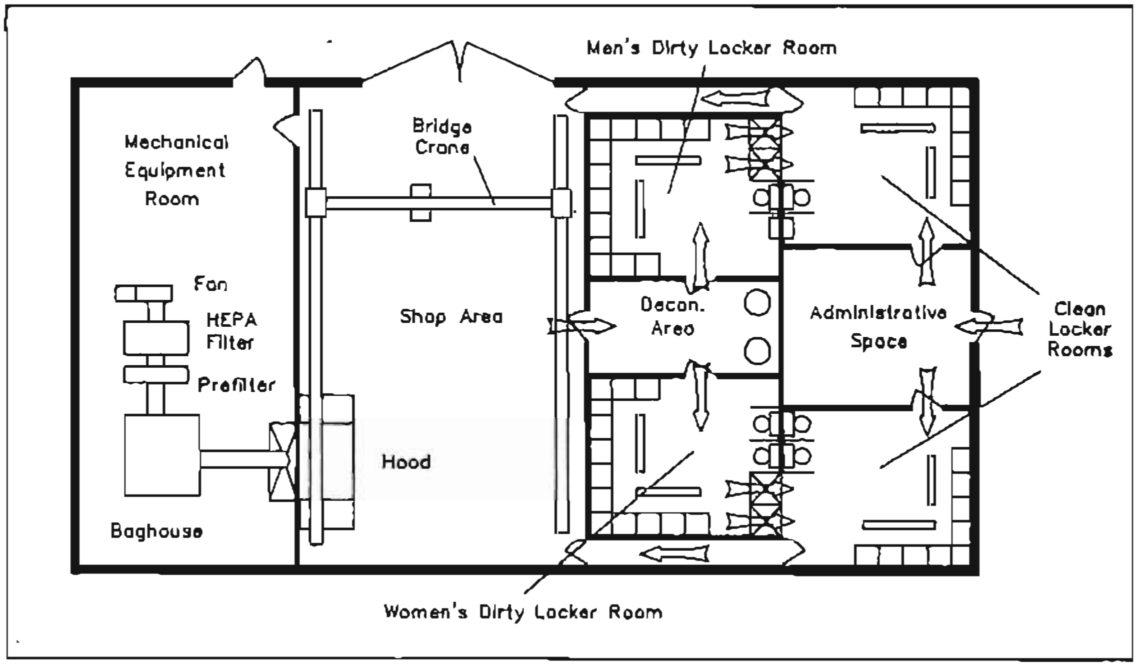
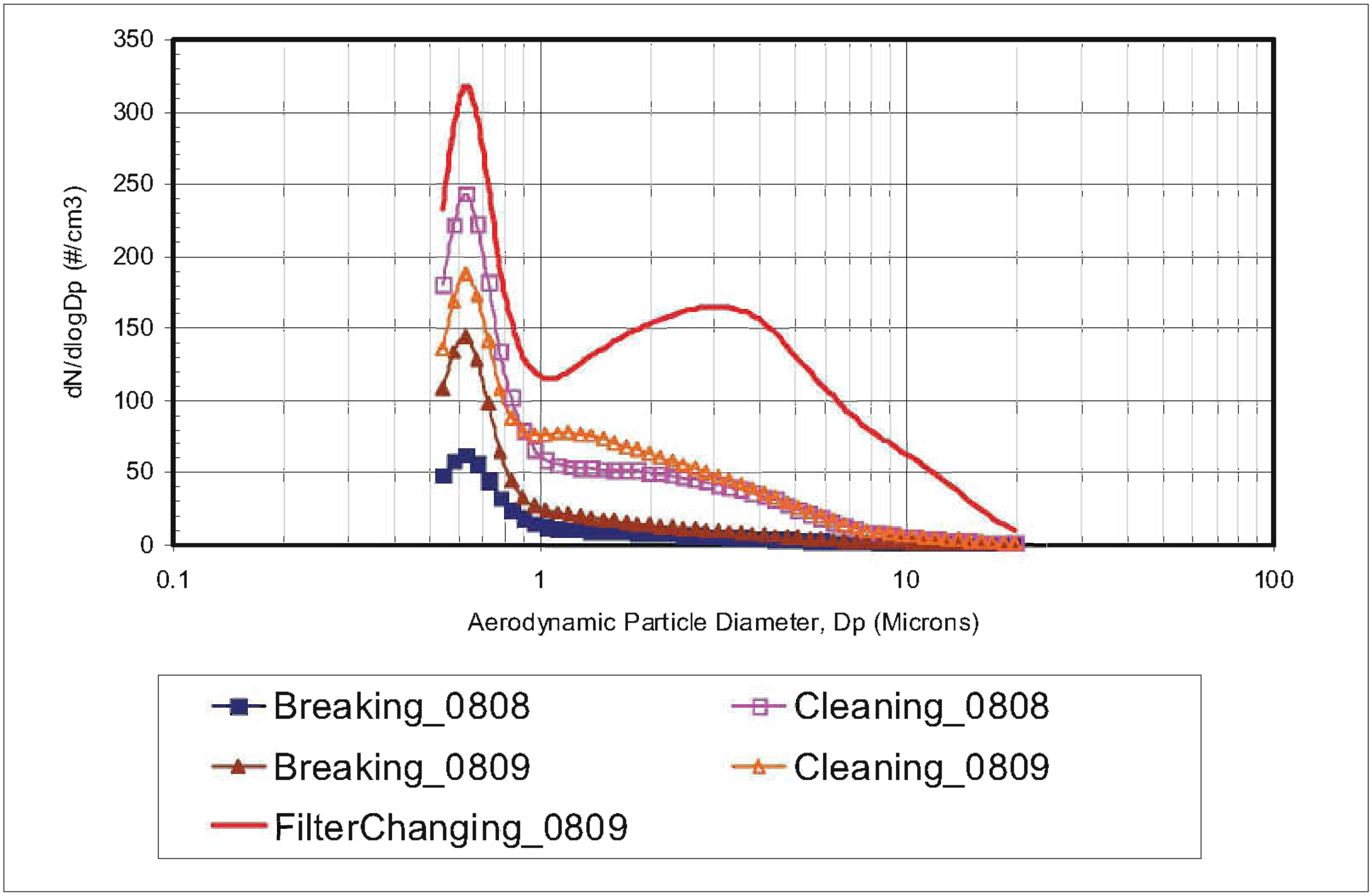


Figure VIII: Size Distribution of Airborne Particles



ENCLOSURE 2

U.S. Department of Labor

Occupational Safety and Health Administration
1851 Executive Center Drive, Suite 227
Jacksonville, Florida 32207-2350
Telephone: 904-232-2895
Facsimile: 904-232-1294

Reply to the Attention of the Area Director

March 8, 2007

Bureau of Prisons
Federal Correctional Institute Marianna, Florida
Attn: [redacted] – Warden
625 FCI Road
Marianna, FL 32446

RE: OSHA Inspection No. 310028832

Dear [redacted]

The results of OSHA's personal air monitoring, area monitoring, and wipe sampling that was performed at your facility on November 8, 2006 for the Cathode Ray Tube glass breaking operation were as follows:

November 8, 2006 – Air Monitoring Results

INMATE	CONTAMINANT PHYSICAL AGENT	RESULTS	OSHA EXPOSURE LIMITS
[redacted]	Lead	Non Detectable	50.0 μg/m³
	Cadmium	Non Detectable	5.0 μg/m³
	Beryllium	Non Detectable	2.0 μg/m³
	Barium	Non Detectable	0.5 mg/m³
[redacted]	Lead	Non Detectable	50.0 μg/m³
	Cadmium	Non Detectable	5.0 μg/m³
	Beryllium	Non Detectable	2.0 μg/m³
	Barium	Non Detectable	0.5 mg/m³
[redacted]	Lead	Non Detectable	50.0 μg/m³
	Cadmium	Non Detectable	5.0 μg/m³
	Beryllium	Non Detectable	2.0 μg/m³
	Barium	Non Detectable	0.5 mg/m³

INMATE	CONTAMINANT PHYSICAL AGENT	RESULTS	OSHA EXPOSURE LIMITS
[redacted]	Lead	Non Detectable	50.0 μg/m^3
	Cadmium	0.000637 μg/m^3	5.0 μg/m^3
	Beryllium	Non Detectable	2.0 μg/m^3
	Barium	Non Detectable	0.5 mg/m^3
[redacted]	Lead	Non Detectable	50.0 μg/m^3
	Cadmium	Non Detectable	5.0 μg/m^3
	Beryllium	Non Detectable	2.0 μg/m^3
	Barium	Non Detectable	0.5 mg/m^3

November 8, 2006 – Wipe Samples

INMATE & LOCATION	CONTAMINANT PHYSICAL AGENT	RESULTS	OSHA EXPOSURE LIMITS
[redacted]	Lead	193.85 μg	Not Established
Inside workstation #1	Cadmium	49.46 μg	Not Established
	Beryllium	Non Detectable	Not Established
	Barium	Non Detectable	Not Established
	Copper	3.33 μg	Not Established
	Iron Oxide	540.8648 μg	Not Established
	Manganese	3.455 μg	Not Established
	Zinc Oxide	789.015 μg	Not Established
[redacted]			
Wrist area underside of Coverall Sleeve	Cadmium	0.5150 μg	Not Established
Inside outer glove, outside cotton inner glove	Zinc Oxide	37.5899 μg	Not Established
	Cadmium	1.5 μg	Not Established
Shipping Area Weigh scale	Iron Oxide	119.4598 μg	Not Established
[redacted]			

INMATE & LOCATION	CONTAMINANT PHYSICAL AGENT	RESULTS	OSHA EXPOSURE LIMITS
Stair platform at glass breaking workstation	Iron Oxide	136.459 µg	Not Established
	Lead	29.20 µg	Not Established
	Zinc Oxide	86.5066 µg	Not Established
	Cadmium	2.39 µg	Not Established
[redacted]			
Inside respirator on face shield	Zinc Oxide	60.2435 µg	Not Established
	Cadmium	0.9650 µg	Not Established
[redacted]			
Overhead bay door area floor	Iron Oxide	84.3582 µg	Not Established
	Lead	6.25 µg	Not Established

November 8, 2006 – Area air monitoring.

INMATE & LOCATION	CONTAMINANT PHYSICAL AGENT	RESULTS	OSHA EXPOSURE LIMITS
[redacted]			
Glass breaking workstation #1	Zinc Oxide	0.0955 mg/m^3	5.0 mg/m^3

* mg/m^3 is the abbreviation for milligrams per cubic meter of air.
* µg is the abbreviation for micrograms.
* µg /m^3 is the abbreviation for micrograms per cubic meter of air.

Overall the facility had been reviewed thoroughly by FCI Marianna. All safety and health plans had been created and put into practice by the Bureau of Prisons generally, and locally, additions were made to the procedures to fit the facility. The air monitoring results were below OSHA's permissible exposure limits and action levels. Therefore, the use of the hooded respirators was not required; however, we STRONGLY ENCOURAGE their continued use.

When working with heavy metals, air concentrations are not the only hazard. Surface contamination and body contamination increases the chance for absorption and ingestion, and that was why wipe samples were collected. From review of the wipe samples the following recommendations were made in writing to the Warden when we shared the results of our sampling with him:

1. Open areas in the personal protective equipment (PPE), such as the wrist area where the coverall sleeve goes under the outer glove, and on top of the inner glove, should be closed by some means, such as with

duct tape, to prevent collection and exposure to cadmium and other heavy metals that are present.

2. When wearing the hooded respirator, ensure that the hood completely covers the neck and shoulders to prevent inward migration of air that is contaminated with cadmium and other heavy metals.

3. When handling the hooded respirators, contaminated gloves or hands or other objects should be kept outside of the respirators to ensure their cleanliness. Mandatory cleaning should be monitored by the foreman, and quality assurance checks should be completed to ensure that the respirators were cleaned and free of heavy metals.

4. A complete noise survey should be performed for the facility to have a baseline. Identify noise producing processes and objects, and if needed, lower the noises levels with engineering controls, such as adding sliders or wheels to the stair platforms.

5. The facility should evaluate and document the proper HEPA filter that is to be used for Vacuum #3. With that, establish a change schedule based on technical and analytical data to prevent recirculation of collected heavy metals from the vacuum to the work environment.

6. Perform quality assurance checks on boxes that are leaving the glass breaking building to ensure they are cleaned, and the outside inmate population is not exposed.

7. Perform quality assurance checks on other noted items of possible environmental contamination from the process which are exposing employees to possible ingestion hazards (see NOTE below).

NOTE: An Industrial Survey that was conducted by KAM Environmental, Inc. ("KAM") was collected by the CSHO during his inspection (see FCI0014). The KAM survey was performed at the facility shortly after the glass breaking began. The KAM survey noted some deficiencies, and recommended actions that were based on their wipe samples. The CSHO wiped some of the same areas that were done during the KAM survey. The CSHO compared his wipe samples to five comparable wipe samples that were done during the KAM survey. Only one comparison caused concern. One of the KAM samples (W2) was a wipe taken from a Glass Breaker's ungloved hand. Since it is against OSHA practice to do this, a wipe sample was taken by the CSHO from the inside of the PPE inner glove and PPE inner sleeve that was against the skin, and then compared to sample W2. Cadmium was detected by thes OSHA wipe (as it was during the KAM survey), and improvements that were mentioned in the KAM survey and other industry practices should be taken to eliminate this exposure. This concept should be implemented for all possible contaminated exposure areas.

8. Heat stress should be evaluated for the inmates and future monitoring performed and documented.

If you have any questions regarding this letter or the results, please contact me or Mark Davis at (904) 232-2895. Thank you for your cooperation during our inspection of your facility, and for your personal support of the safety and health of your employees and the inmates.

Sincerely,

Jeff Romer

FOR JAMES D. BORDERS
Area Director

ENCLOSURE 3

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

National Institute for Occupational Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998

June 1, 2009
HETA 2008-0055

[redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
United States Department of Justice, Suite 13100
Washington D.C. 20530

Dear [redacted]

On November 27, 2007, the National Institute for Occupational Safety and Health (NIOSH) received your request for technical assistance in your health and safety investigation of the Federal Prison Industries (UNICOR) electronics recycling program at Federal Bureau of Prisons (BOP) institutions in Elkton, Ohio; Texarkana, Texas; and Atwater, California. You asked us to assist the United States Department of Justice, Office of the Inspector General (USDOJ, OIG) in assessing the existing medical surveillance program for inmates and staff exposed to lead and cadmium during electronics recycling, and to make recommendations for future surveillance. In addition, you asked us to assess past exposures to lead and cadmium, and to investigate the potential for take home exposure. You later asked us to perform a similar evaluation for the BOP institution in Marianna, Florida. We conducted a site visit at the Marianna BOP institution on February 17–18, 2009. This interim letter summarizes our findings and provides recommendations to improve the safety and health of the inmates and staff at the Federal Correctional Institution in Marianna, Florida. These findings will be included in a final report that will summarize the evaluations at all four institutions.

Background

The Federal Correctional Institution (FCI) in Marianna, Florida, consists of a medium security facility housing male inmates, and an adjacent prison camp housing minimum security female offenders. Electronics disassembly and refurbishment began in 1996 as a UNICOR pilot project and then as a small operation at the camp. Glass breaking was not performed, and televisions and computer monitors were shipped offsite for recycling. As the operation grew, it was moved to an offsite leased building (known as the blue building). In approximately 1999, a demilitarization (demil) operation was started at the camp. This involved disassembly and refurbishment of electronics from local military bases. UNICOR staff was required to be certified in demil to work in that area due to security reasons. The demil operation was closed after a couple of years. Electronics disassembly and refurbishment moved into another offsite leased building in 2001. (known as the gold building) after recycling operations were discontinued at the blue building. After the furniture factory closed in the FCI in late 2002, the recycling operation was moved into the FCI from the gold building. In late 2005, the glass breaking operation (GBO) commenced at the camp. Prior to beginning this operation, the safety officer conducted a job hazard analysis, and inmates were medically cleared to work in the area. The inmates had preplacement biological monitoring and respirator clearance performed. The GBO was where cathode ray tubes (CRTs) from computer monitors or televisions were processed. The GBO ceased operation in May 2008. At the time of our visit, only refurbishment and "sanitization" of computers took place at the camp. Sanitization involves checking equipment for contraband prior to sending it to the FCI factory for disassembly. Electronics recycling at the FCI factory consists of manual disassembly of computers and other electronics, and manual chip recovery.

Assessment

We reviewed the following documents:

- Results of biological monitoring performed between 2005 and 2008 (provided by your office and the Health Services Administrator).

- Medical records and report from the medical examiner for a staff member who died in 2008 after being medically retired from work (provided by the lawyer for her estate).

- Medical records for two staff members and one inmate (provided by you).

- Work instructions for the GBO and maintenance.

- Rosters for inmates working in the GBO that provided dates of work (provided by the factory manager).

- DOJ interviews with staff and inmates.

- Results of industrial hygiene sampling performed by a consultant to UNICOR.

- Occupational Safety and Health Administration (OSHA) report and an internal memorandum describing an OSHA inspection of electronics recycling at FCI Marianna.

- Final report of the industrial hygiene assessment performed by the NIOSH Division of Applied Research and Technology (DART).

- Draft Federal Occupational Health (FOH) report of environmental, safety, and health information related to electronics recycling at FCI Marianna.

Prior to the NIOSH site visit on February 17-18, 2009, we interviewed the factory manager, Health Services Administrator, American Federation of Government Employees (AFGE) Local

4036 President and the AFGE UNICOR representative. During the site visit we held an opening conference with FCI and UNICOR management, AFGE representatives, the UNICOR factory manager, and the Health Services Administrator. After the conference we toured the recycling locations in the FCI and at the camp. We conducted informational meetings with FCI and UNICOR staff, and camp inmates. We met with concerned staff and inmates individually to do medical interviews and address their concerns. We also met with current and former staff and inmates individually at our hotel in the evenings to do medical interviews and address their concerns. We ended the site visit with a closing conference where we presented our initial findings and recommendations. After the site visit we interviewed the Radiation Safety Officer and a representative of the Defense Reutilization Marketing Office (DRMO) at Eglin Air Force Base, Florida.

Results and Discussion[1]

Medical surveillance

Inmates

Medical surveillance began in late 2005 for inmates in the GBO. It is performed annually by the FCI clinic and consists of biological monitoring for blood lead levels (BLL), blood cadmium (CdB), urine cadmium (CdU), urine beta-2-microglobulin (B-2-M), and zinc protoporphyrin (ZPP). Preplacement testing is performed on inmates prior to being cleared to work in the GBO. The inmates are seen by a physician's assistant and their test results are discussed with them. Paper copies of test results are maintained in the inmate's personal medical record but not with UNICOR management. Each inmate's medical records are transferred with them; no medical records are retained at Marianna after an inmate is either transferred or released. The results of the available inmate biological monitoring are summarized in the following sections.

Preplacement BLLs were available for 14 inmates who performed glass breaking. The mean BLL was 1.17 micrograms per deciliter of whole blood (μg/dL) (range: 0.5-2.1 μg/dL). Four periodic or termination BLLs were available. The mean BLL for these four was 1.35 μg/dL (range: 0.4-2.2 μg/dL).

Results were available for 11 inmates who had preplacement CdB tests done. The mean CdB concentration was 1.28 micrograms per liter (μg/L) (range: 0.1-4.0 μg/L). The mean CdB concentration for the seven inmates known to be smokers was 1.73 μg/L (range: 0.2-4.0 μg/L) and for the three known to be nonsmokers was 0.3 μg/L (range: 0.1-0.6 μg/L). Smoking is known to increase CdB levels, sometimes dramatically. Four periodic or termination CdB tests were available and the mean CdB concentration was 0.5 μg/L (range: 0.4-0.6 μg/L). Smoking for inmates was banned between the preplacement and follow-up tests.

Fourteen preplacement CdU test results were available. The mean CdU concentration was 0.62 micrograms per gram of creatinine (μg/g/Cr) (range 0.2-1.7 μg/g/Cr). There were four periodic or termination CdU results available for review. The mean CdU concentration was 0.55 μg/g/Cr

[1] See *Occupational exposure limits and health effects* in Appendix.

(range: 0.3-0.8 µg/g/Cr). There were 12 urinary B-2-Ms, all of which were normal, and 16 ZPPs, one of which was elevated. The rest were normal. Some inmates had urine lead and zinc levels performed (these tests were not indicated or necessary based on the inmates' workplace exposures, however, the results were normal).

UNICOR Staff

The FCI clinic performs the same biological monitoring for UNICOR staff as for inmates. Test results were available for seven staff members, each of whom was tested once. Three were tested in April 2005 and four in March 2007. The mean BLL was 1.2 µg/dL (range: 0.3-2.7 µg/dL). The mean CdB concentration was 0.2 µg/L (range: 0-0.5 µg/L). The mean CdU concentration was 0.43 µg/g/Cr (range: 0.2-1.2 µg/g/Cr). There were six B-2-M results, and all were normal. There were six ZPP results and one was elevated.

In summary, results of biological monitoring of both staff and inmates were unremarkable.

Medical Records Review

Extensive medical records were reviewed for one former staff member who was never assigned to recycling, one current staff member who worked overtime in recycling in the past, and an inmate who apparently never worked in glass breaking, but did work in recycling. We also received extensive records on a staff member who died in 2008 after being medically retired. The inmate's records documented a variety of nonoccupational health problems. The records of the two living staff members also document a number of nonoccupational health problems. Both medical records document that the patients relate their problems to exposures from electronics recycling, including ionizing radiation, however, in the records the physicians do not attribute the medical problems to recycling exposures. Both had skin problems: one person's was documented prior to work in recycling. Both sent photos, which we reviewed and also sent to an occupational dermatologist for review. One had skin biopsies done. Neither had skin conditions related to work in recycling or proximity to recycling, or ionizing radiation. The staff member who died had a medical problem that was unrelated to any work exposures. There was nothing documented by the health care providers in the medical or death records relating any health problems to recycling exposures. Our review of all these records revealed no evidence of any health problems to recycling exposures or ionizing radiation, either.

Public Meeting and Interviews with Staff

During our public meeting with staff, allegations of exposure to ionizing radiation were raised. Staff reported that items arrived from military bases and that the "radiation alarms" had gone off when the trucks left the base on occasion. Some also noted that some items were marked with skull and crossbones. Some staff members reported that CRTs were broken on purpose inside enclosed semi-trailers in the past, prior to the installation of the GBO. Others denied these allegations to us.

Fourteen staff asked to speak with us after our public meeting with concerned Marianna staff on February 18. None worked in electronics recycling. Some reported that they did pat-downs on inmates who worked in recycling or interacted with inmates from recycling in other ways. Medical problems reported were varied, and included shingles, hypertension, sleep apnea, narcolepsy, hypothyroidism, occasional sores on the scalp, poor memory, chronic fatigue after an episode of severe flu-like symptoms, non-melanoma skin cancer, pleurisy, cellulitis (skin infection), bronchiolitis obliterans organizing pneumonia, night sweats, and insomnia. One person had elevated liver enzymes that resolved without treatment, one had a mildly elevated blood selenium level, and one had an elevated urinary arsenic that was normal upon retesting after abstinence from seafood. This arsenic level was not speciated. None of the reported health effects are related to potential exposures from electronics recycling.

Public Meeting and Interviews with Inmates

Several inmates expressed concern about exposure to heavy metals when a monitor was accidentally broken. It was stated that this occurred about twice a week. Some inmates reported that posted procedures were not followed when cleaning up these breakages; however, one inmate reported always following posted procedures. During the NIOSH site visit, no inmates reported breaking glass on purpose outside the booth, either currently or in the past.

Twelve inmates at the camp asked to speak with us after our public meeting with concerned Marianna inmates on February 18. All had worked in recycling at some time, with time frames beginning as early as 2000. None had performed glass breaking. Several wished to know if they should be tested for exposure to lead or cadmium. Medical issues reported were again varied, and included sun damage to the skin on the hands, recurrent urinary tract and respiratory infections, fungal pneumonia, deep venous thrombosis, neck and back spasms, rash on neck, headache, hypertension, cough, and Grave's Disease. None of the reported health effects are related to potential exposures from electronics recycling.

Interviews at the Hotel

Nine people came to the hotel to be interviewed by us. Two were former UNICOR staff assigned to recycling. One was a FCI staff member who did overtime for a brief period in recycling. Four were former staff members who did not work in recycling. Two were former inmates, neither of whom was assigned to recycling. Reported health effects included swollen joints, rash at the waistband, irritability, anxiety, arthritis, hypertension, hyperlipidemia, having the gallbladder removed, poison ivy, sinus infections, recurrent urinary tract infection, hysterectomy, twitching and tingling sensations, white matter lesions in the brain on magnetic resonance imaging, skin lesions, stabbing chest pain, organic brain syndrome secondary to a motor vehicle accident, and asthma. Some individuals reported family members with health problems, including septicemia and secondary acute renal failure, interstitial cystitis, breast and bladder cancer. None of the reported health effects can be related to exposures from recycling of electronics.

Interviews with Eglin AFB Personnel

Both the Radiation Safety Officer and the DRMO representative had been working at Eglin since the time that electronics recycling began at Marianna in the mid-1990s. They reported that Eglin received materials for disposal or disposition from military bases in the southeastern United States. When items are received in DRMO, they are looked up by stock number. If there is any indication that items contain radioactive materials, these items are segregated and the Radiation Safety Officer is notified. The Radiation Safety Officer chooses the appropriate meter for the type of radiation and goes to DRMO to evaluate the items. If they are found to be radioactive, they are either returned to the sender for proper disposal or sent to Battle Creek, Michigan for disposal. No radioactive items are supposed to be disposed of in any other manner.

Industrial Hygiene

Records Review

The OIG provided an environmental monitoring report prepared by KAM Environmental, Inc., and OSHA documents describing an inspection of the GBO on November 7-8, 2006. The KAM report contains sampling data and descriptive information for a site visit conducted on January 19, 2006. This appears to be the only site visit conducted by a UNICOR consultant at the GBO. No industrial hygiene reports or sampling data were provided for any electronics recycling operations at FCI Marianna for the period prior to January 2006.

The KAM report notes that personal air sampling was conducted for two glass breakers and two glass breaker assistants. Air samples were analyzed for barium, beryllium, cadmium, and lead according to Environmental Protection Agency method 6010B. All results were reported to be below the analytical limits of detection for this method, which indicates that eight-hour time-weighted average exposures were below the action levels (ALs) and permissible exposure limits (PELs) established by OSHA. Short-duration samples (30-minutes, maximum) were not collected to determine if the OSHA ceiling limit for beryllium was exceeded. (Based on sampling results at other FCIs, we believe it is unlikely that a hazardous concentration of beryllium would have been present at FCI Marianna.) Workers in the glass booth wore powered air-purifying respirators (PAPRs), "disposable suits," hoods with face shields, steel-toe boots, and heavy work gloves. The report provided no information indicating how personal protective equipment (PPE) is donned or doffed, nor did the report provide a description of work activities during the sampling period.

The KAM consultant collected eight surface wipe samples and four hand wipe samples that were analyzed for cadmium and lead. As we found during our review of most consultant reports from other FCIs, this report did not clearly describe what the sample results represented. It appears that two of the "hand wipe" samples were actually collected from gloves worn by a breaker and assistant breaker, and two samples were obtained from each worker's hands. The latter samples appear to indicate that lead was not detected on workers' skin, while cadmium was detected on the hand of one glass breaker. Cadmium and lead were detected on work surfaces and equipment, including the pallet jack, booth table, booth floor, and workers' gloves. Cadmium and lead were detected outside the booth on the "outdoor floor or walkway to building" (noted in the hand-written chain-of-custody sheet).

The KAM consultant concluded that this is a "clean, efficient, and safe operation when considering the nature of the work performed." The report noted that airborne exposures were not "significant;" however, wipe samples indicate a need for better control of lead on hands, as well as housekeeping improvements to reduce the tracking of lead out of the work area. The consultant provided several recommendations for improving worker hygiene and workplace housekeeping.

The OSHA inspection report, which was provided to the warden, and the internal memorandum from OSHA Region 4 Administrator Cindy Coe Laseter describe the glass breaking operation in detail. Personal air monitoring for barium, beryllium, cadmium, and lead was conducted for two glass breakers, two feeders, and one helper. With the exception of one cadmium sample, the results of all personal samples were below the limit of detection. The results of the cadmium sample were well-below the OSHA AL for cadmium. Lead and cadmium were detected in wipe samples collected from PPE and surfaces in the work area, too.

In addition to the sample results, the OSHA inspection report indicated that:

- Glass breakers wore PPE as described by the KAM consultant (above).
- Feeders' PPE differed from that worn by glass breakers in that feeders wore nuisance dust masks.
- "Full compliance with the OSHA respiratory standard was reviewed. An OSHA violation could not be substantiated at this time."
- Glass breakers used pump-up sprayers to moisten glass and surfaces to control dust.
- High efficiency powered air (HEPA)-filtered vacuum cleaners were used to clean the surfaces of boxes of broken glass before boxes are removed from the booth; however, colorimetric tests to ascertain the effectiveness of cleaning were not done. (No violation could be substantiated at this time.)
- Worker rotation was used "to help minimize the inmates' exposure, and to change work locations to allow everyone the chance to experience each job duty." (No violation was noted.)
- Engineering controls were utilized (Atmos-Tech Industries HEPA units).
- Glass breakers wore PPE while cleaning the GBO with brooms, dust pans, and HEPA vacuums at the end of the work shift or at the end of the day.
- Clean-up/sanitation facilities were provided for GBO workers, i.e., rest room with soap and water.

- Eating and/or drinking were prohibited in the glass breaking building. Inmates were trained in the hazards of heavy metals and the importance of good hygiene.

- Inmates used HEPA vacuum cleaners to remove dust from clothing and shoes before exiting the glass breaking building.

Written recommendations from OSHA to the warden:

- Continue using hooded PAPRs even though air sampling results were below ALs and PELs.

- Tape wrists and other openings in PPE.

- Ensure that the PAPR hood completely covers the neck and shoulders.

- Ensure that respirators are clean and free of heavy metals.

- Perform a baseline noise survey.

- Ensure that the correct HEPA filter is used in Vacuum #3.

- Perform "quality assurance checks" to ensure that boxes leaving the glass breaking building are clean, and do not expose the inmate population to lead and cadmium.

- Perform "quality assurance checks" of other items "which are exposing employees to possible ingestion hazards. (This recommendation did not identify the "items of possible environmental contamination..")

- Perform a heat stress evaluation.

NIOSH/DART and FOH conducted environmental, safety, and health assessments of electronics equipment recycling operations at FCI Marianna in August, 2007. The results of air sampling conducted by NIOSH/DART during routine and non-routine operations on August 8 and 9, 2007 indicated that worker exposures to metals did not exceed occupational exposure limits (OELs). However, the feeders' exposures to cadmium were unexpectedly high on August 8. On that day, cadmium exposures for the two feeders were 6.8 $\mu g/m^3$ and 3.8 $\mu g/m^3$ for the 143-minute sampling period. Those concentrations were much greater than the air sampling results reported for glass breakers on either of the two sampling dates, as well as the results for feeders on August 9. If work on August 8 had not been terminated early due to excessive heat, and the CRTs were processed at the same rate for the remainder of the shift, it is possible that one of the feeders would have been exposed to an 8-hour TWA cadmium concentration above the AL on that day. The difference between the feeders' results on the two days suggests that 1) there was considerable day-to-day variability in worker exposures, and 2) engineering controls at Marianna did not always control airborne dust effectively.

Lead, cadmium and other heavy metals were detected in the surface wipe and bulk dust samples.

Environmental heat monitoring and estimates of work rate indicated that some workers in this facility were exposed to heat stress (e.g., above the American Conference of Governmental Industrial Hygienists (ACGIH®) threshold limit value or at risk of heat stress (e.g., exceeding the ACGIH AL) during this assessment.

Recommendations provided by NIOSH/DART include:

- Implementing a site-specific health and safety program at Marianna that includes a heat stress program.

- Evaluating the respiratory protection program to ensure that it complies with OSHA regulations.

- Focusing on practices to prevent accidental ingestion of lead and other metals, such as housekeeping to reduce surface contamination and hand washing to prevent hand-to-mouth transfer of contaminants.

- Evaluating the feasibility of providing and laundering work clothing for all workers in the recycling facility.

- Equipping change rooms with separate storage facilities for work clothing and for street clothes to prevent cross-contamination.

- Evaluating all UNICOR operations in regard to health, safety and the environment.

- Providing a comprehensive program within the BOP to assure both staff and inmates a safe and healthy workplace.

FOH characterized legacy contamination at the blue and gold buildings where electronics recycling was performed between 1998 and August 2002. Wipe samples collected on beams and ductwork in these buildings detected average lead concentrations of 1600 micrograms per square foot ($\mu g/ft^2$) in the blue building, and 610 $\mu g/ft^2$ in the gold building. Cadmium in these samples was reported to be 220 $\mu g/ft^2$ in the blue building, and 92 $\mu g/ft^2$ in the gold building. Four samples collected from the floor in each building indicated lead and cadmium concentrations were one to two orders of magnitude less at floor level than on beams and ductwork. The specific sources and/or operations that generated this contamination have not been determined.

Conclusions

Limited exposure monitoring data suggests that exposures to metals in the FCI GBO may have been sufficiently low such that the OSHA mandated medical surveillance has not been required. In addition, the results of medical surveillance conducted on inmates and staff were unremarkable. However, we believe that if the GBO reopens, UNICOR should continue to perform the limited biological monitoring that is currently in place as an additional safeguard against excessive exposure and to provide reassurance to inmates and staff. There is no need to perform any medical surveillance if the GBO remains closed. Exposure to metals from electronics refurbishment and disassembly are minimal and do not pose a risk to the health of staff or inmates. There is no evidence to support allegations of exposure to ionizing radiation. There were conflicting reports about whether or not monitors were routinely broken in the back of semi-trailers, however, none of the health effects reported are due to exposure to lead, cadmium, or other exposures that would occur from the breaking of monitor glass.

Recommendations

The following recommendations are provided to improve the safety and health of both the staff and inmates involved with electronics recycling at the FCI Marianna.

1. Although engineering controls and work practices in the current GBO appear to provide effective control of worker exposure to cadmium and lead based upon review of industrial hygiene sampling, comply with the recommendations from NIOSH/DART for improvements to the GBO booth if the GBO reopens. Exposure to feeders should be well characterized, and if similar to breakers, additional engineering controls will be necessary.

2. UNICOR needs to maintain an ongoing program of environmental monitoring to confirm that engineering and work practice controls are sufficiently protective. Environmental monitoring also provides data needed to determine which provisions of the OSHA cadmium and lead standards should be applied for the GBO.

3. While air sampling in the GBO suggests that the level of protection afforded by PAPRs may not be needed, we feel that continued use of PAPRs does have benefits in this setting. Loose fitting PAPRs are comfortable and provide cooling in the potentially hot work environment. In addition, fit testing is not required. Additional periodic air sampling should be conducted to help ensure that exposures remain consistently below all applicable OELs before considering a reduction in the level of respiratory protection in the GBO.

4. Ensure that inmates follow posted procedures for handling accidental breakages of monitors.

5. Ensure full compliance with all applicable OSHA standards, including the General Industry Lead Standard [29 CFR 1910.1025], the Cadmium Standard [29 CFR 1910.1027], the Hazard Communication Standard [29 CFR 1910.1200], and the Respiratory Protection Standard [29 CFR 1910.134]. This includes record keeping requirements, communication requirements, compliance plans, and medical surveillance.

6. Carefully evaluate the qualifications and expertise of consultants who are hired to assess occupational or environmental health and safety issues. One useful benchmark for vetting individuals who provide industrial hygiene services is the designation of Certified Industrial Hygienist (CIH). Certification by the American Board of Industrial Hygiene (ABIH) ensures that prospective consultants have met ABIH standards for education, ongoing training, and

experience, and have passed a rigorous ABIH certification examination. The UNICOR and/or BOP industrial hygienists can assist in the selection of your consultants.

7. Perform a detailed job hazard analysis prior to beginning any new operation or before making changes to existing operations. This will allow UNICOR and BOP to identify potential hazards prior to exposing staff or inmates, and to identify appropriate controls and PPE. Involve the UNICOR and/or BOP industrial hygienists in these job hazard analyses. If medical surveillance is needed then UNICOR and BOP should perform pre-placement evaluations of exposed staff and inmates. This medical surveillance should be overseen by an occupational medicine physician.

8. Appoint a union safety and health representative. This individual should be a regular participant on the joint labor-management safety committee that meets quarterly. Since inmates do not have a mechanism for representation on this committee, ensure that they are informed of its proceedings and that they have a way to voice their concerns about and ideas for improving workplace safety and health.

This interim letter will be included in a final report that will include evaluations at three other BOP facilities. Please post a copy of this letter for 30 days at or near work areas of affected staff and inmates. Thank you for your cooperation with this evaluation. If you have any questions, please do not hesitate to contact us at (513) 841-4382.

Sincerely yours,

Elena H Page

Elena H. Page, M.D., M.P.H.
Medical Officer

Teresa Seo

for David Sylvain, M.S., C.I.H.
Regional Industrial Hygienist
Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

cc:
[redacted], Warden, FCI Marianna
[redacted], President, AFGE Local 4036
Paul Laird, Assistant Director, UNICOR

Appendix

Occupational Exposure Limits and Health effects

In evaluating the hazards posed by workplace exposures, National Institute for Occupational Safety and Health investigators use both mandatory (legally enforceable) and recommended occupational exposure limits (OELs) for chemical, physical, and biological agents as a guide for making recommendations. OELs have been developed by Federal agencies and safety and health organizations to prevent the occurrence of adverse health effects from workplace exposures. Generally, OELs suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. However, not all workers will be protected from adverse health effects even if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the exposure limit. Also, some substances can be absorbed by direct contact with the skin and mucous membranes in addition to being inhaled, which contributes to the individual's overall exposure.

Most OELs are expressed as a time-weighted average (TWA) exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday. Some chemical substances and physical agents have recommended short-term exposure limit (STEL) or ceiling values where health effects are caused by exposures over a short-period. Unless otherwise noted, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during a workday, and the ceiling limit is an exposure that should not be exceeded at any time.

In the U.S., OELs have been established by Federal agencies, professional organizations, state and local governments, and other entities. Some OELs are legally enforceable limits, while others are recommendations. The U.S. Department of Labor Occupational Safety and Health Administration's (OSHA) permissible exposure limits (PELs) (29 CFR[2] 1910 [general industry]; 29 CFR 1926 [construction industry]; and 29 CFR 1917 [maritime industry]) are legal limits enforceable in workplaces covered under the Occupational Safety and Health Act. NIOSH recommended exposure levels (RELs) are recommendations based on a critical review of the scientific and technical information available on a given hazard and the adequacy of methods to identify and control the hazard. NIOSH RELs can be found in the *NIOSH Pocket Guide to Chemical Hazards* [NIOSH 2005]. NIOSH also recommends different types of risk management practices (e.g., engineering controls, safe work practices, worker education/training, personal protective equipment, and exposure and medical monitoring) to minimize the risk of exposure and adverse health effects from these hazards. Other OELs that are commonly used and cited in the U.S. include the threshold limit values (TLVs) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), a professional organization, and the Workplace environmental exposure limits recommended by the American Industrial Hygiene Association, another professional organization. ACGIH TLVs are considered voluntary exposure guidelines

[2] *Code of Federal Regulations.* See CFR in references.

for use by industrial hygienists and others trained in this discipline "to assist in the control of health hazards" [ACGIH 2009]. WEELs have been established for some chemicals "when no other legal or authoritative limits exist" [AIHA 2008].

Outside the U.S., OELs have been established by various agencies and organizations and include both legal and recommended limits. Since 2006, the Berufsgenossenschaftlichen Institut für Arbeitsschutz (German Institute for Occupational Safety and Health) has maintained a database of international OELs from European Union member states, Canada (Québec), Japan, Switzerland, and the U.S. [http://www.hvbg.de/e/bia/gestis/limit_values/index.html]. The database contains international limits for over 1250 hazardous substances and is updated annually.

Employers should understand that not all hazardous chemicals have specific OSHA PELs, and for some agents the legally enforceable and recommended limits may not reflect current health-based information. However, an employer is still required by OSHA to protect its employees from hazards even in the absence of a specific OSHA PEL. OSHA requires an employer to furnish employees a place of employment free from recognized hazards that cause or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970 (Public Law 91–596, sec. 5(a)(1))]. Thus, NIOSH investigators encourage employers to make use of other OELs when making risk assessment and risk management decisions to best protect the health of their employees. NIOSH investigators also encourage the use of the traditional hierarchy of controls approach to eliminate or minimize identified workplace hazards. This includes, in order of preference, the use of: (1) substitution or elimination of the hazardous agent, (2) engineering controls (e.g., local exhaust ventilation, process enclosure, dilution ventilation), (3) administrative controls (e.g., limiting time of exposure, employee training, work practice changes, medical surveillance), and (4) personal protective equipment (e.g., respiratory protection, gloves, eye protection, hearing protection). Control banding, a qualitative risk assessment and risk management tool, is a complementary approach to protecting worker health that focuses resources on exposure controls by describing how a risk needs to be managed [http://www.cdc.gov/niosh/topics/ctrlbanding/]. This approach can be applied in situations where OELs have not been established or can be used to supplement the OELs, when available.

Lead

Occupational exposure to inorganic lead occurs via inhalation of lead-containing dust and fume and ingestion of lead particles from contact with lead-contaminated surfaces. In cases where careful attention to hygiene (for example, handwashing) is not practiced, smoking cigarettes or eating may represent another route of exposure among workers who handle lead and then transfer it to their mouth through hand contamination. Industrial settings associated with exposure to lead and lead compounds include smelting and refining, scrap metal recovery, automobile radiator repair, construction and demolition (including abrasive blasting), and firing range operations [ACGIH 2007]. Occupational exposures also occur among workers who apply and/or remove lead-based paint or among welders who burn or torch-cut metal structures.

Acute lead poisoning, caused by intense occupational exposure to lead over a brief period of time can cause a syndrome of abdominal pain, fatigue, constipation, and in some cases alteration of central nervous system function [Moline and Landrigan 2005]. Symptoms of chronic lead poisoning include headache, joint and muscle aches, weakness, fatigue, irritability, depression, constipation, anorexia, and abdominal discomfort [Moline and Landrigan 2005]. These symptoms usually do not develop until the blood lead level (BLL) reaches at least 30-40 micrograms per deciliter of whole blood (μg/dL) [Moline and Landrigan 2005]. Psychiatric symptoms such as depression, anxiety and irritability appear to be related to high levels of current lead exposure, while decrements in cognitive function are related to both recent and cumulative dose [Schwartz and Stewart 2007]. One study documented a significant positive relationship between white matter lesion of the brain noted on magnetic resonance imaging (MRI) and tibia lead levels in former organolead workers [Stewart et al. 2006]. However, the strongest predictors of white matter lesions are sex, age, blood pressure, education, smoking history, alcohol consumption, and ApoE genotype [Stewart et al. 2006]. Overexposure to lead may result in damage to the kidneys, anemia, high blood pressure, impotence, and infertility and reduced sex drive in both sexes. Studies have shown subclinical effects on heme synthesis, renal function, and cognition at BLLs <10 μg/dL [ATSDR 2007]. Inorganic lead is reasonably anticipated to cause cancer in humans [ATSDR 2007].

In most cases, an individual's BLL is a good indication of recent exposure to lead, with a half-life (the time interval it takes for the quantity in the body to be reduced by half its initial value) of 1-2 months [Lauwerys and Hoet 2001; Moline and Landrigan 2005; NCEH 2005]. The majority of lead in the body is stored in the bones, with a half-life of years to decades. Bone lead can be measured using K-shell x-ray fluorescence instruments, but these are primarily research based and are not widely available. Elevated zinc protoporphyrin (ZPP) levels have also been used as an indicator of chronic lead intoxication, however, other factors, such as iron deficiency, can cause an elevated ZPP level, so the BLL is a more specific test for evaluating occupational lead exposure.

The NIOSH REL for inorganic lead is 50 micrograms per cubic meter of air (μg/m^3) as an 8-hour TWA. This REL is consistent with the OSHA PEL, which is intended to maintain worker BLLs below 40 μg/dL; medical removal is required when an employee has a BLL of 60 μg/dL, or the average of the last 3 tests at 50 μg/dL or higher [29 CFR 1910.1025; 29 CFR 1962.62]. This is intended to prevent overt symptoms of lead poisoning, but is not sufficient to protect workers from more subtle adverse health effects like hypertension, renal dysfunction, and reproductive and cognitive effects [Schwartz and Stewart 2007; Schwartz and Hu 2007; Brown-Williams et al. 2009]. Adverse effects on the adult reproductive, cardiovascular, and hematologic systems, and on the development of children of exposed workers, can occur at BLLs as low as 10 μg/dL [Sussell 1998]. At BLLs below 40 μg/dL, many of the health effects would not necessarily be evident by routine physical examinations but represent early stages in the development of lead toxicity. In recognition of this, voluntary standards and public health goals have established lower exposure limits to protect workers and their children. The ACGIH TLV for lead in air is 50 μg/m^3 as an 8-hour TWA, with worker BLLs to be controlled to ≤ 30 μg/dL [ACGIH 2009]. A national health goal is to eliminate all occupational exposures that result in BLLs >25 μg/dL [DHHS 2000]. A panel of experts recently published guidelines for the management of adult lead exposure intended to prevent both acute and chronic effects of lead poisoning [Kosnett et al. 2007]. They recommended that an employee be removed from exposure if a single BLL exceeds 30 μg/dL, or if two measurements taken over 4 weeks exceed 20 μg/dL. Removal should be considered if control measures over an extended period do not decrease BLLs to < 10 μg/dL. The panel also recommended quarterly BLL testing if the BLL is between 10-19 μg/dL, and semiannual testing if the BLL is < 10 μg/dL. Pregnant women should avoid BLLs > 5 μg/dl. The Third National Report on Human Exposure to Environmental Chemicals (TNRHEEC) found the geometric mean blood lead among non-institutionalized, civilian males in 2001-2002 was 1.78 μg/dL [NCEH 2005]. However, widespread contamination of the environment from leaded gasoline in the past led to significant lead exposure among the general population. This contamination peaked between 1950 and the early 1970s. The average blood lead in Americans in 1965 was over 20 μg/dL [Patterson 1965]. Therefore, persons born prior to the 1970s may have substantial body burdens of lead.

OSHA requires medical surveillance on any employee who is or may be exposed to an airborne concentration of lead at or above the action level, which is 30 $\mu g/m^3$ as an 8-hour TWA ,for more than 30 days per year [29 CFR 1910.1025]. Blood lead and ZPP levels must be done at least every 6 months, and more frequently for employees whose blood leads exceed certain levels. In addition, a medical examination must be done prior to assignment to the area, and should include detailed history, blood pressure measurement, blood lead, ZPP, hemoglobin and hematocrit, red cell indices, and peripheral smear, blood urea nitrogen (BUN), creatinine, and a urinalysis. Additional medical exams and biological monitoring depend upon the circumstances, for example, if the blood lead exceeds a certain level.

Cadmium

Cadmium is a metal that has many industrial uses, such as in batteries, pigments, plastic stabilizers, metal coatings, and television phosphors [ACGIH 2007]. Workers may inhale cadmium dust when sanding, grinding, or scraping cadmium-metal alloys or cadmium-containing paints [ACGIH 2007]. Exposure to cadmium fume may occur when materials containing cadmium are heated to high temperatures, such as during welding and torching operations; cadmium-containing solder and welding rods are also sources of cadmium fume. In addition to inhalation, cadmium may be absorbed via ingestion; non-occupational sources of cadmium exposure include cigarette smoke and dietary intake [ACGIH 2007]. Early symptoms of cadmium exposure may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or cough. Short-term exposure effects of cadmium inhalation include cough, chest pain, sweating, chills, shortness of breath, and weakness [Thun et al. 1991]. Short-term exposure effects of ingestion may include nausea, vomiting, diarrhea, and abdominal cramps [Thun et al. 1991]. Long-term exposure effects of cadmium may include loss of the sense of smell, ulceration of the nose, emphysema, kidney damage, mild anemia, and an increased risk of cancer of the lung, and possibly of the prostate [ATSDR 1999].

The OSHA PEL for cadmium is 5 $\mu g/m^3$ as an 8-hour TWA [29 CFR 1910.1027]. The ACGIH has a TLV for total cadmium of 10 $\mu g/m^3$ (8-hour TWA), with worker cadmium blood level to be controlled at or below 5 micrograms per liter (μg/L) and urine level to be below 5 micrograms per gram creatinine (μg/g/Cr), and designation of cadmium as a suspected human carcinogen [ACGIH 2009]. NIOSH recommends that cadmium be treated as a potential occupational carcinogen and that exposures be reduced to the lowest feasible concentration [NIOSH 1984].

Blood cadmium levels measured while exposure is ongoing reflect fairly recent exposure (in the past few months). The half-life is biphasic, with rapid elimination (half-life approximately 100 days) in the first phase, but much slower elimination in the second phase (half-life of several years) [Lauwerys and Hoet 2001; Franzblau 2005]. Urinary cadmium levels are reflective of body burden and have a very long half-life of 10-20 years [Lauwerys and Hoet 2001].

OSHA requires medical surveillance on any employee who is or may be exposed to an airborne concentration of cadmium at or above the action level, which is 2.5 $\mu g/m^3$ as an 8-hour TWA, for more than 30 days per year [29 CFR 1910.1027]. A preplacement examination must be provided, and shall include a detailed history, and biological monitoring for urine cadmium (CdU) and beta-2-microglobulin (B-2-M), both standardized to grams of creatinine (g/Cr), and blood cadmium (CdB), standardized to liters of whole blood. OSHA defines acceptable CdB levels as < 5 µg/L, CdU as < 3 µg/g/Cr, and B-2-M as < 300 µg/g/Cr. TNRHEEC found geometric mean CdB of 0.4 µg/L among men in 1999-2000. Smokers can have CdB levels much higher than nonsmokers, with levels up to 6.1 µg/L [Martin et al. 2009]. The geometric mean CdU for men in 2001-2002 was 0.2 µg/g/Cr in NHANES III. Periodic surveillance is also required one year after the initial exam and at least biennially after that. Periodic surveillance shall include the biological monitoring, history and physical examination, a chest x-ray (frequency to be determined by the physician after the initial x-ray), pulmonary function tests, blood tests for BUN, complete blood count, and Cr, and a urinalysis. Men over 40 years of age require a prostate examination as well. The frequency of periodic surveillance is determined by the results of biological monitoring and medical examinations. Biological monitoring is required annually, either as part of the periodic surveillance or on its own. We recommend that the preplacement examination be identical to the periodic examinations so that baseline health status may be obtained prior to exposure. Termination of employment examinations, identical to the periodic examinations, are also required. The employer is required to provide the employee with a copy of the physician's written opinion from these exams and a copy of biological monitoring results within 2 weeks of receipt.

Biological monitoring is also required for all employees who may have been exposed at or above the action level unless the employer can demonstrate that the exposure totaled less than 60 months. In this case it must also be conducted one year after the initial testing. The need for further monitoring for previously exposed employees is then determined by the results of the biological monitoring.

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ENCLOSURE 4

September 21, 2007

Memorandum for [redacted]
Lewis M. Barr
Investigative Counsel
Office of the Inspector General
United States Department of Justice

From: **Captain Paul Pryor**
Federal Occupational Health Service

Re: **Worker Heat Stress Measurements - FCI Marianna**

The preliminary heat stress information collected by the health and safety technical team during the survey at the BOP's Marianna, Florida facility on August 8 and 9, 2007, are presented for your review. Included with this information are the heat stress data obtained in the various locations tested in both the male medium security facility (MSF) and the associated female camp (collectively the Federal Correctional Institution (FCI)) (Note: heat stress information was calculated as Wet Bulb Globe Temperature – WBGT); the reference standards/criteria used to determine if heat stress overexposures occurred during the two day sampling period; preliminary conclusions regarding these overexposures measured; and recommendations to reduce and/or eliminate the overexposures found during the investigation period.

The preliminary heat measurement data from FCI Marianna are presented below. Measurements of indoor WBGT were calculated for one hour increments and are presented for each of the two days of the testing at that facility.

WBGT MEASUREMENTS – FCI MARIANNA

Heat Stress Data - August 8, 2007		
Location	**Times**	**Hourly Time Weighted Average (TWA) WBGT in (°F)**
Camp Glass Breaking Room	8:52 a.m. to 9:52 a.m.	83.8
	9:53 a.m. to 10:45 a.m.	85.5
Camp Warehouse	9:41 a.m. to 10:41 a.m.	82.6
	10:42 a.m. to 11:42 a.m.	83.1
	11:43 a.m. to 12:43 p.m.	83.3
	12:44 p.m. to 1:44 p.m.	83.3
	1:45 p.m. to 2:45 p.m.	82.8
MSF Refurbish	10:24 a.m. to 11:24 a.m.	82.9
	11:25 a.m. to 12:25 p.m.	84.0
	12:26 p.m. to 1:26 p.m.	84.4
	1:27 p.m. to 2:27 p.m.	84.4
	2:28 p.m. to 3:28 p.m.	83.8
MSF Disassembly	10:31 a.m. to 11:31 a.m.	83.1
	11:32 a.m. to 12:32 p.m.	84.2
	12:33 p.m. to 1:33 p.m.	84.4
	1:34 p.m. to 2:34 p.m.	84.9
	2:35 p.m. to 3:35 p.m.	84.6

Heat Stress Data - August 9, 2007		
Location	**Times**	**Hourly TWA WBGTin (°F)**
Camp Glass Breaking Room	7:59 a.m. to 8:59 a.m.	85.5
	9:00 a.m. to 10:00 a.m.	86.8
Camp Glass Breaking Room Filter Change	12:35 p.m. to 1:35 p.m.	88.2
Camp Warehouse	8:44 a.m. to 9:44 a.m.	83.5
	9:45 a.m. to 10:45 a.m.	84.8
	10:46 a.m. to 11:46 a.m.	84.9
	11:47 a.m. to 12:47 p.m.	84.7
	12:48 p.m. to 1:48 p.m.	84.5
MSF Refurbish	9:35 a.m. to 10:35 a.m.	84.6
	10:36 a.m. to 11:36 a.m.	85.2
	11:37 a.m. to 12:37 p.m.	85.5
	12:38 p.m. to 1:38 p.m.	85.5
	1:39 p.m. to 2:39 p.m.	86.1
	2:40 p.m. to 3:40 p.m.	86.5
MSF Disassembly	9:04 a.m. to 10:04 a.m.	84.7
	10:05 a.m. to 11:05 a.m.	85.3
	11:06 a.m. to 12:06 p.m.	85.9
	12:07 p.m. to 1:07 p.m.	86.0
	1:08 p.m. to 2:08 p.m.	86.4
	2:09 p.m. to 3:09 p.m.	86.8

Heat Stress Standards and Criteria

Section 19 of the Occupational Safety and Health Act of 1970 (the Act) identifies federal agency safety program and responsibilities and, through its implementing regulations, requires agency heads to furnish federal employees places and conditions of employment "that are free from recognized hazards that are causing or are likely to cause death or serious physical harm." 29 CFR 1960.8. In addition, Executive Order 12196 expands on the responsibilities originating from the Act and requires agency heads to "[a]ssure prompt abatement of unsafe or unhealthy working conditions." In circumstances where such conditions cannot be abated, the agency must develop a plan that identifies a timetable for abatement and a summary of interim steps to protect employees. Id. Employees exposed to the conditions also must be informed of the provisions of the plan.

The criteria OSHA uses to determine overexposures to heat stress were developed by the National Institutes for Occupational Safety and Health (NIOSH) and the American Conference of Industrial Hygienists - Threshold Limit Values (ACGIH - TLV's). Factors normally taken into consideration by NIOSH and the ACGIH in evaluating heat exposure include: the metabolic rate (judged as the work rate) of the worker; the clothing and personal protective equipment worn, and the cycle of work and recovery.

Note: For the purposes of this presentation, the assumption is made that all workers have been acclimatized under heat-stress conditions similar to those anticipated for a minimum of 2 weeks and that there is adequate water and salt intake to those federal employees evaluated.

Work Rates

Having observed work at all Marianna locations evaluated, **work rates** in the MSF and Satellite Camp were determined as shown below:

Location		Task		Work rate
MSF	-	All tasks	-	light / moderate
Satellite Camp	-	Unloading trucks	-	moderate
		Warehouse work	-	light
		GBO* helpers	-	light / moderate
		GBO feeders	-	moderate / **heavy**
		GBO breakers	-	moderate

**Glass Breaking Operation*

As described by the ACGIH[i] - TLV's, **Light work** is illustrated as*: sitting or standing to control machines, performing light hand or arm work.* The **Moderate work** category, considered to be the predominant rate observed at Marianna, is defined by the ACGIH - TLV's as: *Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work, or light pushing and pulling. Normal walking.* The example of **Heavy work** given in the ACGIH - TLV's is described as: "*pick and shovel work*".

Note: Because all workers were not working at the same rate, even though they were assigned the same jobs, some tasks were given overlapping classifications.

Clothing and PPE

Because the evaporation of sweat from the skin is the predominant heat removal mechanism for workers, any clothing or Personal Protective Equipment (PPE) that impedes that evaporation must to be considered in an evaluation of heat stress. Accepted clothing for heat stress evaluation using the TLV WBGT criteria is traditional long sleeve work shirt and pants. This is essentially the level of clothing worn by all workers at the Marianna facility. Therefore an adjustment for clothing beyond such a summer work uniform (Note: See TLV's for Clothing Adjustment Factor – CAFs), should be made for workers in the GBO, due primarily to their use of Tyvek coveralls and possibly Powered Air Purifying Respirators (PAPRs). Tentatively, this adjustment is recommended to be a reduction of the TLV by 2 ^{o}F for workers wearing Tyvek coveralls, and an additional 1 ^{o}F for workers also wearing PAPRs, gloves, and other skin covering. [ii]

ACGIH - Threshold Limit Values

The above work rate and clothing factors can be used, in combination with the hourly work / rest regimen of exposed workers, to find the permissible maximum WBGT heat exposure limit (expressed in ^{o}F) from the table of TLVs:

	Work rate		
	Light	Moderate	Heavy
Continuous work	86 ^{o}F	80 ^{o}F	77 ^{o}F
75% work -25% rest	87 ^{o}F	82 ^{o}F	78 ^{o}F
50% work -50% rest	89 ^{o}F	85 ^{o}F	82 ^{o}F
25% work -75% rest	90 ^{o}F	88 ^{o}F	86 ^{o}F

Conclusions

Medium Security Facility - All workers observed in the MSF working at a moderate rate were exposed to WBGT levels above the recommended standard unless the work – rest regimen was greater than 75% work (i.e., 45 minutes) and 25% rest (i.e., 15 minutes) since the minimum WBGT measured was 82.9 ^{o}F. Note: At times during the survey period that regimen needed to be at least 25% work (i.e., 15 minutes) and 75% rest (or 45 minutes) since WBGT reached as high as 86.8 ^{o}F.

Camp Warehouse Facility - Warehouse workers doing light work were not exposed to WBGT levels above the recommended levels, even if they were working continuously, since the maximum measurement in that location was 85 ^{o}F. However, workers unloading trucks and who where working at a moderate rate would require up to a 50% – 50% work – rest regimen (i.e., 30 minutes work / 30 minutes rest) to stay within recommended levels.

Glass Breaking Operation - If the 2 or 3 ^{o}F CAF is imposed for the workers in the glass breaking operation, then the breakers and/or feeders are above the recommended exposure levels in most instances, and therefore, there are currently no work – rest regimens that can satisfy the heat stress limits. Also, even the helpers who wear PPE would need to be in a 50 – 50 work – rest regimen (i.e., 30 minutes work / 30 minutes rest) or better regimen most of the time to stay within recommended limits.

Recommendations

Due to the elevated heat stress levels measured in the GBO, the technical team recommends that the BOP institute measures to immediately ensure compliance with the ACGIH heat stress criteria. If UNICOR is not presently able to ensure such compliance, it should suspend glass breaking operations at Marianna until a heat stress program can be developed and implemented to offset the potential health problems and/or consequences that may result from glass breaking activities and the elevated temperatures found during this investigation. If the BOP has an equally effective alternative to achieving compliance other than the development of a heat stress plan and the interim suspension of GBO, it should promptly notify the OIG and the technical team.

The following additional general recommendations are based on OSHA, NIOSH, and the ACGIH recognized methods and procedures which can be used to reduce and/or eliminate potential heat stress hazards at FCI Marianna workplaces. After consultation with OSHA, we recommend that these include the following:

1. The BOP should develop a site specific heat stress program that accounts for the heat stress data/information provided in this document, and at a minimum, should incorporate the following:

a. Engineering controls are the preferred method to reduce and/or eliminate occupational stressors in the workplace; therefore, cooling methods, such as, air conditioning systems, should be investigated to reduce the heat load in this work place;

b. A medical surveillance component should be included in the program with pre-placement and periodic screening to identify health conditions which may be aggravated by elevated temperatures;

c. In lieu of implementing engineering controls, the BOP needs to reassess its current use of PPE (i.e., the use of Tyvek, PAPR's, gloves, etc.) and consider adding personal cooling devices, such as, cooling vest or packs for workers in the GBO;

d. An initial and periodic training program informing employees about the effects of heat stress, and how to recognize heat-related illness symptoms and prevent heat-induced illnesses;

e. An acclimation program for new employees <u>or</u> employees returning to work from absences of three or more days;

f. The development of specific procedures to be followed for heat-related emergency situations;

g. Provisions that first aid be administered immediately to employees displaying symptoms of heat-related illness;

h. Annual and periodic heat stress monitoring should be performed to reflect seasonal changes and assist in updating the site specific heat stress program.

2. The BOP should establish provisions for a work/rest regimen so that exposure time to high temperatures and/or the work rate is decreased;

3. The BOP should permit workers access to water at liberty; and

4. It is strongly recommended that the current 2007 version of the ACGIH-TLV's be referenced to assist in adding additional specific information to the Marianna Site Specific Heat Stress program. Therefore, a thorough understanding of the various clothing ensembles worn throughout the year at Marianna (especially during the warmer seasons) and the role that PPE (i.e., the use of Tyvek suites, hoods, gloves, etc.) may play on the effects of heat stress. Additional emphasis should be placed on the TLV's Guidelines for Limiting Heat Strain and the Guidelines for Heat Stress Management. We also recommend that additional materials on heat stress be investigated, such as OSHA's Heat Stress Card (OSHA Publication 3154) which can be found on OSHA's web page http://www.osha.gov/SLTC/heatstress/index.html and http://www.osha.gov/SLTC/heatstress/index.html

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[i] ACGIH Documentation of TLVs.

[ii] Bernard, T.E., Luecke, C.L., Schwartz, S.W., et al, "WBGT Clothing Adjustments for Four Clothing Ensembles Under Three Relative Humidity Levels," J Occup Environ Hyg, 5 (251) 2005.

ENCLOSURE 5

Review of 'Heat Stress Procedures' and 'Operational Requirements' Documents Associated with Electronics Recycling Operations at FCI Marianna

May 15, 2008

Submitted to: [redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
U.S. Department of Justice

Submitted by: Captain Jay Terra, CIH
FOH Safety and Health Investigation Team
Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

I. BACKGROUND

An investigation team comprised of safety and health professionals from the Federal Occupational Health Service (FOH) and the National Institute for Occupational Safety and Health (NIOSH) conducted heat stress characterizations associated with UNICOR's electronics recycling operations at the Federal Correctional Institution (FCI) Marianna. This evaluation was conducted on-site at FCI Marianna on August 8 and 9, 2007, following an assessment earlier in the year by the Occupational Safety and Health Administration (OSHA) that noted concerns with heat stress. Results from this evaluation were presented in a report entitled "Worker Heat Stress Measurements – FCI Marianna," from the Federal Occupational Health Service to the Office of the Inspector General at the United States Department of Justice (OIG) on September 21, 2007.

The heat stress characterizations indicated that inmates (male and female) involved with UNICOR's glass breaking operations (both routine and non-routine activities) are at risk from heat stress during the warmer months (e.g., June through September). This risk was elevated during performance of strenuous activities while using personal protective equipment (e.g., coveralls and respirators) during periods of hot and humid weather conditions. Results from the September 21, 2007 report are summarized below:

- Wet Bulb Globe Temperatures (WBGTs) were measured at one hour increments at various FCI Marianna locations on August 8 and 9, 2007. WBGT values ranged from 82.6° F to 88.2° F in the various locations. WBGT values generally increased from early morning to mid-afternoon. These WBGT values indicate the presence of a heat stress hazard.

- Work rates (workloads) were also estimated by observing various tasks. All tasks in the medium security facility (MSF) were in the light to moderate range. Most tasks in the Satellite Camp including glass breaking operations (GBO) were in the light to moderate range. The exception was the GBO feeders task and the filter change maintenance task which were moderate to heavy.

- For the GBO, WBGT values combined with work rates and the use of personal protective equipment (PPE) and powered air purifying respirators (PAPRs) place workers at risk from heat stress. MSF workers were also at risk, although their level of PPE does not add to the risk as it does for the GBO. Only the warehouse workers at the Camp Warehouse Facility were not at risk.

As a result of these findings, the FOH Safety and Health Investigation Team provided recommendations to FCI Marianna for the control of the heat stress hazard, including ones calling for the enhancement of UNICOR policies and procedures. In response to the recommendations, the Federal Bureau of Prisons (BOP) provided two programmatic documents to the OIG: (1) *Glass Recycling Operational Requirements*, Document # IP-6400-420, 8/6/07, Revision C and (2) *Heat Stress Procedures,* UNICOR–Federal Correctional Institution Marianna (undated).[1]

This report presents the results of the Investigation Team's review of the revised FCI Marianna programmatic documents. The purpose of this review is to provide general feedback on the overall suitability of the documents as a means to comply with pertinent safety and health requirements and to furnish meaningful protection from heat stress. The comments and recommendations provided herein specifically focus on the glass breaking operations at FCI Marianna, although they would generally apply to any activity with heat stress risk.

This report has been reviewed by NIOSH's Engineering and Physical Hazards Branch of the Division of Applied Research and Technology and OSHA's Office of Federal Agency Programs.

II. COMMENTS ON HEAT STRESS DOCUMENTS

The FOH Safety and Health Investigation Team performed a general review of the above-referenced documents in light of current government regulations and 'good practice' standards regarding heat stress. The review was based on the Team's familiarity with the FCI Marianna electronics recycling operations (i.e., glass breaking) as observed in August 2007.

A. Glass Recycling Operational Requirements (Doc. # IP-6400-420, 8/6/07, Revision C)

FOH interprets the *Operational Requirements* document as UNICOR's general policy statement that defines and controls UNICOR safety and health requirements associated with glass breaking operations at FCI Marianna. As such, we believe that specific reference should be made to criteria established by OSHA as well as by the American Conference of Governmental Industrial Hygienists (ACGIH) as it relates to heat stress in the workplace. These OSHA and ACGIH criteria essentially define the current regulatory and 'good practice' requirements with which UNICOR, as an employer, is advised to comply in order to protect its workers.

According to OSHA, a number of feasible and acceptable methods can be used to reduce heat stress hazards in workplaces and comply with the OSHA requirements. In particular, OSHA identifies the following nine elements as necessary for a successful heat stress program.

OSHA-Recommended Elements of a Heat Stress Program

1. Permit workers to drink water at liberty (subject, of course, to restrictions resulting from work in hazardous materials-regulated areas);
2. Establish provisions for a work/rest regimen so that exposure time to high temperatures and/or the work rate is decreased;

[1] See Attachments to this report for the current Revision Record from the *Glass Recycling Operational Requirements* document which was reviewed (as well as an excerpted paragraph) as well as a copy of the *Heat Stress Procedures.* The Attachments also contain a listing of OSHA reference materials regarding heat stress along with several images of the glass breaking operations and facilities at FCI Marianna (taken August 2007).

3. Institute a training program informing employees about the effects of heat stress, and how to recognize heat-related illness symptoms and prevent heat-induced illnesses;
4. Institute a screening program to identify health conditions aggravated by elevated environmental temperatures;
5. Institute an acclimation program for new employees or employees returning to work from absences of three or more days;
6. Specify procedures to be followed for heat-related emergency situations;
7. Implement provisions such that first aid can be effectively administered immediately to employees displaying symptoms of heat-related illness;
8. Develop specific guidelines for investigating whether heat stress conditions are likely (e.g., sampling methods, etc.); and
9. Establish effective site-specific heat stress mitigation techniques using engineering, administrative and/or personal protection equipment controls.

Of these elements, we determined that all are missing or not adequately addressed in the *Glass Recycling Operational Requirements*. At a minimum, the *Glass Recycling Operational Requirements* document should clearly reflect UNICOR's recognition that these nine elements are salient requirements and must be addressed in detail in lower tier documents (e.g., FCI Marianna *Heat Stress Procedures*). This document primarily addresses lead and cadmium exposures with little reference to other occupational exposures such as heat stress.

In addition to incorporating relevant OSHA requirements and information as discussed above, the current ACGIH - Threshold Limit Values (TLVs) regarding heat stress should also be adopted as UNICOR requirements in the FCI Mariana operational requirements and heat stress procedures. These TLVs provide specific heat stress criteria that should be used to form decisions about the conditions under which inmates and staff should and should not be required to work as regards heat stress.

Lastly, we recommend that the *Glass Recycling Operational Requirements* explicitly reference other UNICOR FPI controlling documents that relate to heat stress. As indicated on its coversheet, the *Glass Recycling Operational Requirements* is apparently a component of an integrated management system. Yet, no reference was made of the UNICOR, FCI Mariana Heat Stress Procedures or how training requirements, medical/fitness-for-duty monitoring, change control during unusual or upset conditions, and other such considerations specifically regarding heat stress are integrated into the overall workflow and operations.

B. Heat Stress Procedures

The UNICOR *Heat Stress Procedures* are very general and lack the technical and operational specificity necessary to ensure effective management and mitigation of the heat stress hazard. These procedures do not contain the necessary detail or process to implement heat stress controls.

Examples of the procedure's deficiencies are summarized below:

- Procedure Statement 1: "The FPC Glass Breaking Booth's temperature will be maintained below a Wet Bulb Globe Temperature (WBGT) of 77°F."

Comment: The procedure provides no information on how this is to be achieved. This statement might infer that either cooling will be provided or work will not be performed if 77°F WBGT is exceeded. If cooling is to be provided, the approach and engineering basis should be discussed. In addition, stoppage of work is not a desirable approach if the hazard can be appropriately managed and controlled to conduct work safely.

Comment: The procedure states that if 77°F WBGT is exceeded, then a work/rest regimen will be implemented. This regimen is an appropriate control action, however, it contradicts the statement that the glass breaking booth will be maintained below 77°F WBGT. (Also see comment on Procedure Statement 3.)

Comment: The procedure refers to possible "adjustments" in work schedules. It is unclear whether this refers to early morning, evening, or night shifts when the WBGT is less than 77°F. If so, this option should be explicitly detailed. (Also see comment on Procedure Statement 5.)

- Procedure Statement 2: "The WBGT will be used and the temperatures recorded by the detail supervisor or his designee at the beginning and end of each shift or on an as needed basis."

  Comment: Better criteria regarding when testing is to occur would improve this statement. For instance, the term "as needed" is vague. It would be an improvement if the procedure specified when interim WBGT measurements during the work shift would be appropriate. For instance, the procedure could be written to trigger interim measurements based on the level of initial readings or on ambient temperature readings during the work shift.

- Procedure Statement 3: "If the WBGT exceeds 77°, a Work/ Rest regimen will be implemented in accordance with OSHA guidelines."

  Comment: This statement should reference ACGIH-TLV guidelines, not OSHA guidelines. In addition, clear criteria for specifying work/rest regimens should be provided. (See Table 2, ACGIH-TLVs, Heat Stress and Heat Strain.)

  Note: This comment regarding work/rest regimens also applies to the "Factory Work Stations" paragraph of the procedure.

- Procedure Statement 4: "An additional training component will be added to the Glass Recycling Operational Requirements and the FPC Glass Recycling WorkStation Instructions to explicitly address heat stress prevention, symptoms, and treatment."

  Comment: This statement is written as a future action without any details regarding the training components. This statement should be written in definitive language that defines or references the training course that is required (e.g., curriculum, content, and/or course reference). (See current ACGIH TLV's and OSHA-Recommended Elements of a Heat

Stress Program, summarized above.) Training frequency should be defined, for instance, upon initial assignment with refreshers or reinforcement on some defined periodic basis. Training should specifically include 'signs and symptoms' of heat stress.

Note: This comment regarding detailing the training is also applicable to the "Training" paragraph of the procedure.

- Procedure Statement 5: "Adjustments to the glass breaking booth work schedule may be made to ensure both the safety of the workers and an optimal production schedule. " Comment: The meaning of this statement is unclear, although, it might be inferred that altering work shifts to early morning, evening, or night is intended. Otherwise, it may refer to the length of the shift. This statement should be clarified and detail should be added to define what would trigger the adjustments, what the adjustments could be, and how would they be authorized and implemented.

- Procedure Statement on Work Shift: "Staff will work their full shift rotation as long as the prescribed time limit inside the booth does not exceed four hours in an eight-hour workday."

  Comment: This statement should be rewritten to be consistent with the statements made in *Glass Recycling Operational Requirements* which appear to limit work to one, two-hour shift during the hot months. Alternately, both the operational requirements and the heat stress procedures should be rewritten to reflect the daily decisions regarding the work/rest regimens.

- Procedure Statement referencing IP: "A list of personnel authorized to enter the booth will be posted outside the Glass-Processing Area. Authorized personnel are those individuals assigned to the area that have completed all biological, safety and environmental testing, basic first aid training and identifying heat-stress symptoms training. See IP-6200-420".

  Comment: Verify the accuracy of the document reference; that is, presumably the reference should be IP-6400-420.

- Procedure Statement on Worker Assignments: "Additional workers assigned to the Glass Recycling WorkStation must be medically cleared and are subject to periodic safety training and physical monitoring. See IP-6200-420 FPC Glass Recycling Work Station Instructions."

  Comment: Clarify whether this refers only to the glass breaking operations or the broader operations.

- Procedure Statement on Maintenance: "Air conditioning units will be serviced by a qualified technician on a yearly basis."

Comment: Regarding maintenance of air conditioning units, reference should be made to controlling possible exposure to toxic metals such as lead, regardless of whether such maintenance is conducted by staff or contractors.

- Heat Stress Procedure Omissions: The FPI Mariana Heat Stress Procedures do not address worker acclimation, water/hydration, possible engineering controls, personal cooling devices, medical surveillance, and record keeping for heat exposures and monitoring. Several of the other general and job-specific controls in Table 5, ACGIH-TLVs, Heat Stress and Heat Strain, and the OSHA-Recommended Elements of a Heat Stress Program are also not addressed.

III. RECOMMENDATIONS

Recommendations and guidance are provided below to assist FCI Marianna and the BOP to develop and implement heat stress procedures that will ensure the effective management and mitigation of heat stress hazards.

In general, considerations for implementing heat stress controls in a workplace are as follows:

1. Evaluate the feasibility of engineering controls to mitigate heat stress conditions, and implement such engineering controls, if feasible;

2. Establish the work activity level (workload) by using Table 3, ACGIH-TLVs, Heat Stress and Heat Strain;

3. Measure worksite-specific WBGT values for both routine and non-routine activities during the warmer weather months;

4. Apply the appropriate protective clothing adjustment factor (CAF) to the measured WBGT values by using Table 1, ACGIH-TLVs, Heat Stress and Heat Strain or other documented sources in the literature;

5. If warranted, establish a work/rest regimen by using the information from steps 1, 2, and 3 above and applying that information to Table 2, ACGIH-TLVs, Heat Stress and Heat Strain;

6. Consider personal protection equipment (PPE) such as cooling devices that are appropriate and effective for the work activity and location. Also, as feasible, select PPE to protect workers from other hazards (such as lead), in consideration of the heat stress hazard;

7. Consider administrative controls that use exposure times, recovery times, work shifts, work practices, and other factors to limit physiological strain; and

8. Provide other appropriate general controls as delineated in Table 5, ACGIH-TLV, Heat Stress and Heat Strain, as well as OSHA-Recommended Elements of a Heat

Stress Program. This includes providing training and information regarding heat stress, water and other fluids, acclimation adjustments, record keeping for exposures and monitoring, among others.

We recommend that the FCI Marianna heat stress procedure be rewritten to address the above items. Specific recommendations and guidance for these general items as they relate to FCI Marianna are provided below.

A. Engineering Controls

Feasible engineering controls are the favored approach to controlling heat stress. We recommend that FCI Marianna conduct an engineering evaluation to determine if cooling of the glass breaking work environment is feasible. This engineering evaluation should be conducted by personnel experienced in industrial ventilation systems designed to control temperature in the presence of local exhaust ventilation systems and hazardous materials. For instance, any cooling provided to the glass breaking area must be implemented in a manner that maintains the effectiveness of the booth ventilation system and places the area in a negative pressure relative to other occupied areas.

Implementation of an effective cooling system could eliminate or at least reduce the heat stress hazard. Lacking these engineering controls (or prior to their implementation), other elements of a heat stress program should be implemented.

B. Workload Determinations

Workloads for the various activities (both routine and non-routine) at FCI Marianna should be determined using a job hazard analysis approach and the example metabolic rate categories of Table 3, ACGIH-TLVs, Heat Stress and Heat Strain. Types of activities should be categorized and then assigned a workload category (i.e., rest, light, moderate, heavy, and very heavy). Assuming that activities are consistent and fairly constant from shift to shift, this determination could be made once initially and recorded. The determination could then be reconfirmed on some periodic basis, or when there is a significant change in the activity.

The FOH report of September 21, 2007 identified workloads for various FCI Marianna work activities. Most were in the light to moderate category, including several activities in the glass breaking operation. The glass breaking operation feeders had a moderate to heavy workload. FCI Marianna should make these determinations for its activities and implement appropriate heat stress control actions accordingly.

C. WBGT Measurements and Protective Clothing Adjustment Factor

The FCI Marianna heat stress procedure should address the timing and frequency of WBGT monitoring and the conditions when regular or periodic monitoring during the work shift are warranted. Once the WBGT value is determined, the protective clothing adjustment factor is added to the value (see Table 1, ACGIH-TLVs, Heat Stress and Heat Strain or other documented sources).

Adjustment factors are generally not used for fully encapsulating or impermeable PPE. Instead, physiological monitoring would likely be necessary.

However, the PPE used at the FCI Marianna glass breaking operations is not impermeable or fully encapsulating. The adjustment factor for polyolefin coveralls is 1° C or 1.8° F as shown in Table 1, ACGIH-TLVs, Heat Stress and Heat Strain. Other literature assigns hooded Tyvek 1422A coveralls with an adjustment factor around 2°C or 3.6 °F. Other types of coveralls offering a water barrier, while still being vapor permeable, can range in adjustment factors from 6°C to 8.5°C. (See "Heat Stress and Protective Clothing: an Emerging Approach from the United States", Thomas E Bernard, Am. Occup. Hyg., Vol 43, No.5, 1999 for these and other suggested adjustment factors.)

FCI Marianna should determine and specify the adjustment factors for the types of PPE and respiratory protection equipment (RPE) that are used. FCI Marianna should confirm that the PPE used is not considered to be "impermeable."

D. Work/Rest Regimen

The FCI Marianna procedure should detail the process to establish work/rest regimens. Based on the workload, WBGT measurement, and protective clothing adjustment factor, the work/rest regimen should be established using Table 2, ACGIH-TLVs, Heat Stress and Heat Strain. The notes associated with Table 2 should be reviewed and understood.

Work/rest regimens based on the TLV are for the acclimated worker. Work accommodations are appropriate for the non-acclimated worker. For instance, the action limits in Table 2 are more appropriate for the non-acclimated worker. Other accommodations may also be appropriate for the non-acclimated worker.

During rest periods, it is advisable to provide for a cool down area equipped with water/fluids. Worker movement to the cool down area should be through a decontamination area where workers remove PPE/RPE. The decontamination area should be designed to ensure that toxic metal contamination is not carried to the cool down area.

E. Personal Protective Equipment

The use of PPE to reduce heat exposure should be considered and included in the FCI Marianna heat stress procedure, as appropriate. This equipment could include such items as cooling or "ice" vests, cooling neck collars, and others. These items are commercially available. It should be ensured that these devices do not interfere with the effectiveness of PPE/RPE used to prevent exposure from hazardous materials.

It may be possible to adjust work/rest regimens if personal cooling devices can be used (i.e., somewhat increase the work period over the rest period). Feedback from workers regarding their condition, comfort, and strain should be sought if this is attempted.

PPE/RPE used to protect workers from hazardous materials should be selected in consideration of the heat stress hazard. For instance, in the case of the glass breaking operation, more breathable materials for PPE would be preferred as long as they are effective to prevent exposure to metals dusts and fumes. Manufacturers and vendors should be able to provide information regarding effectiveness in prevention of metals exposure and heat stress.

This recommendation is NOT intended to imply that the current PPE is not optimum. FCI Marianna is simply encouraged to verify that PPE selected is an appropriate choice for metals exposure and heat stress hazards.

F. Administrative Controls

Administrative controls should be considered and addressed in the FCI Marianna heat stress procedure. Work/rest regimens would, of course, be one example of administrative controls. Another example would be the adjustment of work shifts from day to early morning, evening, or night. This example might be alluded to in the current heat stress procedure, but it was not clear. The length of work shifts is another administrative control.

Basically a modification to the work regime or work practice that would limit physiological strain while accomplishing the work objective, and while not adversely impacting exposure controls for other hazards would be an appropriate administrative control.

G. Other Controls and Considerations

Table 5, ACGIH-TLVs, Heat Stress and Heat Strain lists general controls for consideration and incorporation, as appropriate, into the FCI Marianna heat stress procedure. The OSHA-Recommended Elements of a Heat Stress Program should also be addressed in the procedure. Some of these as well as other general controls are discussed below, as applicable or not applicable to the preparation of a revised FCI Marianna heat stress procedure.

- Water/Fluids: Provision of water/fluids should be addressed in the procedure. As a possible example if feasible, water should be made available during rest periods in a cool down area (free of toxic metal exposure).

- Acclimation of Workers: Approaches to acclimate workers to the hot environment with necessary accommodations should be addressed. The ACGIH-TLV Heat Stress and Heat Strain section provides some information on this topic. OSHA-Recommended Elements of a Heat Stress Program also states that re-acclimation of workers is necessary if they are away from the job for more than three days.

- Training: The means of training, its general content, and its periodic reinforcement should be addressed in the heat stress procedure.

- First Aid and Emergency Response: The procedure should address how first aid and emergency response will be provided to workers suffering acutely from heat exposure.

- Record Keeping: Heat stress exposure and monitoring data and information must be maintained for staff and inmates involved in the GBO operations.

- Heat Strain Physiological Monitoring: Physiological monitoring approaches are also discussed in ACGIH-TLVs Heat Stress and Heat Strain; however, this monitoring is not a desired approach, unless absolutely necessary. Usually this monitoring is reserved for cases where impermeable PPE is required. If FCI Marianna should require use of impermeable PPE, then physiological monitoring may need to be added to the heat stress procedure.

IV. CONCLUSIONS

Based on the evaluation of the FCI Marianna glass breaking operations, the FOH Safety and Health Investigation Team offers the following conclusions.

1. Workers performing glass breaking and other operations at the MSF and Satellite Camp at FCI Marianna are at risk from heat stress.

2. FCI Marianna Heat Stress Procedures lack many of the steps, information, and detail necessary to ensure management and control of the heat stress hazard.

3. To ensure effective management and control of the heat stress hazard, FCI Marianna needs to rewrite its heat stress procedures to be consistent with ACGIH-TLVs, Heat Stress and Heat Strain section, as well as OSHA-Recommended Elements of a Heat Stress Program.

4. The Glass Recycling Operational Requirements also need to be revised to reflect the heat stress issues discussed in this report and in the rewritten procedures.

5. Even prior to the preparation of rewritten procedures, FCI Marianna should proceed with the recommendations and guidance offered in this report, as well as with the ACGIH and OSHA information previously cited.

The FOH Safety and Health Investigation Team recognizes the recent efforts put into improving the safety of its glass breaking operations by FCI Marianna and the BOP, particularly as it relates to heat stress. The comments provided in this report should be construed in this light. Additional assistance is available upon request.

ATTACHMENTS

- Revision Record and salient paragraph excerpted from *Glass Recycling Operational Requirements*, Document # IP-6400-420, (8/6/07, Revision C)
- Heat Stress Procedures, FCI Marianna
- OSHA information related to heat stress
- Selected images of glass breaking operation at FCI Marianna (Aug. 2007)

[Taken from ***Glass Recycling Operational Requirements*****, Document # IP-6400-420, (8/6/07, Revision C)**

REVISION RECORD

Rev.	Date	Change Description	Initials		
			AW	FM	MR
A	10\12\06	Newly Issued	-	-	-
B	6\11\07	Additional Hot weather instruetions added.			
C	8\6\07	Speeifie Hot weather proeesses added.			

3.4 Daily Operations:

Work shifts are to be limited to four hours per day. Therefore, the Glass-Processing Area will require two shifts for the normal workday. These operations are for the months of October thru May. Due to the geographical location of MNRC and the excessive heat during June, July, August and September work in the inner glass booth is limited to a 2 hour A.M. shift. The WorkStation utilizes 2 person crews in the inner glass booth. This normally results in a crew rotation where the crews are working in the inner booth every third day.

Staff may work the full shift as long as their time inside the booth does not exceed four hours in an eight-hour workday.

UNICOR

FEDERAL CORRECTIONAL INSTITUTION
3625 FCI Road
Marianna, Florida 32446

Heat Stress Procedures

Work shifts are limited to four hours per day. Glass-Processing Area will require two shifts for the normal workday.

1. The FPC Glass Breaking Booth's temperature will be maintained below a Wet Bulb Globe (WBGT) temperature of 77°.
2. The WBGT will be used and the temperatures recorded by the detail supervisor or his designee at the beginning and end of each shift or on an as needed basis.
3. If the WBGT exceeds 77°, a Work/ Rest regimen will be implemented in accordance with OSHA guidelines.
4. An additional training component will be added to the Glass Recycling Operational Requirements and the FPC Glass Recycling WorkStation Instructions to explicitly address heat stress prevention, symptoms, and treatment.
5. Adjustments to the glass breaking booth work schedule may be made to ensure both the safety of the workers and an optimal production schedule.

Note: During periods of sustained high temperatures the frequency of WBGT use may be increased.

Staff will work their full shift rotation as long as the prescribed time limit inside the booth does not exceed four hours in an eight-hour workday.

A list of personnel authorized to enter the booth will be posted outside the Glass-Processing Area. Authorized personnel are those individuals assigned to the area that have completed all

biological, safety and environmental testing, basic first aid training and identifying heat-stress symptoms training. See IP-6400-420 Glass Recycling Operational Requirements
Additional workers assigned to the Glass Recycling WorkStation must be medically cleared and are subject to periodic safety training and physical monitoring. See IP-6200-420 FPC Glass Recycling WorkStation Instructions.

Factory Work Stations:

A work rest regiment will be implemented when temperatures exceed Wet Bulb Globe temperature as prescribed by OSHA.

Training:

All staff will be required to obtain CPR certification every two years.
Staff will conduct heat stress training to all workers on an annual basis and will conduct heat stress training with the glass workers monthly during elevated heat conditions in conjunction with monthly safety talks. Staff will train workers on proper hydration techniques in conjunction with the heat stress training.

Maintenance:

Air conditioning units will be serviced by a qualified technician on a yearly basis. The Wet Globe tester will be re-calibrated annually.

OSHA Information, Technical Manual and Publications

- OSHA Technical Manual, Section III: Chapter 4
- Appendix III: 4-1 Heat Stress – General Workplace Reviews;
- Appendix III: 4-2 Heat Stress- Related Illness/Accident Follow-Up;
- Appendix III: 4-3 Measurement of Wet Bulb Temperatures (Intended to assist industry in developing appropriate Heat Stress Programs).
- OSHA Publication 3154 2002 (Provides additional reference information on implementing heat stress programs and "Heat Stress Information Cards Heat Stress Card (OSHA Publication 3154) in both English and Spanish.

Additional ou treach materials regarding he at st ress c an be found on OSHA's w eb page at http://www.osha.gov/SLTC/heatstress/index.html.]

Image 1: Glass breaking operation by workers in PAPRs and disposable coveralls

Image #2: Filter changing operation

Image 3: Worker repositioning gaylord box of CRTs

Image 4: Enclosed room containing glass breaking operation

FCI TEXARKANA

EVALUATION OF ENVIRONMENTAL, SAFETY, AND HEALTH INFORMATION RELATED TO UNICOR E-WASTE RECYCLING OPERATIONS AT FCI TEXARKANA

PREPARED FOR THE UNITED STATES DEPARTMENT OF JUSTICE
OFFICE OF THE INSPECTOR GENERAL

Submitted to: [redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
U.S. Department of Justice

Submitted by: Mr. George Bearer, CIH
FOH Safety and Health Investigation Team
Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

April 27, 2010

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Attachments

1.0 INTRODUCTION

At the request of the U.S. Department of Justice (DOJ) Office of the Inspector General (OIG), the Federal Occupational Health Service (FOH) coordinated environmental, safety and health (ES&H) assessments of electronics equipment recycling operations at a number of Federal Bureau of Prisons (BOP) facilities around the country. The assessments were conducted as a result of whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium at electronics recycling operations overseen by Federal Prison Industries (UNICOR).[1] The allegations stated that these exposures were occurring from the breaking of cathode ray tubes (CRTs) and other activities associated with the handling, disassembly, recovery, and recycling of electronic components found in equipment such as computers and televisions (i.e., e-waste). [2] It was further alleged that appropriate corrective actions had not yet been taken by BOP and UNICOR officials and that significant risks to human health and the environment remained.

This FOH report[3] consolidates and presents the findings of technical assessments performed at UNICOR's e-waste recycling operations at the Federal Correctional Institution in Texarkana, Texas (FCI Texarkana) by industrial hygienists and other environmental, safety, and health specialists representing federal agencies including FOH, the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH) Division of Surveillance Hazard Evaluation and Field Studies/Hazard Evaluations and Technical Assistance Branch (DSHEFS/HETAB), the Occupational Safety and Health Administration (OSHA), and the U.S. Environmental Protection Agency (U.S. EPA). Reports and field data from these agencies are presented in the attachments to this report (see references for these reports in Section 7.0). The primary objectives of these assessments were to characterize current UNICOR operations and working conditions at FCI Texarkana in light of the whistleblower allegations and to identify where worker exposures, environmental contamination/degradation, and violations of governmental regulations and BOP policies may still exist so that prompt corrective actions may be taken where appropriate. In addition, this FOH report also relies upon information from documents assembled by the OIG which were developed by various consultants, regulatory agencies, BOP, and UNICOR staff.

The overall purpose of this report is to characterize current operations and working conditions at Texarkana (i.e., 2003 to present) especially with respect to the potential for

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[1] FPI, (commonly referred to by its trade name UNICOR) is a wholly-owned, Government corporation that operates factories and employs inmates at federal correctional institutions.

[2] E-waste is defined as a waste type consisting of any broken or unwanted electrical or electronic device or component.

[3] FOH prepared this report in September 2009 and its findings and conclusions address e-waste recycling conditions known to FOH at that time. FOH provided the report to the OIG, which shared it with the BOP and sought feedback on it. The BOP and UNICOR later provided their comments to FOH about the report's contents, which resulted in FOH making limited changes to some text and figures, as reflected herein.

inmate and staff exposures[4] that may result from present day e-recycling activities as well as from legacy contamination on building components from e-recycling operations which took place in the past. This report consolidates findings from those contributing to the OIG investigation and evaluates additional information assembled regarding BOP and UNICOR recycling operations (e.g., consultant reports, programs and procedures, and various records and documents). Conclusions and recommendations presented in this report are based on the entire body of available reports, data, documents, interviews, and other information.

FCI Texarkana is one of six BOP institutions for which an assessment report has been prepared by FOH. On October 10, 2008, FOH issued a separate report entitled "*Evaluation of Environmental, Safety, and Health Information Related to Current UNICOR E-Waste Recycling Operations at FCI Elkton*" [FOH 2008a] detailing current exposure conditions at FCI Elkton. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in e-waste electronics, pertinent regulatory requirements, and other information that provides additional context to this report on FCI Texarkana. FOH will be preparing assessment reports for two remaining BOP institutions that perform recycling upon completion of their respective ES&H assessments.

Currently, e-waste recycling operations at FCI Texarkana involve receipt of waste electronics from various locations around the country, disassembly and sorting activities ('breakdown'), and the associated material handling and facilities maintenance required to support these operations. Although glass breaking operation(s) (GBO) were suspended UNICOR-wide in June 2009, this report addresses the Texarkana GBO conducted during the field activities performed by OSHA and FOH in December 2006, FOH in March 2007, and NIOSH/HETAB in July 2008. The FCI Texarkana Factory Manager stated that the last GBO at FCI Texarkana was performed on May 29, 2009 and that UNICOR will re-evaluate the status of glass breaking at the end of 2009. In September 2009, the UNICOR General Manager for e-waste recycling disclosed that it is very unlikely GBO will resume at FCI Texarkana or elsewhere within the BOP system since processing of CRTs is now, and will likely continue to be, outsourced. FCI Texarkana recycling facilities and operations are described below in Section 2.0 in greater detail.

2.0 UNICOR E-WASTE RECYCLING FACILITIES AND OPERATIONS AT FCI TEXARKANA

UNICOR e-waste recycling operations commenced at FCI Texarkana in 2001. These past operations were conducted in the basement of the UNICOR factory in the FCI and included receiving and sorting, disassembly, packaging, and shipping. In late 2001, glass

[4] In this report, the term "exposure" refers to the airborne concentration of a contaminant (e.g., lead or cadmium) that is measured in the breathing zone of a worker but outside of any respiratory protection devices used. Unless otherwise noted, "exposure" should not be confused with the ingestion, inhalation, absorption, or other bodily uptake of a contaminant since, in part, concentrations reported and discussed in this report are not adjusted based on respirator protection factors. However, when reported, it is indicated whether the exposure was within the protective capacity of the respirator.

breaking operations (GBO) were initiated involving the processing of CRTs from computer monitors and televisions.

As with other UNICOR e-waste recycling operations, current recycling of electronic components at this facility involves receiving and sorting, disassembly, GBO (currently suspended), and packaging and shipping. Cleaning and maintenance in support of these processes are also conducted. See FOH reports for USP Lewisburg and FCI Marianna for a more detailed description of these activities that generally applies to FCI Texarkana. [FOH 2009a; FOH 2009b] Further information on FCI Texarkana operations are discussed in this section, below.

There currently are two disassembly areas at UNICOR Texarkana: a warehouse in the camp area outside the perimeter fence of the FCI; and the basement of the UNICOR factory inside the FCI. Printers, scrap computers, cable boxes, VCRs and typewriters are processed at the UNICOR factory, whereas items including CRTs/monitors, telephonic equipment, and miscellaneous scrap are processed at the camp warehouse. At each location, the pieces of equipment are dismantled and components (plastic, wire, aluminum, glass, etc.) are separated. Some items are baled and others are left in large boxes. Components are then weighed, inventoried, and sold to vendors. Higher valued items are placed in a secure area inside the camp warehouse while lower valued items are sent to the UNICOR factory or to one of two adjacent pole barns. Items in these storage areas are later sorted and transferred to their assigned areas for testing and, if appropriate, manual disassembly so that components can be recovered and recycled.

From 2001 to 2004, e-waste recycling operations were performed largely without the benefit of adequate engineering controls, respiratory protection, medical surveillance, or industrial hygiene monitoring. Initially, the GBO utilized a retrofitted local exhaust ventilation (LEV) system that had been used by the FCI's furniture factory. In addition, large fans were reportedly used for cooling the work area, but also had the effect of reducing the ability of the LEV system to capture the dust from CRT glass breaking. This resulted in the dissemination of dust from the GBO throughout the basement. Dust removed from the LEV was collected in a box and placed in the trash.

In the summer of 2002, the GBO was temporarily moved to an old dairy barn at the camp (the lower security part of the FCI) while a containment area was built for the GBO in the UNICOR factory basement. The containment area in the UNICOR factory consisted of wooden walls topped by a screen which was designed to decrease airborne migration of what UNICOR staff and inmates described as "silver floating material" from the GBO. The GBO was moved back to the basement of the UNICOR factory in the fall of 2002.

In May 2004, the GBO was moved to its current location at the UNICOR warehouse at the camp. Unbroken glass from monitors and televisions (i.e., CRTs) was placed in bins and sent to the camp's glass breaking area where a glass breaking room was constructed and put into service. The glass breaking area was divided into seven sections, identified as zones 1 through 7 on the enclosed diagram (See Figure 1). Except for the inmate locker area and storage closet which are enclosed by walls, the zones were separated by vinyl strip curtains suspended from the ceiling.

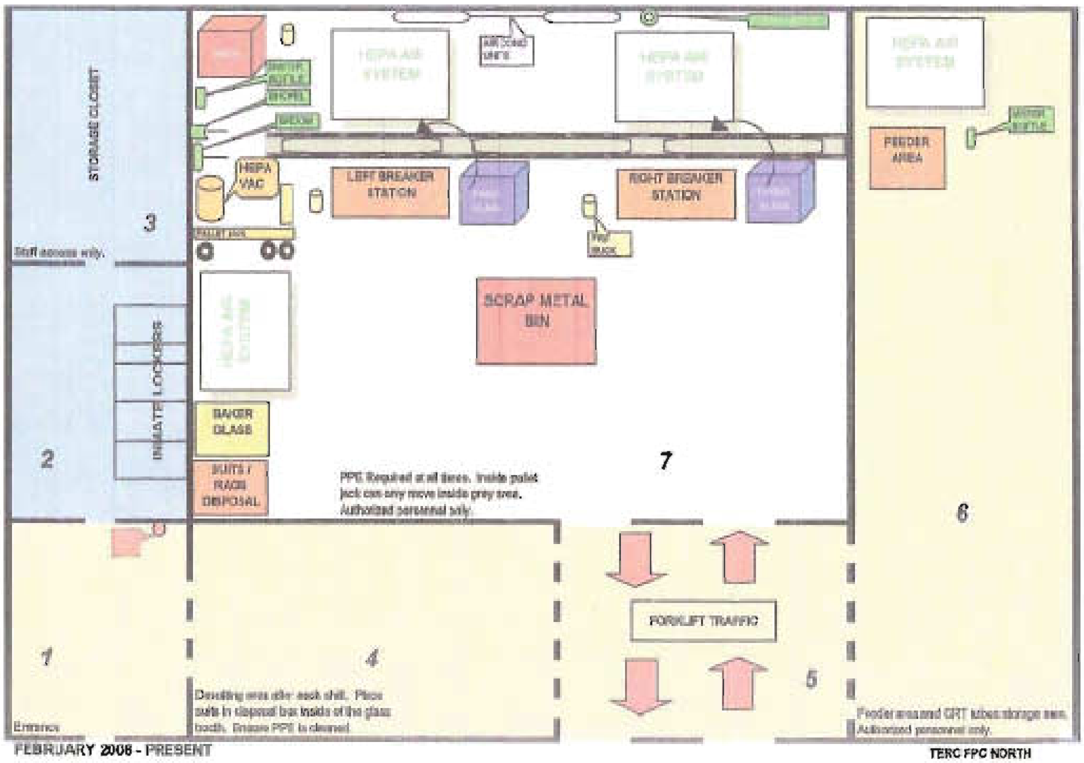

Figure 1 Glass breaking area at the camp, FCI Texarkana.

The GBO involved moving the CRTs to the room where the glass was broken inside the containment area and collected in large boxes. Once the box was full, a piece of cardboard was placed on its top, and it was shrink-wrapped with plastic after which it was moved outside to the pole barn area. When approximately 37,000 pounds of glass had been accumulated, it was loaded and shipped to a glass recycler using the vendor's shipping containers.

The glass breaking room is reported to have undergone various modifications since its opening in May 2004 but its most recent configuration used two stand-alone high efficiency particulate air (HEPA) filtered ventilation units (LEV systems) to control dust emissions at the panel and funnel glass breaking stations. These HEPA units re-circulated filtered air back into the glass breaking room. Plastic strip curtains at the face (intake) of each HEPA unit partially enclosed the CRT while it was manually broken. Two additional HEPA-filtered ventilation systems provided general air filtration to remove dust from the air in the glass breaking room. One of these units was in the feeder area and the other was along a wall in zone 7. In 2007, air-conditioning was installed in the GBO, and four large exhaust fans were installed on opposite walls of the factory (two fans on each wall). The GBO and facilities as they existed in 2007 are shown in Images 1-3 that follow.

Image 1. Glass breaking room (in background) with containers of CRTs outside the glass breaking enclosure awaiting breakage


Image 2. Worker HEPA vacuuming glass breaking station wearing a powered air purifying respirator (PAPR)

Image 3. Disassembly station

The glass breaking process involved two inmate glass breakers, one at each workstation inside the glass breaking room, who used hammers to break the CRTs. CRTs were provided to the breakers by two inmate feeders (positioned in Zone 6, see Figure 1), who placed intact CRTs onto a manual conveyor that allowed CRTs to be rolled into the areas contained by vinyl strip curtains at each of the two breaking stations (i.e., right side and left side stations). At the right side breaker station, the breaker reached through the vinyl strip curtain and broke the funnel glass, which dropped into a Gaylord box beneath the conveyor. What was left of the CRT was rolled into the enclosure at the second (left) station where panel glass was similarly broken by a worker and allowed to drop into a second Gaylord box. The electron gun and metal components were also removed during the breaking process and deposited into containers.

As reflected in the NIOSH/HETAB report (see Attachment 3), at the time of their site visit and according to factory personnel, the GBO processed 300 to 400 CRTs per day during two work shifts, which ran for three hours in the morning and two hours after lunch.[5] From a pool of approximately eight inmates, four were assigned to work as glass breakers (two work simultaneously) and feeders (two work simultaneously) during each work shift. Each inmate was allowed to work as a glass breaker for a maximum of one shift per day. At the start of morning and afternoon shifts, glass breakers and feeders took personal protective equipment (PPE) from their lockers and donned the PPE in the change-out area in zone 4. At the end of the shift, workers returned to zone 4 where they removed the PPE (see Section 4.1.5 for a description of PPE practices).

[5] In December 2006 while accompanying OSHA during their inspection, FOH observed that CRTs were processed at a somewhat lower rate of one per every one and one half to two minutes.

Movement of workers and equipment in and around the GBO was controlled to reduce dust carryout on shoes and equipment. Glass breakers were the only workers allowed in zone 7 during glass breaking, and they remained in zone 7 throughout the work shift. The pallet jack used in zone 7 never left zone 7. Forklifts entered the glass breaking room no further than zone 5. Full Gaylord boxes were shrink-wrapped before being moved to the edge of zone 5, where the boxes were removed with a forklift.

At the end of a shift, the glass breakers and feeders dry-swept the GBO floor, then wet mopped it with a dilute mixture of Simple Green® and water. A HEPA vacuum cleaner was used to remove dust from various surfaces in zone 7, and from the face of the pre-filters on the HEPA units at the glass breaking stations. Workers remained in PPE while performing end-of-shift cleanup. Dry sweeping and shovels were also used to clean the floor after full Gaylord boxes were removed from the GBO. Pre-filters installed in HEPA units were changed weekly. The HEPA filter in each unit was changed annually by inmates wearing PPE. This was accomplished by removing the pre-filter, HEPA vacuuming accessible surfaces, removing the HEPA filter, and sliding the filter into a plastic bag which is then double-bagged for disposal. [NIOSH/HETAB 2009]

The NIOSH/HETAB report presents details on PPE, respiratory protection, engineering controls, and work practices used during glass breaking and other recycling activities. These controls are summarized in Sections 3.0 and 4.0 of this report and detailed in the NIOSH/HETAB report, Attachment 3.

3.0 BOP/UNICOR SAFETY AND HEALTH PROCEDURES AND PRACTICES AT FCI TEXARKANA

Under 29 CFR 1960 each federal agency is obligated to develop a comprehensive and effective safety and health program. Such programs establish requirements and processes for controlling occupational hazards and meeting federal occupational safety and health regulations. The BOP has established an ES&H policy entitled Occupational Safety, Environmental Compliance, and Fire Protection (BOP Program Statement 1600.09). UNICOR's compliance with this policy will be evaluated in the OIG's final report.

Various OSHA standards require written programs or plans to address occupational hazards or implement hazard control measures. Examples applicable to UNICOR's e-waste recycling activities performed at FCI Texarkana, particularly for glass breaking, include:

- 29 CFR 1910.1025: Lead requires a written lead compliance plan;
- 29 CFR 1910.1027: Cadmium requires a written cadmium compliance plan;
- 29 CFR 1910.134: Respiratory Protection requires a written respiratory protection program; and
- 29 CFR 1910.95: Occupational Noise Exposure requires a written hearing conservation program.

In addition to the specific OSHA standards listed above, another hazard that could be associated with FCI Texarkana recycling operations is heat exposure. Although OSHA does not have a specific standard for heat exposure, it can regulate this hazard under its "General Duty Clause" [OSHA 1970] that requires employers to furnish a workplace that is free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees.

Even when specific hazards do not meet the exposure threshold for a written plan/program to comply with a specific standard, a good practice approach warrants that a general safety and health plan should be in place to identify workplace hazards and specify appropriate hazard controls and safe work practices.

UNICOR's ES&H practices and programs associated with the e-waste recycling activities conducted at FCI Texarkana are discussed below.

3.1 Safety and Health Practices and Procedures to Control Toxic Metals Exposure

UNICOR at FCI Texarkana has several documents that describe safety and health practices and requirements for e-waste recycling activities. These define measures and requirements to control toxic metal exposures and include the following:

- Work Instruction – Glass Breaking Procedures;
- Work Instruction – Cathode Ray Tube (CRT) Processing Procedures;
- Cathode Ray Tube (CRT) Lead Compliance Program; and
- UNICOR Texarkana Process Descriptions

Each of the documents is discussed below. [Note: FCI Texarkana also has a document entitled Lead Awareness Program; however this document is not related to electronic recycling and is not discussed in this report.]

The Work Instruction entitled "Glass Breaking Procedures" applies to the breaking of CRT glass inside the glass breaking room and the area and activities immediately outside the glass breaking room that support the breaking activities. This document describes mandatory safety equipment (i.e., PPE); practices for removing PPE; hygiene practices; end-of-shift clean-up procedures; respirator cleaning, inspection, and storage procedures; clean-up procedures for accidental CRT breakage; and glass breaking room clean-up practices. Staff and inmate workers inside the glass breaking room are required to wear a "reverse air flow hood and HEPA filter system" (presumably powered-air purifying respirator, PAPR), leather/Kevlar® work gloves, long sleeves, safety boots, and jumpsuit. The type of "jumpsuit" is not further described. Outside assistants are required to wear safety glasses, leather/Kevlar® work gloves, safety boots, and jumpsuits. PAPRs or other respirators are not required for these workers. The use of wet methods and HEPA vacuums is emphasized for clean-up and PPE/respirator decontamination processes. Hand washing is also emphasized.

The Work Instruction entitled "Cathode Ray Tube (CRT) Processing Procedures" also applies to the breaking of CRT glass. This document addresses biological monitoring requirements; engineering controls; PPE requirements including respiratory protection; signage; daily operational practices for the work shift; care and use of PPE; exposure monitoring, surface testing, and ventilation testing requirements; work practices for glass breaking and handling; and personal hygiene and cleaning procedures. This procedure contains some information not addressed in the previously described "Glass Breaking Procedures," such as biological monitoring. In addition, engineering controls are described in general terms, but the type of LEV system is not addressed. In some ways, this procedure contradicts or differs from the Glass Breaking Procedures. For instance, this procedure calls for the use of air purifying respirators (APRs), while the previous procedure describes PAPRs. The use of "jumpsuits" by assistants outside the glass breaking room is not specified in this procedure, while they are required by the Glass Breaking Procedures. The use of two layers of jumpsuits for breakers is specified in this procedure but two suits are not specified in the Glass Breaking Procedures. Finally, hearing protection is specified in this procedure, but not in the Glass Breaking Procedures. UNICOR should ensure that its procedures are consistent with each other and with implemented practices.

The Cathode Ray Tube (CRT) Lead Compliance Program states that its purpose "… is to describe policy and outline responsibilities to assure a coordinated plan for the safe handling of the lead containing cathode ray tubes." As a policy and responsibility document, this program is very general in nature and does not specify the engineering and work practice controls designed to maintain lead at levels below the OSHA PEL. The program does not refer to the previously described procedures that do contain certain exposure control information. The program does call for training to address the lead hazard, respiratory protection use, PPE use, and hazardous waste handling. It also mentions housekeeping, hygiene practices, and medical surveillance, but does not provide much detail. The program requires a semi-annual program evaluation to ensure compliance with the OSHA lead standard. In FOH discussions with the Factory Manager, he was unaware of this program and stated that FCI Texarkana did not have a Lead Compliance Program. He stated that semi-annual program evaluations are not performed. FOH forwarded the written program to the Factory Manager, and he confirmed that he had not seen this program and stated that the program must be a draft that was never implemented.

The UNICOR Texarkana Process Descriptions include a section that addresses inmate PPE requirements (including respiratory protection), medical monitoring requirements, and exposure monitoring/surface testing, as well as a section that summarizes hygiene and cleaning procedures. Requirements are similar to those discussed in the work instructions described above. Respirators are identified as "reverse air flow" with HEPA filters, and protective clothing is described as a disposable suit.

Regarding the above glass breaking documents, should GBO resume at UNICOR facilities, UNICOR should consider standardizing work instructions and procedures for all factories, where possible. Standardized documents could then be refined and tailored for specific factories should certain factory-specific operations differ in some ways. Any programs should also be clearly labeled for status; that is, draft, active, expired, supersedes, etc. UNICOR should develop a document control process to ensure documents are current, operable, and consistent, as well as to ensure that they are reviewed and revised, as appropriate.

Since UNICOR at FCI Texarkana requires use of respiratory protection during glass breaking, non-routine maintenance of LEV HEPA filters, and cleaning activities, a written respiratory protection program is required by OSHA. FCI Texarkana has a document entitled "Respiratory Protection Program," TEX-1616.2L, October 19, 2005 to satisfy this requirement. This document addresses medical evaluation, fit testing, respirator use and maintenance, training, and other subject matter. This program accurately specifies the use of PAPRs for workers performing glass breaking inside the glass breaking room. This respiratory protection program, however, covers the institution as a whole and is fairly generic in nature. For instance, the document specifies PAPRs for glass breaking, but does not specifically address the use, cleaning, maintenance, and storage of PAPRs used during glass breaking. To supplement this document, however, the glass breaking procedures described above do contain this type of content. In its report presented as Attachment 3, NIOSH/HETAB stated that it reviewed respirator medical clearance records and observed respirator use and storage. The report indicates that this program is being implemented, although NIOSH/HETAB made suggestions for improving respirator practices (see Section 4.1.5 and Attachment 3).

Job orientation and safety training is provided to inmates working in the recycling factory. However, for general activities conducted on the factory floor (i.e., disassembly and materials handling), a written safety and health document to define existing workplace hazards and control measures is not in place for UNICOR recycling conducted specifically at FCI Texarkana. As a "good practice" approach, such a document should be developed and implemented to concisely define the safety and health practices and requirements specific to FCI Texarkana recycling. The document should address PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping and cleaning practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Non-routine or periodic work activities should also be addressed in the document, particularly those that potentially disturb dusts such as cleaning and handling/disposing of wastes from HEPA vacuums or containers. The approach to evaluate new or modified processes should be addressed as well. The document could also specify requirements for periodic site assessments, hazard analyses, inspections, monitoring, actions for new or changed processes, and regulatory compliance reviews.

3.2 Safety and Health Practices and Procedures to Control Noise Exposure

Noise exposure above the OSHA action level triggers the requirement for a written hearing conservation program and implementation of associated practices. In 2006, a UNICOR consultant found that noise levels "may exceed the exposure limits established by OSHA." Another UNICOR consultant performed a more complete noise survey in

February 2007 and found various areas that have noise exposure at levels that require implementation of a hearing conservation program and implementation of acoustic engineering controls and/or hearing protection. In addition, FOH found that noise exposures inside the glass breaking room during GBO were at levels that require implementation of a hearing conservation program (see Section 4.4 for further information).

A written hearing conservation program is available at FCI Texarkana that applies to the institution as a whole, which would include UNICOR recycling activities. It has a "reviewed on" date of July 26, 2007. This program calls for baseline and annual audiometric testing, training, and hearing protection requirements. Section 4.d. of this program lists "designated high noise areas and activities." Only one area/activity is listed which is "UNICOR." It does not specify the areas and activities of UNICOR that require workers to be enrolled in the hearing conservation program. Some OSHA elements of a hearing conservation program are not contained in this program, such as a monitoring program and recordkeeping.

According to the FCI Texarkana Factory Manager and Safety Specialist, this program has been implemented. Audiometric testing is provided annually and has been done so for years and applies to all inmate workers. For instance, in 2007, the Factory Manager stated that 129 workers were tested. Hearing protection is required in all "teardown" areas, and FOH and NIOSH/HETAB reported that hearing protection was worn. Training is provided during safety talks and job orientation. In addition, after the 2007 UNICOR consultant noise study, the pallet assembly operations were discontinued to eliminate this source of noise exposure.

Correspondence dated May 23, 2007 from an Associate Warden to the Warden stated that the Safety Department reviewed noise survey and hearing conservation implementation status. The correspondence stated that after a full review of the hearing conservation program, "all elements of the OSHA Hearing Conservation Program have been implemented." This demonstrates that an implementation review has been performed for this program.

The written hearing conservation program could be improved for UNICOR recycling by specifying requirements for hearing protection for the recycling operations, defining the means of providing training in the hazard and control of noise as well as training content, specifying requirements for periodic monitoring, and specifying the means for informing workers of monitoring results and for record keeping. However, UNICOR at FCI Texarkana has reportedly implemented an on-going hearing conservation program that includes key elements of the OSHA noise standard. UNICOR should verify the effective implementation of this program (see Section 4.4).

3.3 Other Safety and Health Practices and Procedures

UNICOR has prepared a document titled "Heat Stress Program" dated 09/26/08. This latest program will be evaluated by FOH prior to the completion of the OIG investigation. The FCI Texarkana Factory Manager stated that some actions were taken to reduce heat exposure, such as installation of air conditioning in the glass breaking room, installation of box fans in roof locations in the general factory area, moving most outside operations to covered (shaded) areas, and some temperature monitoring. UNICOR should ensure that a heat exposure assessment is performed at FCI Texarkana in accordance with the requirements of its recently adopted Heat Stress Program.

As part of e-waste recycling operations, FCI Texarkana refurbished the plastic casing around computer monitors. According to the FCI Texarkana Factory Manager, this refurbishment involved sanding of the plastic in preparation for painting. This activity was discontinued in 2006. The Factory Manager stated that workers wore P-100 disposable, filter facepiece respirators for this activity, which are approved for toxic dusts with a protection factor of 10. UNICOR and FCI Texarkana did not conduct a hazard analysis for this operation prior to implementation. The Factory Manager stated that sample(s) were submitted for analysis, but records for sample type(s) and result(s) were not available at the time of this report.

Hazards associated with this activity include inhalation of fine dust particles and brominated flame retardants (BFRs), such as polybrominated diphenyl ethers (PBDEs). BFRs in general and PBDEs in particular are found in televisions and computers and have caused both scientific and public concern because they have been found to bioaccumulate in humans. One group that is potentially exposed to PBDEs is workers within electronic recycling facilities. [Pettersson-Julander, et.al. 2004] Elevated concentrations of PBDEs have also been observed in an electronics dismantling plant, where elevated serum levels of PBDEs have been documented. [Thuresson 2004]

Another operation performed at FCI Texarkana involved the removal of lead-containing solder from circuit boards in computer monitors and CPU components. In an August 2005 memorandum issued by the FCI Texarkana Safety Manager to the BOP Central Office Industrial Hygienist, details about this operation were provided along with the results of laboratory tests performed on the waste generated (i.e., removed solder). According to the report, the repair operation involved six workers, one of whom was dedicated full time to solder removal. The report indicated that circuits were heated with a soldering iron so that the solder could be removed via a 'home-made' vacuum collection system which drew the solder into a plastic jar located underneath the work bench. The report also indicated that workers wore approved eye protection, the room air was circulated using joist-mounted fans, and visible fumes and/or smoke from the desoldering were not observed during the Safety Manager's visit. Finally, the report stated that no air sampling had been conducted in this work area. (Based on a subsequent OIG interview in 2008, the current Factory Manager indicated that he believed air sampling was eventually done. However, a report of that sampling could not be located. The monitor/CPU repair operation was eventually halted due to lack of customers.)

As part of an overall safety and health program, UNICOR should develop a thorough hazard analysis program. This program should include baseline hazard analysis for current operations and job (activity-specific) hazard analyses for routine activities,

activities performed under an operations and maintenance (O&M) plan, non-routine activities, and new or modified activities. This applies to all UNICOR recycling factories.

4.0 FIELD INVESTIGATIONS AND MONITORING RESULTS

Several field investigations of FCI Texarkana e-waste recycling operations have been conducted since 2002. These investigations are listed below:

- A UNICOR consulting firm performed personal exposure and area air monitoring in October 2002 (see Section 4.1.1).

- A second consulting firm performed industrial hygiene (IH) evaluations of the recycling operations in September 2004, May 2005, May 2006, and December 2007. These evaluations included personal and area exposure monitoring and surface sampling. Some included LEV, ventilation, and noise testing (see Section 4.1.2).

- As part of UNICOR's annual monitoring program for its factories that was implemented in 2009, a UNICOR consultant performed exposure monitoring, surface testing, ventilation testing, and noise monitoring in April and June 2009 (see Sections 4.1.2 and 4.4).

- OSHA conducted an inspection in December 2006. FOH personnel were on-site in an observational capacity during the inspection. The OSHA inspection report is provided as Attachment 1 to this report (also see Section 4.1.3).

- As part of the DOJ OIG investigation, FOH conducted a field investigation in March 2007 to determine the extent of metal surface contamination on various building components and to conduct noise monitoring. FOH sampling results and observations are provided in this report and Attachments 2a and 2b (also see Sections 4.1.3, 4.2.2, and 4.4).

- As part of the DOJ OIG investigation, NIOSH/HETAB conducted an assessment of the medical surveillance program in July 2008. This assessment also included an exposure assessment. The NIOSH/HETAB report is provided as Attachment 3 (also see Sections 4.1.5 and 4.3).

- U.S. EPA conducted a Resource Conservation & Recovery Act (RCRA) Compliance Evaluation Inspection (CEI) in November 2008. [EPA 2009] This report is provided as Attachment 4 (also see Section 4.5).

Results of the UNICOR consultant studies, OSHA inspection, FOH studies, NIOSH/HETAB medical surveillance and exposure assessment, and U.S. EPA RCRA CEI are summarized and discussed in this section[6].

Metals of greatest interest for occupational exposures related to e-waste recycling include lead, cadmium, and barium. Beryllium can also be associated with e-waste materials and is also of interest because of its adverse health effects and low exposure limit. These metals were the focus of the field investigations. See the FCI Elkton report referenced in Section 1.0 for details regarding e-waste hazards.

Exposure monitoring results are compared to the legally enforceable permissible exposure limits (PELs) and action levels established by OSHA. In addition, non-mandatory ACGIH TLVs and NIOSH recommended exposure limits (RELs) are also provided for reference. Personal exposure limits are often based on 8-hour time weighted average (TWA) exposures and the TWAs are applicable to the exposures discussed in this report. Table 1 provides exposure limits for lead, cadmium, barium, and beryllium. PELs, action levels, and TLVs for other hazards can be found in OSHA standards (29 CFR 1910) and the 2009 ACGIH TLVs. [ACGIH 2009]

Table 1
Occupational Exposure Limits[1]

	LEAD ($\mu g/m^3$)	CADMIUM ($\mu g/m^3$)	BARIUM ($\mu g/m^3$)	BERYLLIUM ($\mu g/m^3$)
OSHA PEL	50	5.0	500	2[5]
OSHA ACTION LEVEL[2]	30	2.5	N/A	N/A
ACGIH TLV (Total Exposure)	50	10.0	500	0.05[4]
ACGIH TLV (Respirable Fraction)	N/A	2.0	N/A	N/A
NIOSH REL	50	*Ca*[3]	500	0.5

Notes:

1. All limits are based on an 8-hour time weighted average (TWA) exposure. NIOSH RELs are based on TWA concentrations of up to a 10-hour workday during a 40-hour workweek.
2. The action level is an exposure level (often around half of the PEL) that triggers certain actions, such as controls, monitoring, and/or medical surveillance under various OSHA standards.
3. *Ca* (Potential Occupational Carcinogen). NIOSH RELs for carcinogens are based on lowest levels that can be feasibly achieved through the use of engineering controls and measured by analytical techniques. [NIOSH 2005]
4. ACGIH TLV 2009 adoption.
5. OSHA also has 5 $\mu g/m^3$ ceiling and 25 $\mu g/m^3$ peak exposure limits.

[6] Given the many variables that may impact air sampling and exposure monitoring, testing data and findings can vary from one period to the next. Also, the findings, interpretations, conclusions and recommendations in this report may in part be based on representations by others which have not been independently verified by FOH.

Exposure standards for noise and heat are discussed in the sections below where results of the investigations are presented.

4.1 Investigations for Exposure to Toxic Metals

Given the various materials and components in e-waste, recycling activities have the potential to result in worker exposure to toxic metals including, in particular, lead and cadmium. The magnitude and potential health consequences of exposures are dependent on a number of factors such as workplace ventilation, work practices, protective equipment utilized (e.g., respirators, protective clothing, gloves, etc.), duration of exposures, and others. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, their relative toxicities, pertinent regulatory requirements, and other information.

Investigations that included evaluation of toxic metals exposure during FCI Texarkana's e-waste recycling operations are discussed below in chronological order of the studies. These investigations were conducted by UNICOR consultants, OSHA, FOH, and NIOSH/HETAB. As part of the OIG investigation both FOH and NIOSH/HETAB reviewed and evaluated UNICOR consultant reports. Commentary provided on these reports in Sections 4.1.1 and 4.1.2 consolidates both FOH and NIOSH/HETAB reviews.

4.1.1 UNICOR Consultant Monitoring and Sampling of October 2002

A consulting firm conducted a limited amount of sampling during routine operations at FCI Texarkana e-waste recycling facilities on October 24, 2002. This sampling included personal and area exposure monitoring, surface wipe sampling, and bulk dust sampling. Samples were analyzed for lead and cadmium. This sampling episode would have been conducted following relocation of the glass breaking area from the dairy barn to the FCI and prior to the construction of the current glass breaking room with LEV systems. Results are summarized below.

- Two personal exposure samples showed lead exposure at 23 $\mu g/m^3$ and 9.2 $\mu g/m^3$ and cadmium at exposure < 2.1 $\mu g/m^3$. Two area samples showed lead at 8 $\mu g/m^3$ and 13 $\mu g/m^3$, with cadmium at < 1.7 $\mu g/m^3$. Presumably these samples were collected in the glass breaking area, but the location and activity are not clearly identified. The lead exposures were below the action level and PEL, but the duration of the samples was not clear and TWA results were not provided (sample volumes were 480 liters). The higher lead result approached the action level if this result is an 8-hour TWA, however, the result is likely for a shorter duration. The cadmium detection limits were near the action level of 2.5 $\mu g/m^3$, which limits the data's usefulness to determine whether exposures were low or near important levels such as the action level.

- Six surface wipe samples were collected and analyzed. Surface lead results ranged from 8 µg/sample to 32 µg/sample. Cadmium ranged from <1 µg/sample to 4.1 µg/sample. Presumably the sampling areas were each 100 cm^2, although this is not specified. See Section 4.2 for a discussion of surface contamination guidelines and other surface monitoring results.

- A bulk sample, identified as "CRT Monitor" had a lead concentration of 3,810 mg/kg and cadmium less than the detection limit.

This report was very basic and simply provided sample locations, sample types, and results. Little discussion of the significance of the results was provided. No information or observations were provided regarding the work practices or hazard controls. No conclusions were provided regarding the exposures, except the statement that workers wore respiratory protection; therefore, "the levels detected do not pose an immediate health threat to personnel working in this operation."

4.1.2 Annual UNICOR Consultant Evaluations of 2004 through 2007

A different consultant conducted annual industrial hygiene evaluations of FCI Texarkana e-waste recycling operations in September 2004, May 2005, May 2006, and December 2007. In addition to exposure monitoring and surface sampling, some of these studies included noise and ventilation testing. The usefulness of these studies was limited by a lack of work practice and hazard control evaluations and lack of substantive interpretation of results, conclusions, and recommendations. Each of these evaluations is discussed below.

4.1.2.1 Consultant Evaluation of 2004

In September 2004, the consulting firm conducted an industrial hygiene evaluation. Personal exposure, area air, and surface wipe samples were collected during glass breaking and other activities. Samples were analyzed for lead, cadmium, barium, and beryllium. Results are presented below:

- Three personal breathing zone and two area air samples were collected in the glass breaking room during GBO. The highest lead exposure was 9.1 µg/m^3, which is less than the PEL of 50 µg/m^3 and action level of 30 µg/m^3. One of the personal exposures for cadmium was reported by the consultant to have exceeded the PEL and action level. This exposure was 7.4 µg/m^3, as compared to the PEL of 5 µg/m^3 and action level of 2.5 µg/m^3. In reality, this higher cadmium result for the three hour sample exceeded the action level but not the PEL when calculated as an 8-hour TWA exposure. All other samples were less than the cadmium action level.

- The consultant collected nine wipe samples in the "glass breaking and surrounding areas," six of which were from the skin (hands) and clothing of inmates working within the glass breaking area. In the narrative report, results are reported in "concentrations per square inch," but the report does not define the unit of "concentrations." The back-up data summary sheets show the units as µg, but do not define the surface area sampled. The consultant provided no discussion of the significance of these results.

The consultant reported that one of the personal exposures during glass breaking exceeded the cadmium PEL and action level, but did not provide information regarding the implications of this exposure (in reality this exposure was above the action level but below the PEL). For instance, actions required under the OSHA cadmium standard to respond to and reduce this exposure were not discussed, and no recommendations were made to mitigate exposures. In general, the consultant reported the airborne exposure results versus the OSHA PELs and action levels, but did not provide any analysis of work practices or controls and did not offer any recommendations. No analysis of surface contamination results was provided.

4.1.2.2 Consultant Evaluation of 2005

In May 2005, the same consultant conducted a similar industrial hygiene evaluation as in September 2004. Results are summarized below.

- Six personal breathing zone samples were taken in the glass breaking area during GBO (three in the morning shift and three in the afternoon shift for breakers and feeders). The consultant reported that the highest lead exposure was 9.8 $\mu g/m^3$, which was about the same as the highest lead exposure in the September 2004 monitoring episode. This level is below the lead PEL and action level. The highest cadmium personal exposure was 1.4 $\mu g/m^3$ for a two hour sample. These exposures appear to be for the duration monitored (i.e., about 2 hours), rather than 8-hour TWA exposures. The consultant reported that "continued exposure for the remainder of an 8-hour shift at this rate would result in an exposure that does not exceed the PEL, TLV, or action level."

- Area air samples taken in disassembly areas showed exposures to be well below the lead and cadmium PELs and action levels.

- Twelve surface wipe samples were collected in the glass breaking and surrounding areas. Six of these samples were collected from various factory surfaces and six were collected from the skin (hands) of inmates in the glass breaking area. Surfaces within the factory ranged in lead contamination from 0.174 $\mu g/in^2$ to 3.333 $\mu g/in^2$ (25.1 $\mu g/ft^2$ to 480 $\mu g/ft^2$). Cadmium ranged from 0.049 $\mu g/in^2$ to 0.278 $\mu g/in^2$ (7.1 $\mu g/ft^2$ to 40.0 $\mu g/ft^2$). The consultant provided no interpretation or information regarding the significance of these results.

- One surface wipe sample had detectable beryllium at 0.002 $\mu g/in^2$, which equates to about 0.03 $\mu g/100cm^2$. Although detectable, this level is less than the DOE Chronic Beryllium Disease Prevention Program (CBDPP) release criteria of 0.2 $\mu g/100cm^2$. Again, the consultant offered no interpretation of this result.

As in 2004, the consultant reported the airborne exposure results versus the OSHA PELs and action levels, but did not provide any analysis of work practices or controls and did not offer any recommendations. No analysis of surface contamination results was provided.

4.1.2.3 Consultant Evaluation of 2006

In May 2006, the same consulting firm that conducted surveys in 2004 and 2005 performed a third industrial hygiene evaluation. This evaluation was more comprehensive than the previous studies in that in addition to toxic metal airborne and surface testing, the evaluation included a noise survey, an evaluation of air flow patterns, and a ventilation survey for the glass breaking area. Results are summarized below.

- Six personal breathing zone exposure monitoring samples were collected for glass breakers and feeders. The highest lead exposure was 17 $\mu g/m^3$ for the duration sampled (about 2.5 hours), which is less than the lead PEL and action level. The consultant reported that two cadmium personal samples for breakers "exceeded the current action level for the time frames sampled" (2.9 $\mu g/m^3$ and 2.6 $\mu g/m^3$ versus the 2.5 $\mu g/m^3$ action level) but that "these samples would not exceed the action level as 8-hour TWAs due to the limited work schedules."

- Area air samples taken outside the glass breaking area on the factory floor where disassembly is performed were well below the lead and cadmium PELs and action levels.

- Ten surface wipe samples were collected, six of which were from workers' hands, two from areas inside the glass breaking room, and two from areas outside the glass breaking room. The narrative report discusses results in units of $\mu g/cm^2$, while the data table reports results as $\mu g/in^2$. The values are not corrected for units; therefore, it appears that these data are not properly reported. The consultant gave no interpretation regarding the significance of these results.

- The consultant evaluated air flow patterns in the glass breaking area. The consultant found that, in general, the air flow direction within the glass breaking area was toward the face of one of the glass breaking units. The air flow around the exterior perimeter (e.g., plastic strip walls) "was generally outward and away from the plastic wall of the breaking area." The consultant did not provide any discussion or interpretation as to the adequacy or inadequacy of this condition. FOH notes that this result could imply that air flow is out of the glass breaking room and into the factory at this location. If so, this is not a desirable condition, because airborne toxic metals dusts could be released from the glass breaking room through the plastic curtain and into the factory area. In the event that glass breaking operations resume at FCI Texarkana, UNICOR should further evaluate this condition to determine if air flow patterns are acceptable.

- The consultant also measured face velocities for each of four LEV systems that serve the glass breaking operation. The system face velocities were 433 feet per minute (fpm) (feeder ventilation unit outside the glass breaking room), 190 fpm (unit inside the glass breaking room), 133 fpm (left breaker ventilation unit), and 83 fpm (right breaker ventilation unit). The consultant did not provide any discussion or interpretation as to the adequacy or inadequacy of the individual systems or the systems as they operate together.

- The consultant also performed noise monitoring. The consultant reported that some exposures "may" exceed exposure limits established by OSHA. Some exposures were above the level that requires the implementation of a hearing conservation program, if they are representative of 8-hour TWA exposures. See Section 4.4 for a more detailed discussion of the consultant and FOH noise surveys.

As in 2004 and 2005, the consultant reported the airborne exposure results versus the OSHA PELs and action levels, but did not provide any analysis of work practices or controls and did not offer any recommendations. No analysis of surface contamination results was provided. Ventilation measurement results were presented, but no interpretation of the results and no recommendations were provided.

4.1.2.4 Consultant Evaluation of 2007

In December 2007, the same consulting firm performed a fourth industrial hygiene evaluation. This evaluation included exposure monitoring, surface wipe sampling, and testing of the LEV and ventilation systems. Results are discussed below.

- Six personal breathing zone exposure monitoring samples were collected for glass breakers and feeders. The highest lead exposure was 20 $\mu g/m^3$ for the duration sampled (about 2.5 hours), which is less than the lead PEL and action level. The highest cadmium exposure was 1.3 $\mu g/m^3$ for the duration sampled. As 8-hour TWA's, these results were well below the OSHA action levels and PELs. The highest lead exposure was comparable to 2006, while the highest cadmium exposure was less than half of the 2006 exposure.

- Area air samples taken outside the glass breaking area on the factory floor where disassembly is performed were well below the lead and cadmium PELs and action levels.

- Six surface wipe samples were collected from workers' hands and another six samples were collected from various areas of the recycling factory. The narrative report presents results in micrograms only, without providing a microgram per unit of area result that can be compared to surface contamination guidance. This requires UNICOR to explore the result tables in the appendices to calculate results that it can use. The consultant did report that hand samples collected after hand washing showed no detectable lead or cadmium contamination levels. The consultant gave no interpretation regarding the significance of the area surface results.

- The consultant evaluated air flow patterns in the glass breaking area. As in 2006, the consultant found that, in general, the air flow direction within the glass breaking area was toward the face of one of the glass breaking units. The air flow around the exterior perimeter (e.g., plastic strip walls) "was generally outward and away from the plastic wall of the breaking area." The consultant did not provide any discussion or interpretation as to the adequacy or inadequacy of this condition. FOH notes that this result could imply that air flow was out of the glass breaking room, through the plastic curtains, and into the factory at this location. If so, this was not a desirable condition, because airborne toxic metals dusts could have been be released from the glass breaking room through the plastic curtain and into the factory area. In the event that glass breaking operations resume at FCI Texarkana, UNICOR should further evaluate this condition to determine if air flow patterns are acceptable.

- The consultant also measured face velocities for each of four LEV systems that serve the GBO. The system face velocities were 543 feet per minute (fpm) (feeder ventilation unit outside the glass breaking room), 208 fpm (unit inside the glass breaking room), 165 fpm (left breaker ventilation unit), and 95 fpm (right breaker ventilation unit). The consultant did not provide any discussion or interpretation as to the adequacy or inadequacy of the individual systems or the systems as they operate together.

As in previous reports, the consultant reported the airborne exposure results versus the OSHA PELs and action levels, but did not provide any analysis of work practices or controls and did not offer any substantive recommendations. No analysis of area surface contamination results was provided. Ventilation measurement results were presented, but no interpretation of the results and no recommendations were provided.

4.1.2.5 Consultant Evaluation of 2009

On April 27-29, 2009, a UNICOR consultant performed air monitoring, surface testing, and ventilation testing at the FCI disassembly factory. On June 22, 2009, the consultant performed similar evaluations at the camp disassembly factory. The purpose of the air monitoring was to evaluate worker exposures to lead, cadmium, and beryllium during the recycling operations underway at the time. This evaluation was conducted as part of UNICOR's annual monitoring program implemented in 2009 for its factories. This monitoring did not include glass breaking, because all GBO at UNICOR factories was suspended in June 2009.

At the FCI, a total of nine personal air samples were collected on workers involved with various e-waste operations including metal recovery (copper and aluminum), sorting, disassembly, sweeping, and baling. At the camp, a total of eight area and personal air samples were collected from locations inside and outside the former glass breaking booth and on persons working in the sorting area, at disassembly tables, and in the CPU handling area. For both the FCI and the camp, the consultant's reports stated that all measured lead, cadmium, and beryllium air concentrations were well below allowable OSHA limits.

The UNICOR consultant also tested the air ventilation systems during the site visits. The consultant reported that both the FCI and camp factories used only exhaust fans and open doors to ventilate the areas. The consultant provided air flow measurements for the various exhaust fans being utilized. No conclusions or recommendations concerning the ventilation testing were provided.

Based on the evaluations performed, the consultant recommended that several types of disposable dust masks (N-95 or better) be made available to workers based on their personal preference and that Appendix D of the OSHA Respiratory Protection standard be provided to the workers voluntarily using the masks. The consultant further recommended that use of the masks should not be made mandatory and advised that the results of his testing be communicated to the workers monitored within 15 days of receipt.

The consultant also performed surface wipe and bulk dust sampling in areas where e-waste recycling is conducted. At the FCI factory, 21 samples were collected of which five recorded surface lead levels higher than the OSHA guidance level of 200 $\mu g/ft^2$ for clean areas. Of these five samples, ranging from 266 to 2,961 $\mu g/ft^2$, four were collected from work surfaces (tables and floors) while the fifth sample was from overhead mechanical surfaces (lights, beams, ductwork). At the camp factory, 20 samples were collected, of which three samples exceeded the OSHA guidance level for lead of 200 $\mu g/ft^2$ for clean areas. The three samples ranged from 409 to 1,003 $\mu g/ft^2$. One was from a work surface ("glass breaking booth floor"), while the other two were from elevated surfaces ("light above former glass breaking booth" and "beam above glass breaking booth"). For both factories, all cadmium and beryllium wipe sample levels were reported to be below EPA residential (non-workplace) guidance levels.

In addition to providing the testing results, the consultant's reports indicated that dry sweeping in the disassembly factories must be limited to the collection of larger parts and that floors need to then be HEPA vacuumed and mopped. Similarly, the reports stated that workstations (e.g., where computers/monitors and similar items are disassembled) need to be HEPA vacuumed and/or wet wiped more frequently. The camp report also provided the recommendation to clean the floor in the former glass breaking area "one more time." No recommendations were provided dealing with the contamination on the elevated surfaces.

The consultant did not document PPE or work practices in the reports. In addition, temperatures during the June evaluation were elevated, but the potential for heat exposure was not addressed. The consultant did conduct noise monitoring and these results are reported in Section 4.4.

4.1.2.6 Summary of Annual Consultant Evaluations-2004 through 2009

In summary, the annual UNICOR consultant industrial hygiene evaluations conducted in 2004, 2005, 2006 and 2007 provided important exposure monitoring data for the FCI Texarkana recycling operations. However, the usefulness of these evaluations was limited by the lack of analysis and discussion of work practices and hazard controls, along with the lack of conclusions and recommendations. Discussion of the significance of surface contamination and ventilation results is particularly lacking. NIOSH/HETAB characterized these evaluations as consisting of "a boilerplate letter with several appendices containing sampling data" (see Attachment 3). In addition, the consultant did not monitor non-routine activities (e.g., filter changes, among others).

The 2009 consultant reports did provide certain conclusions and recommendations which was an improvement over previous evaluations. However, the report did not provide an interpretation of the ventilation measurements, did not address the potential heat exposure condition in June, and did not fully document work practices and controls as stated in the purposes of his report.

UNICOR should ensure that as part of exposure monitoring episodes, its consultants also evaluate and report on work practices and hazard controls and provide appropriate conclusions and recommendations related to its findings. Non-routine activities should also be monitored.

4.1.3 OSHA Inspection of 2006

On December 14, 2006, OSHA performed air sampling for toxic metals at FCI Texarkana's recycling facilities. OSHA tested for 14 metals including cadmium, lead, barium, and beryllium. Personal samples for two glass breakers, a feeder, and a "teardown" (disassembly) worker were collected. All were reported as "ND" (not detectable). Results for individual metals were not reported, but presumably all 14 metals were ND.

Two surface samples were collected from a soft drink machine and snack machine. All metals tested were ND.

FOH notes that results from the UNICOR consultant monitoring of 2004, 2005, and 2006 showed detectable levels for lead and cadmium during glass breaking. For instance, cadmium in May 2006 was found by the consultant to be as high as 2.9 $\mu g/m^3$ for the duration sampled, and lead was as high as 17 $\mu g/m^3$ for the duration sampled. The OSHA report did not specify the detection limit for its sampling.

OSHA noted that glass breakers were protected with disposable coveralls, PAPRs, gloves and booties. Feeders wore disposable coveralls, work gloves, safety glasses, and particulate masks. Disassembly workers wore safety glasses, work gloves, ear plugs, and aprons, and some wore disposable particulate respirators voluntarily.

4.1.4 FOH Observations during the 2006 OSHA Inspection

FOH investigators accompanied OSHA during the December 2006 OSHA inspection. FOH observed OSHA inspectors as they performed their inspections, and participated in OSHA's entrance/exit briefings and other meetings. FOH also performed on-site inspections, interviews, and document reviews, independent of OSHA activities. FOH observations regarding work activities during its December site visit and the OSHA inspection included the following:

- CRTs were processed (broken) at a rate of about one every 1.5 to 2 minutes.

- The OSHA inspection did not include non-routine activities such as cleaning/replacing LEV HEPA filters or cleaning debris from accidentally broken CRTs.

- In and around the glass breaking area, dry sweeping occurred throughout the shift to keep any dust/debris from accumulating. Overall, the GBO appeared to be very clean and the LEV system seemed to be effective. Dry sweeping is specifically prohibited by OSHA lead and cadmium standards and resulted in an OSHA violation at FCI Lewisburg. OSHA did not issue such a violation at FCI Texarkana.

- At the end of the shift, HEPA vacuuming and wet mopping were carefully conducted. Water from wet mopping was dumped down the drain. Inmate workers sprayed and HEPA vacuumed containers as they were removed from the glass breaking area.

- Inmate workers discarded Tyvek® coveralls, but continued to wear their issued clothing that were underneath the Tyvek® coveralls. No special laundering was performed.

- Biological monitoring records were provided to OSHA, with identifiers redacted by the medical administrator. Testing is performed initially, annually, and upon discharge.

- FOH reported that hearing protection is required in factory areas, but that all elements of a hearing conservation program are not in place, specifically signage and a monitoring program including noise dosimetry. During the inspection, OSHA verbally suggested completing a noise dosimetry study. A more complete noise survey was conducted by a UNICOR consultant in 2007. [Note: As discussed in Section 3.2, UNICOR at FCI Texarkana has implemented key elements of a hearing conservation program, although improvements can be made.]

FOH followed up this site visit with a site evaluation in March 2007. Results for that study are provided in Section 4.2.2.

4.1.5 NIOSH/HETAB Exposure Assessment

As part of its evaluation of the FCI Texarkana medical surveillance program (see Section 4.3), NIOSH/HETAB conducted an exposure assessment of UNICOR's e-waste recycling operations on July 16, 2008. A total of eight personal breathing zone samples were collected during both morning and afternoon glass breaking shifts. Monitoring was performed for breakers and feeders. Five area samples were collected; one inside the glass breaking room, one in the change area, and the others in various areas outside the glass breaking room. In addition, 15 surface wipe and hand wipe samples were collected. All samples were analyzed for lead and cadmium. Results are summarized below and presented in detail in the NIOSH/HETAB report in Attachment 3.

- Personal breathing zone samples for breakers and feeders collected during the morning and afternoon shifts were well-below the OSHA action levels and PELs for lead and cadmium. Cadmium exposures for breakers ranged from 0.59 $\mu g/m^3$ to 1.7 $\mu g/m^3$ for the duration of exposure. Lead exposures for breakers ranged from 3.9 $\mu g/m^3$ to 7.0 $\mu g/m^3$ for the duration of exposure. As 8-hour TWAs, these exposures would be about 2.5 to 3.5 times lower than the values reported. Feeder exposures were less than breakers with all but one found at "trace" levels, which is detectable but less than the minimum quantifiable concentration.

- Two area air samples collected outside the glass breaking room during glass breaking were below the minimum detectable concentration for both lead and cadmium. A sample in the forklift traffic area was 0.13 $\mu g/m^3$ for cadmium and 1.8 $\mu g/m^3$ for lead. A sample in the change area was 0.25 $\mu g/m^3$ for cadmium and 1.5 $\mu g/m^3$ for lead. One area air sample taken on top of an air handler was 0.24 $\mu g/m^3$ cadmium and 1.5 $\mu g/m^3$ lead. These area samples are well below the OSHA action levels and PELs.

- A wipe sample from a locker in the change area had lead at 59 $\mu g/100cm^2$ (about 550 $\mu g/ft^2$). A change-out table in this area had comparable lead levels. Another locker wipe had lead at 31 $\mu g/100cm^2$ (about 290 $\mu g/ft^2$). These levels are above the OSHA guideline for clean areas of 200 $\mu g/ft^2$ and indicate that some lead was being transported from the glass breaking area.

- Wipe samples collected from the floor in and near the forklift traffic areas where Gaylord boxes are removed from the glass breaking area were as high as 90 $\mu g/100cm^2$ (about 830 $\mu g/ft^2$). This indicates that some contamination was being carried out of the glass breaking room despite work practice controls that were implemented to prevent/reduce this carry out (see Attachment 3 for details).

- Hand wipe samples collected at the end of the shift after hand washing suggested that hand washing removes most, but not all contaminants. Glass breakers should be encouraged to wash hands thoroughly to remove contamination.

[Note: See Attachment 3 for additional surface wipe sample results and discussion.]

As part of its study, NIOSH/HETAB also evaluated past industrial hygiene exposure monitoring and surface sampling conducted by UNICOR consultants, OSHA, and FOH. These studies were the same as those discussed in Sections 4.1, above and 4.2, below. NIOSH/HETAB's analyses of the consultant studies are consistent with the FOH review, and results from both reviews are provided in Section 4.1 of this report. See Attachment 3 for further information regarding NIOSH/HETAB findings for past studies.

NIOSH/HETAB reported on the engineering controls put in place at FCI Texarkana to control lead and cadmium emissions. Two LEV systems controlled dust emissions at the panel and funnel glass breaking stations. These were stand-alone HEPA filtered ventilation units. Plastic strip curtains provided a partial barrier between the worker and the CRT where it was broken. Two additional HEPA ventilation units provided general air filtration to remove dust from the glass breaking room. In 2007, air conditioning units were installed in the glass breaking room, and four exhaust fans were installed on opposite walls on the factory, outside the glass breaking room. Pre-filters installed in the HEPA units were changed weekly. Each unit's HEPA filter was changed annually by inmates wearing PPE. This process involved removing the pre-filter, HEPA vacuuming accessible surfaces, removing the HEPA filter, and sliding the filter into a plastic bag which was then double-bagged for disposal. Based on a review of all UNICOR consultant reports, the filter change-out activities have never been monitored at FCI Texarkana for lead and cadmium exposures. [Note: As noted by NIOSH/DART in reports for other UNICOR factories, the frequency of filter change-outs should be based on pressure drop across the filters rather than on an arbitrary schedule.]

PPE for breakers and feeders included hearing protection, Tyvek® suits, Kevlar® sleeves, Kevlar® gloves, and steel-toe footwear. In addition, glass breakers wore PAPRs with HEPA filters. Feeders remained outside of the glass breaking room and did not wear PAPRs, but wore safety glasses for eye protection instead of the PAPR faceshield.

Workers donned PPE in the change-out area. At the end of the shift, workers removed their PPE in this same area. At the time of NIOSH/HETAB's site visits workers stored PAPRs and other PPE in a single locker. After NIOSH/HETAB's July 2008 site visit, new lockers were installed so that workers could store PAPRs separately from other PPE to reduce the opportunity for residual dusts from gloves and other PPE to contaminate PAPRs.

NIOSH/HETAB recommended improvements to the change room, PPE practices, and decontamination processes. Specifically, NIOSH/HETAB recommended that separate storage be provided for non-work uniforms and GBO work apparel/PPE. All potentially contaminated work clothing and PPE should remain in the "dirty" chamber of the change room and non-work clothing should not come in contact with work items. Workers should be required to wash their hands and any exposed skin after doffing PPE and before putting on uniforms when exiting the GBO. Work clothes and PPE should never be worn outside the GBO. Laundry personnel should be made aware of the potential exposure to lead and cadmium from work clothes and take action to minimize exposure to themselves.

NIOSH/HETAB concluded in its summary of its exposure assessment for FCI Texarkana recycling operations as conducted in July 2008, that air samples were well below the OSHA action levels and PELs for lead and cadmium. NIOSH/HETAB further concluded that the low airborne concentrations indicated that the HEPA units (i.e., LEV systems in the glass breaking room) were effective at removing cadmium and lead dusts at the point of generation and therefore prevented the dusts from entering workers' breathing zones. Nevertheless, surface contamination deposited in the glass breaking room indicated that contaminated dusts escaped capture by the LEV systems in sufficient quantities to build up on surfaces (see Section 4.2.2). Based on surface wipe sampling, NIOSH/HETAB also concluded that despite existing work practice controls, some levels of lead and cadmium contamination were being carried out of the glass breaking room. Hand wipe results indicated the need for rigorous hand washing practices. These findings emphasize the continued importance of vigilant personal hygiene, housekeeping, and cleaning practices, as well as improved work practices to limit carry-out of contamination.

[Note: See Section 4.3 for results of the NIOSH/HETAB evaluation of the medical surveillance program, as well as conclusions regarding exposures from operations conducted prior to 2004.]

4.2 Surface Wipe and Bulk Dust Sample Results

As part of the OIG investigation, FOH conducted bulk dust and surface wipe sampling at FCI Texarkana in areas where e-waste recycling is performed. Samples were analyzed for total lead, cadmium, and other toxic metals. In addition, some bulk dust samples were analyzed using the Toxic Characteristic Leaching Procedure (TCLP) to determine whether contamination should be treated as hazardous waste. Available guidance to evaluate surface sample results are discussed below in Section 4.2.1. Results for the surface wipe, bulk dust and TCLP samples are discussed in Section 4.2.2, below.

4.2.1 Guidance for Evaluating Surface Samples

Federal standards or other definitive criteria have not been developed for acceptable levels of lead or cadmium surface contamination or dust concentrations in industrial areas where activities are performed involving lead and/or cadmium bearing materials. However, several recommendations or guidelines, primarily for lead, provide points of reference to subjectively evaluate the significance of surface contamination. Some guidelines are available and are noted below (see the NIOSH/DART Elkton report for a more detailed discussion of guidelines):

- OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace (i.e., 29 CFR 1926.62) can be summarized and/or interpreted as follows: all surfaces shall be maintained as 'free as practicable' of accumulations of lead; the employer shall provide clean change areas for employees whose airborne exposure to lead is above the PEL; and the employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination. The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of the Department of Housing and Urban Development's (HUD) initially proposed decontamination guideline of 200 $\mu g/ft^2$ for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas. In situations where employees are in direct contact with lead-contaminated surfaces, such as working surfaces or floors in change rooms, storage facilities, and lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level.

- For other surfaces (e.g., work surfaces in areas where lead-containing materials are actively processed), OSHA has indicated that no specific level can be set to define how no "clean is clean" or what level of lead contamination meets the definition of "practicable." Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of lead dust does not become a source of employee lead exposures. OSHA [29 CFR, Part 1910.1025] has stated that any method that achieves this end is acceptable.

- Lange [2001] proposed a clearance level of 1,000 $\mu g/ft^2$ for floors of non-lead free commercial buildings and 1,100 $\mu g/ft^2$ for lead-free buildings. These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions.

- HUD [24 CFR 35] has established clearance levels for lead on surfaces after lead abatement. These levels range from 40 to 800 $\mu g/ft^2$, depending on the type of surface. The level of 200 $\mu g/ft^2$ is most commonly used. These levels, however, apply to occupied living areas where children reside, and are not intended for industrial operations.

- Regarding lead in bulk dust or soil samples, the U.S. EPA [EPA n.d.] has proposed standards for residential soil-lead levels. The proposed level of concern requiring some degree of risk reduction is 400 ppm (mg/kg), and the proposed level requiring permanent abatement is 2,000 ppm (mg/kg). Again these levels are for residential settings, rather than for industrial settings.

- There is no quantitative guidance for surface cadmium concentrations. OSHA [40 CFR 745.65]states that surfaces shall be as free as practicable of accumulations of cadmium, all spills and sudden releases of cadmium material shall be cleaned as soon as possible, and that surfaces contaminated with cadmium shall be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne.

The discussion regarding surface wipe and bulk dust sample results is presented below in context of these available recommendations and guidelines.

4.2.2 FOH Surface Wipe, Bulk Dust, and TCLP Results

During its March 2007 field investigation, FOH collected surface wipe and bulk dust samples from various locations in the FCI Texarkana recycling facilities both inside the glass breaking room and in the general factory and associated areas. Samples were analyzed for lead and cadmium. Bulk samples were either analyzed for total lead and cadmium or extractable TCLP lead and cadmium for comparison to hazardous waste disposal criteria. Summary results for these samples are presented below (see Attachments 2a and 2b for complete results).

- Seven surface wipe samples were collected from various locations inside the glass breaking room. Five of the samples were from horizontal surfaces, such as the top of air handling units (AHUs) and tables. These samples ranged from 2,000 $\mu g/ft^2$ to 17,000 $\mu g/ft^2$. The two highest samples were from grooves at the back of the AHUs. Cadmium ranged from 220 $\mu g/ft^2$ to 2,700 $\mu g/ft^2$ for these samples. The other two samples were from horizontal plastic strips/sheeting and had lead concentrations of 50 $\mu g/ft^2$ and 220 $\mu g/ft^2$. The five horizontal surface levels are elevated but are contained within the glass breaking room. The data indicate, however, that lead and cadmium emissions occurring from the GBO were not completely captured by the AHUs (LEV systems). The data also confirm the importance of continued and vigilant cleaning of this area and the importance of controlling any potential for carry-out of contamination.

- Seven surface samples were collected from lockers. These samples ranged from 170 $\mu g/ft^2$ to 480 $\mu g/ft^2$ for lead and from 7 $\mu g/ft^2$ to 40 $\mu g/ft^2$ for cadmium. Five of the six samples were above the OSHA lead guideline for clean areas of 200 $\mu g/ft^2$ and one sample was at this level. These results are comparable to locker surface wipe results found by NIOSH/HETAB (see Section 4.1.5). The results indicate that some contamination was being carried out from the glass breaking room.

- A surface wipe sample collected from a lift that carries Gaylord boxes into the glass breaking room was at 3,900 $\mu g/ft^2$ lead. This shows elevated contamination levels. It is consistent with forklift area samples collected by NIOSH/HETAB that showed some contamination is being carried out of the glass breaking room. This sample emphasizes the need to clean materials and equipment leaving the glass breaking room.

- Two floor samples outside the glass breaking room had lead at levels of 13 μg/ft^2 and 27 μg/ft^2 and cadmium at 1 μg/ft^2. These levels are well below the OSHA lead guideline for clean areas of 200 μg/ft^2. A sample outside the glass breaking room on top of a heating, ventilating, and air conditioning (HVAC) system had lead at 480 μg/ft^2 and cadmium at 70 μg/ft^2. This sample indicates that elevated surfaces outside the glass breaking room are subject to build up of contamination because they are not subject to the same cleaning regimen as areas such as floors and work surfaces.

- Two bulk samples (split samples) were collected from a cable box near the former glass breaking area in the basement of the UNICOR factory in the FCI. These samples had elevated levels of lead (over 3,000 mg/kg) and cadmium (over 7,000 mg/kg). Although this dust was contained within the box, these results indicate significant release of contamination from former GBO. A tunnel exists in this area that runs from the FCI basement to the power plant. Based on the above samples, this and other nearby areas could also be contaminated. The FCI Safety Specialist believed that this area was cleaned; however, UNICOR should evaluate the extent of contamination in these areas and take any necessary actions for further clean-up or remediation, based on results.

- A bulk sample of dry sweepings of material around disassembly areas showed lead at 2,000 mg/kg and cadmium at 160 mg/kg. These levels are significant enough that UNICOR should determine proper disposal methods for this material per TCLP testing. Dry sweeping should be avoided to prevent creating an airborne hazard. Improved cleaning and housekeeping practices should be implemented.

- Four bulk and two liquid samples were collected for TCLP analysis to determine proper disposal status versus U.S. EPA RCRA regulations for hazardous waste (see Table 2 for TCLP criteria). A glove, a waste glass box sample, and two mop rinse water samples were found to contain extractable lead and cadmium at levels below the TCLP criteria shown in Table 2.

Table 2
Maximum Concentration of Selected Contaminants
for the Toxicity Characteristic[1]

Contaminant	TCLP Regulatory Level
Arsenic	5.0 mg/L
Barium	100.0 mg/L
Cadmium	1.0 mg/L
Chromium	5.0 mg/L
Lead	5.0 mg/L
Mercury	0.2 mg/L

[1][40 CFR 261.24].

- Two samples from boxes under the AHUs showed differing results. The funnel glass box was less than the TCLP criteria for lead and cadmium, but the panel glass box showed lead at 55 mg/L which is 11 times greater than the lead TCLP criteria, while cadmium was not detectable. It is unclear whether the type of glass is the cause of this difference.

FOH surface wipe testing indicates that lead and cadmium contamination was released inside the glass breaking room and contaminants accumulated on elevated surfaces. Although the LEV system appeared to be effective in maintaining airborne personal exposures below the OSHA PEL and action levels, it did not capture all emissions and surface dust accumulations resulted. This contamination is generally contained within the glass breaking room, but vigilant cleaning and housekeeping is required to keep levels in check. FOH surface wipe data in locker areas, on lifts, and on other surfaces outside the containment area also support the NIOSH/HETAB conclusion that some carry out of contamination occurred despite work practices that were put in place to limit this event (see Section 4.1.5 and Attachment 3 for NIOSH/HETAB findings).

UNICOR and FCI Texarkana should implement an operations and maintenance (O&M) plan to limit contact with existing lead and cadmium contamination, limit its accumulation (especially if the GBO is resumed), prevent and/or control any releases of the contamination to the air, and generally prevent potential for inhalation and ingestion (i.e., hand-to-mouth contact) exposure. Further surface testing should be periodically conducted to ensure that surface contamination levels do not increase over time, and to take preventive and corrective action should levels start to build up. With proper controls established, this O&M plan could include periodic clean-up of surfaces not subject to routine cleaning by inmate or other workers. Elements of an O&M plan are discussed in Section 6.0, Recommendations.

Should UNICOR permanently discontinue GBO at FCI Texarkana, the glass breaking room and LEV systems should be fully decontaminated and decommissioned in a manner that ensures control of the lead and cadmium hazards. Any decommissioning of the glass breaking room and LEV systems should be preceded by additional thorough cleaning/remediation followed by surface wipe testing to verify surfaces are adequately free of contamination. These processes should be conducted using appropriate hazard control and verification measures (see Section 6.0 for more information regarding necessary steps for system decommissioning).

UNICOR should conduct surface wipe and bulk dust sampling to also evaluate contamination levels in the areas in and around the former glass breaking area that did not have the level of engineering and other hazard controls used in the current glass breaking room. This includes the old dairy barn and the tunnel running from the FCI basement to the power plant, even though the Safety Specialist thought the latter area had been cleaned. Clean-up, remediation, O&M, and other appropriate hazard control measures should be implemented based on results.

4.3 Assessment of the Medical Surveillance Program

As part of the DOJ/OIG investigation, NIOSH/HETAB assessed the existing medical surveillance program for inmates and staff exposed to lead and cadmium during e-waste recycling at FCI Texarkana. NIOSH/HETAB conducted a site visit in July 2008 to conduct this assessment. Results are summarized below and are presented in detail in the NIOSH/HETAB report provided in Attachment 3.

- Medical surveillance began in late 2003 for inmates performing GBO (about two years after the initiation of GBO). It is performed annually by the FCI clinic and consists of limited biological monitoring, a medical and occupational history questionnaire, and respirator clearance. Biological monitoring consists of blood lead levels (BLL), blood cadmium (CdB), urine cadmium (CdU), urine beta-2-microglobulin (B-2-M), and zinc protoporphyrin (ZPP). Preplacement testing is performed on inmates prior to being cleared for glass breaking work, with the exception of those already breaking glass when surveillance began.

- Preplacement BLLs for 13 inmates who performed glass breaking ranged from 1.1 to 5.0 micrograms per deciliter (μg/dL) with one below the limit of detection (LOD). Of the 17 periodic or termination BLLs, eight were below the LOD and the other nine ranged from 1.2 to 2.4 μg/dL. One inmate who worked in the GBO since 2001 had a BLL below the LOD in March 2004. Another had a BLL of 5 μg/dL in August 2002 which reflects exposure prior to the installation of the current glass breaking room with LEV which was implemented in May 2004.

- Of 24 preplacement CdB tests, 18 were below the LOD and the remainder ranged from 1.1 to 6.6 μg/L. Two inmates with the highest levels were not cleared to perform glass breaking. Of 28 periodic or termination CdB tests, 23 were less than the LOD and the remainder ranged from 0.5 to 2.5 μg/L. Two inmates (both smokers) who performed glass breaking since 2001 had CdB levels of 1.8 μg/L and 2.5 μg/L. Another (a non-smoker who had stopped breaking and then restarted) had a CdB level that was less than the LOD. NIOSH/HETAB cannot determine if the higher levels were due to smoking which is known to increase CdB levels. For the inmates as a whole, smokers had on average higher CdB levels than non-smokers.

- Of 24 pre-placement CdU tests, the 10 above the LOD ranged from 0.29 to 2.2 micrograms per gram of creatine (μg/g/Cr). Of 20 periodic or termination CdU results, the five above the LOD ranged from 0.3 to 1.3 μg/g/Cr. The half-life of cadmium in urine is years to decades; therefore, the results indicate exposure over time. Of the three inmates who performed glass breaking since 2001, the highest result was 0.61 μg/g/Cr. OSHA defines acceptable CdU as less than 3 μg/g/Cr.

- All 38 urinary B-2-Ms and all 26 ZPPs were normal.

- One inmate claimed to have been removed from glass breaking due to abnormal test results. In late 2003, his CdB was 6.2 μg/L, CdU and B-2-M were below the LOD, and BLL was 4 μg/dL. OSHA defines acceptable CdB as less than 5 μg/L. His chart noted that tests were to be repeated in six weeks, but this was not done. NIOSH/HETAB noted that it was unclear whether the tests represent significant exposure to cadmium or laboratory error, given the elevated CdB result, but low CdU result. After the NIOSH/HETAB site visit, retests of this inmate showed that CdB was 1.0 μg/L and CdU 0.8 was μg/g/Cr.

- Questionnaires from 41 inmates revealed no medical complaints that could be related to recycling. Medical records for two inmates reported to have serious medical problems secondary to work in recycling were reviewed. Causes for their medical problems were not related to recycling.

- Medical surveillance is performed for UNICOR staff by their private physicians so their exams are not standardized. Biological monitoring results for staff were unremarkable. Two initial or annual questionnaires reviewed did not note any medical complaints that could be related to recycling work.

Overall, NIOSH/HETAB found that the results of biological monitoring for both staff and inmates were generally unremarkable. However, medical staff should follow up on any abnormal test results in a timely manner. Any abnormal test result that is unexpected should be repeated. The elevated pre-placement CdB results for more than one inmate are examples of abnormal tests that should be repeated. If follow up results remain abnormal, then a cause should be determined.

NIOSH/HETAB concluded that recycling at FCI Texarkana was performed from late 2001 to May 2004 without appropriate engineering controls, respiratory protection, medical surveillance, and industrial hygiene monitoring. Sparse biological monitoring and industrial hygiene data during this period precludes quantification of exposures to lead and cadmium. The glass breaking room in use immediately prior to suspension of GBO (with LEV system and other hazard controls) was considered a significant improvement with respect to controlling worker exposure to lead and cadmium.

According to NIOSH/HETAB, since May 2004, employee exposures have been sufficiently low that OSHA-mandated medical surveillance has not been required. Based on existing records and current operations, medical surveillance can be discontinued for inmates and staff performing glass breaking (should GBO be resumed), disassembly, and other recycling operations. At UNICOR's discretion, it can continue the limited biological monitoring that is currently in place as an additional safeguard against excessive exposure, and as a reassurance to staff and inmates.

NIOSH/HETAB also provided recommendations to improve worker protection practices for staff and inmates. Among others, these recommendations included an ongoing environmental and exposure monitoring program, continued use of PAPRs for glass breaking, cleaning and housekeeping improvements, hygiene improvements, PPE use and storage improvements, and job hazard analysis implementation. See Attachment 3; Section 4.1.5, NIOSH/HETAB Exposure Assessment; Section 5.0, Conclusions; and Section 6.0, Recommendations for further information on the NIOSH/HETAB medical surveillance evaluation and exposure assessment study.

4.4 Investigations for Noise Exposure

For this report, FOH reviewed noise monitoring measurements taken by a UNICOR consultant in May 2006, another UNICOR consultant in February 2007, and another in 2009. In addition, as part of the OIG investigation, FOH conducted a limited amount of noise monitoring during its site visit of March 2007. Results of these studies are presented in this section.

In May 2006, a UNICOR consultant collected area sound level measurements in various inside and outside locations of the FCI Texarkana recycling facility. Measurements were taken with a sound level meter and were "instantaneous" area measurements and did not represent personal exposure dosimetry (i.e., 8-hour TWA results). Of the 15 measurements reported (not including peak impact levels), three were above 85 dBA which is the 8-hour TWA exposure at which OSHA requires implementation of a hearing conservation program. This program includes audiometric testing, hearing protection, training, and other protective measures such as engineering or administrative controls when exposures exceed 90 dBA. The three activities with levels above 85 dBA included "inside UNICOR downstairs monitor sanding," "inside UNICOR upstairs pallet assembly area," and "outside UNICOR breaker station." Overall, the consultant found that "based on this data, personal exposure in some parts of the facility may exceed the exposure limits established by OSHA." The consultant offered no recommendations to address these findings, but did state that OSHA required a hearing conservation program when exposures equal or exceed 85 dBA as an 8-hour TWA.

In February 2007, another UNICOR consultant performed a noise assessment to profile noise exposures throughout the UNICOR recycling factory. Again, sound level measurements were taken rather than personal noise dosimetry. Results are summarized below.

- In the "Camp Recycling Warehouse," the glass booth and the component disassembly area were reported to be "borderline hazardous" for noise. The consultant stated that personnel in both of these areas need to be enrolled into the facility's hearing conservation program. The consultant also recommended implementation of acoustic engineering controls, but if not feasible, then hearing protection should be utilized.

- In the "Camp Compactor Shed," the immediate area around the baler was reported to be "noise hazardous" while the baler(s) are in operation, and the personnel assigned to this area "must" be enrolled in the facility's hearing conservation program. Again, acoustic engineering controls were recommended, but if not feasible, then hearing protection should be utilized.

- In the "Industrial Building," the entire west half of the building encompassing the pallet manufacturing, electronic demanufacturing, and the copper stripping areas was reported to be "noise hazardous" when pallet manufacturing is in process. The consultant stated that personnel in this area "must" be enrolled into the facility's hearing conservation program. Again, acoustic engineering controls were recommended, but if not feasible, then hearing protection should be utilized. Also in this building, similar findings and recommendations were reported for the compactor baler area west of the loading dock when the balers are in operation.

In summary, the consultant found various operations and work areas that require worker protection in accordance with the OSHA noise standard, 29 CFR 1910.95, Occupational noise exposure. Protective measures involve the implementation of a hearing conservation program for exposed workers that includes such elements as audiometric testing, training, hearing protection, monitoring program, and record keeping. The consultant recommended enrollment in a hearing conservation program, along with other controls, but did not discuss the current status of such requirements.

In March 2007, FOH conducted a limited noise survey of the GBO at FCI Texarkana. Four personal noise dosimetry samples were collected, two for breakers working inside the containment area and two for feeders working outside the containment area. The two breakers inside the containment area had noise exposures at about 87 dBA as an 8-TWA, while the two feeders were at about 73 dBA and 74 dBA. The breaker exposures were above the OSHA action level for noise. These data are consistent with that found by the UNICOR consultant in February 2007.

In April 2009 as part of UNICOR's annual monitoring program, a UNICOR consultant conducted personal noise dosimetry to evaluate noise exposures during various e-waste recycling operations taking place at the FCI Texarkana Prison disassembly factory. A similar evaluation was performed by the consultant at the Camp e-waste disassembly factory in June 2009.

At the FCI factory, noise doses were obtained from six workers involved in various activities judged to have the potential to exceed OSHA action levels including working at e-waste teardown tables, operating a baler, and working at an aluminum recovery work station. The determined noise exposures ranged from approximately 12 to 52 percent of the OSHA PEL, with only an employee from the aluminum recovery operation recording a dose in excess of the OSHA hearing conservation action level (i.e., 50 percent of the PEL or 85 dBA as an 8-hour TWA). The consultant's report recommended that all of the workers in the aluminum recovery area be included in a hearing conservation program that includes annual training, audiometric testing, and other requirements as defined by OSHA (see 29 CFR 1910.95).

At the camp factory, noise doses were obtained from five inmates working at e-waste handling tables, operating a baler, and driving a forklift. With the determined noise exposures of ranging from approximately 13 to 48 percent of the OSHA PEL, none of the workers recorded a dose in excess of the OSHA hearing conservation action level. However, three of the five measurements (i.e., forklift operator and workers at two tables) approached this limit.

According to the FCI Texarkana Factory Manager and as discussed in Section 3.2, above, a hearing conservation program is in place at FCI Texarkana. Hearing protection is required, audiometric testing is performed annually, and training is provided. The UNICOR consultants of 2006 and 2007 seemed to be unaware of the hearing conservation program and implementation status based on the comments and recommendations in their reports. For instance, they did not acknowledge the implementation of the hearing conservation program and did not evaluate its implementation status. The UNICOR consultant of 2009 recommended that certain workers be enrolled in a hearing conservation program, but also did not acknowledge the Factory Manager's claim to FOH that such a program was in place for all factory workers. UNICOR should verify that a hearing conservation program is in place at FCI Texarkana.

4.5 Environmental Issues

FOH conducted a review of available documents pertaining to environmental issues associated with the current (i.e., from 2003) e-waste recycling operations conducted by UNICOR at FCI Texarkana. In particular, FCI Texarkana's written Hazardous Waste Program was reviewed along with a report prepared by the U.S. Environmental Protection Agency (EPA) summarizing results from a Resource Conservation and Recovery Act (RCRA) Compliance Evaluation Inspection (CEI) conducted November 18-19, 2008.

FCI Texarkana's written Hazardous Waste Program has the stated purpose of "providing a safe and healthy work environment for all staff and inmates and to provide procedures and guidelines for the disposal of hazardous waste". The document indicates a 'Reviewed On' date of July 26, 2007 and references various directives including BOP's August 16, 1999 Program Statement, Occupational Safety and Environmental Health Manual (1600.8), along with a number of federal EPA regulations dealing with hazardous waste, employee alarm systems, and emergency and fire prevention plans. Also included in the document are procedures for determining whether a solid waste must be classified as hazardous together with a number of FCI Texarkana processes or activities that have the potential to produce hazardous waste (e.g., "maintenance of motor vehicles", "construction, renovation, and maintenance activities", "manufacturing or refinishing furniture", among others). Additionally, the program states that a department "may accumulate up to 55 gallons of hazardous waste at satellite accumulation points" and identifies two such points at FCI Texarkana (i.e., the paint shop and the health services infectious waste storage closet). No specific mention is made of wastes associated with e-waste recycling. The Hazardous Waste Program also specifies a number of requirements dealing with hazardous waste weight determination, accumulation and storage (containers, labeling, incompatibilities, emergency contingencies, etc.), transportation, manifesting, record keeping and reporting, and training. It states that the

Facilities Landscape Foreman has been designated as the Hazardous Waste Storage Site Coordinator (HWSSC) at FCI Texarkana and identifies a number of responsibilities for this position relating to the above-referenced requirements, some shared with the Safety Manager.

A review was performed of EPA's RCRA CEI report and associated correspondence. The CEI was conducted by a team of EPA officials accompanied by representatives of the DOJ OIG. The purpose of the inspection was to observe and review the facility's solid and hazardous waste management practices, specifically as they pertain to RCRA. Included in the scope of the inspection were e-waste breakdown and recycling facilities located in the UNICOR warehouse of the satellite (camp) area and the recycling factory within the FCI. EPA also inspected other operations at FCI Texarkana including the filter manufacturing factory, a general vehicle maintenance facility, electrical shop, machine shop, a municipal trash area, and an on-site power plant.

Based on EPA's CEI, waste streams associated with the e-waste recycling operations include spent HEPA filters from the air filtration units inside the glass breaking area, filters and dust collection bags from the portable vacuums used to clean up associated dusts, and used PPE (e.g., disposable gloves) from workers in the glass breaking area. Laboratory data provided by FCI Texarkana showed the spent HEPA filters and disposable gloves to be characteristically hazardous for Lead (D008). Further, EPA inspectors learned that FCI Texarkana sometimes receives used electronic equipment containing mercury. At the time of the EPA inspection, FCI Texarkana had one 5-gallon bucket of mercury/electronic components labeled as universal waste and ready for shipment. All hazardous and non-hazardous wastes stemming from the e-waste recycling operations were reportedly collected by Safety-Kleen Systems and transported to a Safety-Kleen Systems facility for processing.

Several areas of concern were documented in EPA's inspection report. Specifically, findings indicated that spent filters generated from the GBO had been disposed of in the past as non-hazardous waste (i.e., prior to FCI Texarkana's submittal of samples to a laboratory for a Toxicity Characteristic Leaching Procedure (TCLP) analysis which showed these spent filters to be characteristically hazardous for Lead (D008) and Chromium (D007)). Also, based on inspection of the GBO and related facilities, an open Gaylord box was observed inside the glass breaking room storing spent filters and PPE (found to be characteristically hazardous for lead and/or chromium) but lacking the requisite "hazardous waste" labels and accumulation dates. The EPA cited the following regulations pertinent to these findings:

- 40 CFR 265.173(a)—a container holding hazardous waste must always be closed during storage, except when necessary to add or remove waste;
- 40 CFR 262.34(a)(2)—a generator may accumulate hazardous waste on-site for 180 days or less without a permit provided the date upon which each period of accumulation begins is clearly marked and visible for inspection on each container; and

- 40 CFR 262.34(a)(3)—a generator may accumulate hazardous waste on-site for 180 days or less without a permit, provided that while being accumulated on-site, each container is labeled or marked clearly with the words "hazardous waste".

Also, EPA inspectors observed an unlabeled 30 gallon steel container in the recycling factory which was reported by FCI Texarkana staff to contain used oil. EPA cited the following regulation pertinent to this finding:

- 40 CFR 279.22(c)(1)—containers and aboveground tanks used to store used oil at generator facilities must be labeled or marked clearly with the words "Used Oil".

The EPA inspection report also provided findings dealing with the non-e-waste recycling operations at FCI Texarkana. Specifically, the report noted the presence of unlabeled 30-gallon steel containers storing spent xylene and paint waste in the Facilities Area generated from paint spray gun cleaning activities. The Texas Commission on Environmental Quality's (TCEQ) Texas Administrative Code (TAC) section 335.262(c)(2)(F) was cited which requires that such wastes be labeled with the words "Universal Waste – Paint and Paint Related Waste." Also in the Facilities Area, FCI Texarkana staff stated than the spent "black beauty" sand from a sand blasting machine was to be disposed of in the municipal trash without the required testing to determine the whether it should be handled as a RCRA hazardous waste.

At the time of the inspection, EPA determined that the BOP had potentially mischaracterized the generator status of FCI Texarkana by reporting it as a Conditional Exempt Small Quantity Generator (CESQG). As a result of the inspection, EPA potentially found FCI Texarkana to be a Small Quantity Generator (SQG) because it was estimated to generate between 220 and 2,200 pounds of hazardous waste per month, primarily from e-waste recycling, painting, machining, and general cleaning activities. EPA also determined that FCI Texarkana generates universal waste from other areas of the FCI.

Subsequent to the CEI inspection and as a result of supplemental information related to EPA's inspection findings that included information the BOP provided to EPA on March 23, 2009, a response to an EPA RCRA information request on July 30, 2009, telephone discussions with the FCI's waste contractor, Safety-Kleen Systems, and other pertinent information, a RCRA Enforcement Officer from the Hazardous Waste Enforcement Branch, EPA Region 6, issued correspondence to FCI Texarkana stating the EPA has determined that FCI Texarkana, including all UNICOR operations conducted at the prison, is currently a CESQG and is therefore exempt from RCRA regulations. The correspondence letter further noted that should the generator status change the prison would become subject to RCRA regulations.

5.0 CONCLUSIONS

Conclusions concerning environmental, safety, and health aspects of UNICOR's e-waste recycling operations at FCI Texarkana are provided below under the following subsections:

- Heavy Metals Exposures;
- Noise Exposure and Other Hazards;
- Health and Safety Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

Various conclusions may be applicable to all UNICOR recycling factories with similar operations and activities. These conclusions are supported by the results, findings, and analyses presented and discussed in Sections 3.0 and 4.0 of this report, as well as the documents assembled by the OIG. These conclusions, in part, are consolidated from the various federal agency reports, and are also supplemented by FOH based on the entire body of information assembled and reviewed. See Attachments 1 through 4 for additional conclusions from the individual contributing federal agencies OSHA, FOH, NIOSH/HETAB, and U.S. EPA.

5.1 Heavy Metals Exposures

1. Based on monitoring results from 2004 through 2007 performed by UNICOR consultants, current routine e-waste recycling operations conducted in the general factory areas (not including glass breaking) have minimal inhalation exposure potential to lead, cadmium, and other metals. Lead and cadmium exposures were well below OSHA action levels.

2. Since 2005, breaker and feeder exposure monitoring during GBO showed that lead, cadmium, and other metals exposures were below the OSHA PELs and action levels when calculated as 8-hour TWA exposures. Between 2005 and 2008, exposure monitoring was performed by a UNICOR consultant (2005, 2006, and 2007), OSHA (2006), and NIOSH/HETAB (2008). In 2004, a UNICOR consultant found that cadmium exposure was above the action level but less than the PEL as an 8-hour TWA. This higher exposure has not been reproduced during subsequent monitoring events. Also, prior to suspension of GBO in 2009, breakers wore PAPRs during glass breaking with a protection factor of 25 which provided for additional exposure control.

3. Prior to suspension of GBO in 2009, exposure monitoring had not been conducted for the cleaning and change-out of LEV pre-filters (performed weekly), HEPA filters (performed annually), and other non-routine activities. These activities had potential for higher lead and cadmium exposures, and worker exposure monitoring should be conducted should GBO be resumed.

4. The GBO HEPA filter change was conducted on an annual schedule, rather than based on pressure drops across the filters.

5. Based on FOH surface wipe samples in the glass breaking room at the UNICOR warehouse, elevated levels of lead and cadmium were found to accumulate on horizontal surfaces. Although the LEV systems were effective in maintaining personal airborne exposures below the action levels, it is apparent that the systems did not fully capture contaminants and that significant surface levels accumulated. This also indicates continued importance of vigilant cleaning practices, as well as improved work practices to reduce potential for carry-out of contamination. If glass breaking is not to be resumed, UNICOR should fully decontaminate the glass breaking area and LEV systems prior to their decommissioning. The same applies to the former LEV system that was used at the FCI before GBO were moved to the UNICOR warehouse.

6. Based on NIOSH/HETAB and FOH surface wipe samples in locker areas, forklift areas, and on lifts, carry-out of contaminants from the glass breaking room occurred despite work practices designed to limit this occurrence. Surface levels from lockers, for instance, were well above the OSHA clean area guideline for lead contamination of 200 $\mu g/ft^2$.

7. Bulk samples from a cable box collected by FOH near the former glass breaking area were elevated in lead and cadmium concentrations and indicate the need for additional evaluation of surface contamination in this and other nearby areas. The old dairy barn was also a past area of GBO that should be evaluated for contamination.

8. In addition to existing and improved housekeeping practices, implementation of an operations and maintenance (O&M) plan is needed to control potential exposure from existing and recurring contamination. An element of the O&M plan could include periodic clean-up of surfaces by inmate workers that are not subject to routine cleaning; however, this would have to be performed using proper hazard controls and work practices.

9. Dry sweeping of lead and cadmium-containing dusts was observed at FCI Texarkana by both FOH and NIOSH/HETAB despite the prior OSHA violation for dry sweeping issued to the FCI Lewisburg recycling factory in 2006. Dry sweeping is explicitly prohibited by the OSHA lead standard.

10. NIOSH/HETAB found that the results of biological monitoring for both staff and inmates were generally unremarkable. However, medical staff should follow up on any abnormal test results in a timely manner. Any abnormal test result that is unexpected should be repeated.

11. NIOSH/HETAB concluded that since May 2004, employee exposures have been sufficiently low that OSHA mandated medical surveillance has not been required.

Based on existing records and current operations, medical surveillance can be discontinued for inmates and staff performing glass breaking, disassembly, and other recycling operations. At UNICOR's discretion, it can continue the limited biological monitoring that is currently in place as an additional safeguard against excessive exposure, and as a reassurance to staff and inmates.

12. NIOSH/HETAB concluded that recycling at FCI Texarkana was performed from late 2001 to May 2004 without appropriate engineering controls, respiratory protection, medical surveillance, and industrial hygiene monitoring. Sparse biological monitoring and industrial hygiene data during this period precludes determination of the extent of exposure to lead and cadmium. The glass breaking room in place when the GBO was suspended (with LEV system and other hazard controls) is considered a significant improvement with respect to controlling worker exposure to lead and cadmium.

13. FOH considers the performance of annual exposure monitoring starting in 2004 at FCI Texarkana to be important in establishing and ensuring effective hazard controls and continuing improvements. FOH encourages continuation of this practice. However, in reviewing UNICOR consultant exposure assessment reports, both FOH and NIOSH/HETAB found that the reports lacked substantive evaluation of work practices and hazard controls. Interpretation, perspective, and analysis of results were often lacking. In addition, recommendations were generally not provided to validate and/or contribute to continuing improvement of work processes and worker protection. This is in contrast to the noteworthy practice found to be in place at USP Lewisburg that provided for comprehensive annual exposure assessments that included critical review, assessment, and recommendations.

5.2 Noise Exposure and Other Hazards

14. UNICOR consultants and FOH found that noise levels in various factory areas were above the OSHA action level that triggers the requirement for implementation of a written hearing conservation program. According to 29 CFR 1910.95, Occupational Noise Exposure, a hearing conservation program consists of a monitoring program, employee notification of results, audiometric testing, hearing protection, training, and record keeping, among other elements. According to the Factory Manager, UNICOR at FCI Texarkana has implemented a hearing conservation program including audiometric testing and hearing protection. Recommended improvements for this program and verification of its implementation are provided in Section 6.0, Recommendations.

15. Sanding of plastic monitors occurred at FCI Texarkana. According to the Factory Manager, P-100 filtering face masks were used for nuisance dusts, but a hazard analysis was not performed to identify and control hazards associated with PBDE's. The Factory Manager stated that samples were submitted for some type of analysis, but the report was not available. Similarly, it does not appear that a

comprehensive hazard analysis was performed relating to the desoldering operation associated with monitor/CPU repair as described in the Safety Manager's 2005 memorandum.

16. Although according to the Factory Manager, measures have been implemented to reduce heat exposure, a heat exposure assessment has not been performed in accordance with UNICOR's Heat Stress Program.

17. Although not specifically reviewed at FCI Texarkana, tasks that are potentially biomechanically taxing were observed by NIOSH at other UNICOR e-waste recycling factories. Similar tasks are performed at FCI Texarkana.

5.3 Health and Safety Programs, Plans, and Practices

18. UNICOR's work instructions for glass breaking and CRT processing and its process descriptions contain worker protection practices and requirements to control lead and cadmium hazards, such as PPE, respiratory protection, and cleaning practices, among others. The written documents generally reflect the controls and practices implemented during the work processes; however, some aspects of the worker protection requirements are not consistent between the documents and actual work practices. In other cases, the documents do not provide specific information on the type of PPE used, such as for "jumpsuits" (protective clothing). Should GBO be resumed, UNICOR should ensure that documents at FCI Texarkana reflect actual practice and are consistent with each other in all respects.

19. NIOSH/HETAB and OSHA reported on the type of PPE and respiratory protection that was worn by breakers and feeders during GBO. PPE (including respiratory protection) used during the work was appropriate. However, NIOSH/HETAB identified deficiencies and potential improvements in the storage, doffing, and other practices associated with PPE (see Section 4.1.5, Section 6.0, and Attachment 3).

20. UNICOR-FCI Texarkana's respiratory protection program identifies PAPRs as the respirator to be used during glass breaking. This document, however, does not detail use and storage practices for this type of respirator. The work instruction for glass breaking does provide information for PAPR cleaning, inspection, and storage, but the CRT processing procedure calls for the use of air purifying respirators, not PAPRs. Respiratory protection documentation should be revised to be consistent.

21. For general e-waste recycling activities conducted on the factory floor (i.e., disassembly and materials handling), a FCI Texarkana-specific UNICOR safety and health document to define existing workplace hazards and control measures is not in place.

22. UNICOR has not implemented semi-annual assessments of its compliance with the OSHA lead standard as stated in the FCI Texarkana Lead Compliance Program. The Factory Manager stated that the program was a draft and has not been implemented. UNICOR should ensure that the status of written programs be clearly identified on its documents.

23. UNICOR does not have an adequate hazard analysis program in place at FCI Texarkana and many of its other factories.

5.4 Health and Safety Regulatory Compliance

24. Current routine FCI Texarkana operations conducted in the factory and other associated areas (not including glass breaking) are in compliance with the aspect of the OSHA lead and cadmium standards regarding control of employee exposure to levels below the PELs.

25. Since September 2004, personal exposures during GBO have been less than the OSHA lead and cadmium PELs as 8-hour TWAs; therefore, prior to their suspension, FCI Texarkana operations for glass breaking were in compliance with the aspect of the OSHA lead and cadmium standards regarding control of employee exposure below the PELs.

26. As reported by NIOSH/HETAB, prior to May 2004, UNICOR recycling operations at FCI Texarkana were not in compliance with OSHA lead and cadmium standards regarding, engineering controls, PPE requirements, exposure monitoring, medical surveillance, and other aspects (see Attachment 3).

27. As observed by NIOSH/HETAB in July 2008 and FOH in March 2007, dry sweeping is conducted at FCI Texarkana recycling operations. This is explicitly prohibited by OSHA lead and cadmium standards, and is performed despite the OSHA violation issued for dry sweeping to FCI Lewisburg in 2006.

28. Prior to 2007, UNICOR had not conducted complete noise monitoring as recommended by OSHA and as required to ensure compliance with 29 CFR 1910.95, Occupational Noise Exposure. Other aspects of a hearing conservation program, such as audiometric testing and hearing protection were in place, however.

5.5 Environmental Compliance

29. FCI Texarkana's Hazardous Waste Program does not address policies and procedures specific to e-waste operations.

30. At the time of the U.S. EPA's RCRA Compliance Evaluation Inspection conducted on November 18-19, 2008, a U.S. EPA Inspector determined that FCI Texarkana FCI had disposed of spent HEPA filters characteristically hazardous

for lead generated from the GBO as non-hazardous waste. Similarly, containers of used oil stored in the Recycling Factory were not properly labeled. However, FCI Texarkana was determined currently to be a conditionally exempt small quantity generator (CESQG) of hazardous waste and therefore exempt at this time from RCRA regulations.

31. Concerns were also expressed by EPA about other operations and conditions (i.e., non-e-waste recycling) at FCI Texarkana including lack of testing of spent sand blasting grit and inappropriately labeled containers of waste paint, solvent (xylene), and used oil.

6.0 RECOMMENDATIONS

Recommendations concerning environmental, safety, and health aspects of UNICOR's e-waste recycling operations at FCI Texarkana are provided below under the following subdivisions:

- Heavy Metals Exposures;
- Noise Exposure and Other Hazards;
- Health and Safety Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

These recommendations relate to the conclusions presented above in Section 5.0. Some recommendations are taken from supporting documents such as the NIOSH/HETAB report (Attachment 3) and U.S. EPA RCRA Compliance Evaluation (Attachment 4). See these reports for additional recommendations and details. Other recommendations are developed by FOH from the body of data and documents reviewed to prepare this report. Various recommendations may apply to all UNICOR recycling factories where similar e-waste recycling activities are performed.

Recommendations are provided for current factory operations as well as GBO that were suspended in mid-2009. Recommendations that apply to glass breaking at FCI Texarkana are only applicable if glass breaking is resumed there; however, the recommendations may also be relevant to GBO performed at other UNICOR factories.

As a global recommendation, BOP and UNICOR should ensure that it has and allocates the appropriate level of staff, other personnel resources, and material resources to effectively implement these recommendations and to sustain an effective ES&H program over time.

6.1 Heavy Metals Exposures

1. As recommended by NIOSH/HETAB, should the currently suspended GBO be resumed, UNICOR should continue use of PAPRs for workers conducting glass

breaking, glass breaking room cleaning, and LEV filter change-out (see Attachment 3, Recommendation 2).

2. UNICOR should continue its exposure monitoring program that has been conducted annually since 2004. This monitoring will serve to document continued control of the lead and cadmium hazards. This recommendation, which goes beyond the requirements of the OSHA lead and cadmium standards, would provide important documentation to establish consistently low exposures and provide a basis for continued improvements. This recommendation applies to recycling activities even if glass breaking remains suspended. This recommendation is consistent with NIOSH/HETAB Recommendations 1 and 2 of Attachment 3.

3. UNICOR should ensure that as part of its monitoring program, the practices of weekly LEV pre-filter change-out, annual HEPA filter change-outs, and other non-routine activities with potential for metals exposure are included in the monitoring plan.

4. UNICOR should implement GBO HEPA filter changes based on the pressure drop across the filters. A pressure gauge should be installed to determine when filter changes are required.

5. As required by OSHA lead and cadmium standards, UNICOR should also promptly conduct exposure monitoring for any future changes that could result in an increased level of exposure, such as changes in work operations, work processes/practices, quantities or types of materials processed, new activities, and non-routine activities. Periodic monitoring should be conducted to evaluate any existing or newly developed engineering controls to make sure that the controls are operating at the design parameters.

6. In addition to personal exposure monitoring, the UNICOR exposure assessment program should continue to evaluate surface contamination levels. UNICOR should establish a surface contamination guideline that it intends to use to evaluate results and plan any clean-up or O&M actions.

7. UNICOR should scope the work activities of its exposure assessment consultants to include a critical review and evaluation or work practices and hazard controls. The consultants should evaluate exposure results in the context of its evaluation of such practices and controls and provide recommendations for continued improvements. For example, as consultants provide data and results regarding metal exposures, noise exposures, effectiveness of engineering controls, and surface contamination levels, they should also offer expert interpretation of results with any recommendations for improvements of controls, practices, and systems. [Note: Recent consultant reports for USP Lewisburg could serve as an example of the scope of the consultants' evaluations and content of reports.]

8. In the event that GBO are resumed, UNICOR should improve work practices to prevent carry-out of glass breaking room contamination into the locker area and into the general factory area. Also see NIOSH/HETAB recommendations in Attachment 3 and in Section 6.3, below.

9. Based on FOH bulk dust samples from a cable box near the former glass breaking area, UNICOR should further evaluate surface contamination in this and nearby areas. This evaluation should include the tunnel from the FCI basement to the power plant and former LEV system. UNICOR should control any contamination found through O&M, clean-up, and/or remediation, depending on sample results. The FCI Texarkana Safety Manager stated that he recollected that the tunnel had been cleaned. UNICOR should verify this and conduct surface testing to confirm the area is adequately clean.

10. As part of the surface contamination testing program, UNICOR should also evaluate other legacy GBO areas, such as the old dairy barn, for potential legacy contamination. UNICOR should clean-up or remediate these areas, if indicated by the results.

11. UNICOR should develop and implement an operations and maintenance (O&M) plan to ensure that surface contamination is minimized and that existing contamination does not result in inhalation or ingestion exposures. Elements of this plan could include:

    - Identification of activities that could disturb contamination (e.g., HVAC maintenance, periodic or non-routine cleaning of elevated or other surfaces, access to areas where higher levels of surface contamination are present, and various building maintenance functions);

    - Processes to identify and control hazards for routine and non-routine activities (e.g., job hazard analysis process prior to conducting certain work with identification of mitigating actions);

    - Mitigating techniques and procedures during activities of concern (e.g., dust suppression and/or clean-up and capture, filter removal and bagging processes, and use of PPE and respiratory protection);

    - Training and hazard communication;

    - Disposal of contaminated materials based on testing data such as TCLP tests; and

    - Periodic inspection, monitoring and evaluation of existing conditions, as appropriate. Exposure monitoring is particularly recommended for activities that can disturb surface dust. [Note: Follow-up surface sampling is important to ensure that surface contamination does not build up and to take preventive and corrective action, if it does.]

At UNICOR's discretion, the O&M plan could also include periodic clean-up of surfaces by inmate or other workers; that is, surfaces that are not subject to routine clean-up and housekeeping activities. If this element were adopted, however, UNICOR should ensure that practices to control exposures are included in the plan and implemented, such as appropriate worker training, PPE, respiratory protection, exposure monitoring, medical surveillance (if required based on hazard analysis and monitoring results), clean-up methods (e.g., HEPA vacuuming and wet methods), waste disposal, hygiene practices, and others deemed appropriate by UNICOR. Initial exposure monitoring should be conducted to determine whether exposure during clean-up is above the action levels for lead and cadmium. TCLP testing should also be conducted on waste materials generated to ensure proper disposal. Controls for future clean-up activities should then be based on exposure results. [Note: See FOH report for USP Lewisburg [FOH 2009] that describes the preparation, hazard analysis, training, controls, work practices, and performance of a clean-up activity conducted for warehouse elevated surfaces. This is a noteworthy practice that could serve as a model for other activities conducted under an O&M plan.]

12. Should UNICOR decide to permanently stop CRT breaking at FCI Texarkana, it should decontaminate and decommission the LEV and enclosure systems. If performed, this activity should be preceded by proper hazard analysis, training, preparation, development and implementation of safe work practices and hazard controls, exposure monitoring, hazardous waste testing and disposal, and clearance sampling. Depending upon the hazard analysis results, this could be performed by a remediation contractor or inmate workers under an O&M Plan. If the latter option is chosen, UNICOR should ensure the preparations described above are in place and should ensure that inmate workers are trained and qualified to perform this task. FOH emphasizes that based on FOH surface wipe samples of March 2007, areas of the containment and LEV systems are contaminated with lead and cadmium at levels far above guidelines discussed in Section 4.2.

13. Should glass breaking be resumed, UNICOR should evaluate the current FCI Texarkana LEV and ventilation systems relative to recommendations provided by NIOSH for other recycling factories (see FOH reports for USP Lewisburg and FCI Marianna with NIOSH reports attached). [FOH 2009a; FOH 2009b]. UNICOR should ensure that air does not flow from inside the glass breaking room to the general factory areas, as a UNICOR consultant report seemed to imply.

14. As recommended by NIOSH/HETAB and as prohibited by the OSHA lead and cadmium standards, UNICOR should discontinue dry sweeping. NIOSH/HETAB recommends the use of a floor squeegee to carefully collect large pieces of debris that cannot be effectively HEPA vacuumed from the floor. Dusts should be

cleaned by HEPA vacuum and wet methods. (See NIOSH/HETAB report, Attachment 3, Recommendation 4.)

15. NIOSH/HETAB concluded that continued medical surveillance is not required based on current exposure conditions; however, NIOSH/HETAB states that, at UNICOR's discretion, it can continue the limited biological monitoring that is currently in place as an additional safeguard against excessive exposure, and as a reassurance to staff and inmates.

6.2 Noise Exposure and Other Hazards

16. UNICOR should improve its hearing conservation program to include all elements defined by 29 CFR 1910.95, Occupational noise exposure. The means of providing the training component of this program should be defined.

17. UNICOR should perform an assessment to ensure that the hearing conservation program is fully implemented as indicated by the Factory Manager and Safety Specialist. [Note: Consultants performing noise monitoring in 2006, 2007, and 2009 did not seem to be unaware that such a program was implemented.]

18. UNICOR should ensure that FCI Texarkana has implemented heat exposure assessments and controls as required by the UNICOR heat stress program.

19. UNICOR should also ensure that other hazards are evaluated and controlled such as tasks that are potentially biomechanically taxing (e.g., lifting and repetitive stress).

6.3 Safety and Health Programs, Practices, and Plans

20. At FCI Texarkana, UNICOR should revise its work instructions, process descriptions, respiratory protection program and other documentation to ensure consistency in work practice and hazard control content among the documents and to ensure all written documents are consistent with actual work practices and processes. This recommendation applies to all UNICOR recycling factories.

21. Based on the above document inconsistencies and the uncertain status of the Lead Compliance Program, UNICOR should implement a document control system to clearly define document status, establish review and revision cycles, and ensure that the written documents consistently reflect work practices.

22. As a "good practice" approach, UNICOR should prepare a concise written safety and health document specifically for its e-waste recycling operations at FCI Texarkana as well as for each of its other recycling factories that lack such a document. Such a document should be developed and implemented to define the safety and health requirements and practices for all the various recycling activities including general activities conducted on the factory floor (i.e., disassembly and

materials handling). This document would serve to concisely define the safety and health practices and requirements specific to FCI Texarkana recycling, such as PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping and cleaning practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Non-routine or periodic work activities should also be addressed in the document, particularly those that potentially disturb dusts such as cleaning and handling/disposing of wastes from HEPA vacuums or containers. The document could also specify requirements for periodic site assessments, hazard analyses, actions for new or changed processes, inspections, and regulatory compliance reviews and help to ensure that practices are consistent with written requirements. .

23. NIOSH/HETAB recommends that UNICOR improve its change room, PPE practices, and decontamination processes. Specifically, NIOSH/HETAB recommends that separate storage be provided for non-work uniforms and GBO work apparel/PPE. All potentially contaminated work clothing and PPE should remain in the "dirty" chamber of the change room; non-work clothing should not come in contact with work items. Workers should be required to wash hands and exposed skin after doffing PPE and before putting on uniforms when exiting the GBO. Work clothes and PPE should never be worn outside the GBO. Laundry personnel should be made aware of the potential exposure to lead and cadmium from work clothes and take action to minimize exposure to themselves. (See Attachment 3, Recommendation 5.)

24. UNICOR should develop and implement a hazard analysis program that includes baseline hazard analysis for current operations and also job (activity-specific) hazard analysis (JHA) for both routine and non-routine activities. UNICOR and FCI Texarkana should conduct JHAs for any new, modified, or non-routine work activity prior to the work being conducted. It should also conduct hazard analyses of existing processes that have not had such an analysis. The JHA process is intended to identify potential hazards and implement controls for the specific work activity prior to starting the work. For instance, the JHA process should be integral to an effective O&M plan, as described in Section 6.1. (Also see NIOSH/HETAB report, Attachment 3, Recommendation 7.)

25. BOP, UNICOR, and FCI Texarkana should ensure that staff and consultants conducting ES&H assessments, evaluations, inspections, and monitoring activities are qualified for their assigned tasks and led by certified or highly qualified professionals. One benchmark for vetting individuals performing industrial hygiene services is the ensure certification in the practice of industrial hygiene (CIH) by the American Board of Industrial Hygienists (AIHA). (Also see the NIOSH/HETAB report, Attachment 3, Recommendation 6.)

26. BOP and UNICOR should implement a system to list, track, and document closure of any identified deficiencies or recommendations, regardless of the

source. Closure of deficiencies and recommendations with records of those accepted (and implementation details), along with those not accepted or pending (and why) is important to document improvement actions. This recommendation applies to all UNICOR recycling factories. This topic will be discussed in further detail in the final OIG report.

6.4 Health and Safety Regulatory Compliance

27. UNICOR should discontinue dry sweeping of lead and cadmium contaminated dusts.

28. UNICOR should ensure the evaluation of heat exposures and implement hazard controls accordingly.

29. UNICOR should evaluate and appropriately control ergonomic hazards.

30. Also see hazard analysis recommendations in Section 6.3.

6.5 Environmental Compliance

31. FCI Texarkana's Hazardous Waste Program should be updated to reflect the current BOP Program Statement (i.e., 1600.9).

32. Although its current status as a Conditionally Exempt Small Quantity Generator does not subject FCI Texarkana to EPA RCRA regulations, UNICOR and FCI Texarkana should consider the concerns or deficiencies identified in the U.S. EPA RCRA CEI report (e.g., dealing with labeling containers appropriately and characterizing suspect wastes like spent sand blasting grit; see Attachment 4) to conduct proper waste management practices. FCI Texarkana should also take note of both federal and state universal waste regulations.

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ATTACHMENTS

ATTACHMENT 1

U. S. Department of Labor
Occupational Safety and Health Administration

INSPECTION NARRATIVE
WORK SITE & EMPLOYER INFORMATION

Employer
FCI Texarkana
OSHA Inspection No. 309541423

Inspection Date: December 13-14, 2006

Compliance Officers: Kenneatha Clark; Jorge Delucca

FOH representatives: Frank Fitzpatrick, Project Manager for Federal Occupational Health, Bethesda, MD; William Bird, FOH Dallas office.

Site management representatives: [redacted] FCI Texarkana Warden; [redacted] Associate Warden; [redacted] Factory Manager; [redacted] FCI Texarkana, Safety Manager; [redacted] President, Local Union 2459.

Inspection Location: Outside (minimum security) and inside (low security) UNICOR facilities, FCI Texarkana.

Company Information: P.O. Box 9500, Texarkana, TX 75505

Telephone No. : 903-838-4587; FAX: 903-223-4440

Inspection Purpose:
The employer received an OSHA Inspection in response to a memorandum from the OSHA National Office, dated October 4, 2006 that directed that the Dallas Area Office inspect the computer recycling operations at FCI Texarkana as part of an independent study being conducted under the oversight of the Department of Justice Office of the Investigator General. The purpose of the inspection was to determine if inmates working on computer recycling were exposed above the Permissible Exposure Limits of lead, cadmium, beryllium and barium.

Background Information:
The Federal Bureau of Prisons is a large organization that employs a union workforce consisting of approximately 35,000 employees nationwide. UNICOR is a trade name for Federal Prison Industries, Inc. There were 1430 inmates at FCI Texarkana as of December 7, 2006, plus 341 inmates at the "Camp" or outside facility, and a staff of 275 for a total of 2046 personnel. A total of 181 inmates were involved in recycling operations.

Previous OSHA History: Prior to this Inspection, the Federal Bureau of Prisons had 99 previous

OSHA inspections since 1990.

Opening Conference:
An opening conference was held with FCI Texarkana management team. After presenting credentials the purpose and scope of the inspection was explained. The scope was a focused inspection on exposure monitoring to toxic metals during glass breaking and computer and electronic components recycling operations.

Inspection findings: The team that conducted the study at FCI Texarkana consisted of one CSHO from OSHA Region 9, a CSHO from OSHA Region 6, a project manager from USPHS-FOH, and a contractor from the FOH Dallas office.

The first day we conducted an opening conference and a walk around of the UNICOR facilities.

There are two factories: a filter operation located on the top floor of the "interior facility" and the recycling facility. Recycling started in October 2001. The latter is split into two areas: the "outside (or Camp Warehouse) facility" which is a minimum security area in a metal building by the docks and another in the "inside facility" inside the low security FCI facility.

Filter Factory: This operation was located on the top floor of the "inside facility". Hours of operation are 7:15 a.m. to 3:45 p.m. It started operation one and one-half years ago. It manufactured filters for air conditioners. It consisted of a staff of 3 plus 40 inmates. Operations include "pleaters" that shape the filter paper and machines that glue the filter paper and chicken wire together. The noise is produced by compressed air nozzles and a table saw. A consultant industrial hygienist had conducted a noise survey of the area and determined that the noise produced by the compressed air was "impact/impulse noise below the OSHA threshold of 140 dBA". The table saw is used intermittently. This operation was outside the scope of the inspection. No industrial hygiene evaluations were conducted in this area by our team. No health or safety issues were identified.

Outside (Camp Warehouse) Facility: The recycling facility receives computer equipment such as monitors, printers and other peripheral equipment. The equipment is inspected for contraband and sorted. There was a total of 58 inmates assigned to the outdoor recycling facility (18 are part-time and work 4 hours/day). A total of 75 inmates are authorized. Most inmates are involved in 'tear down work" which involves disassembling electronic components such as using power tools to unscrew the items, separate metal from plastic which was placed in separate boxes for shipment to metal and plastic recycling facilities. This facility does the glass breaking.

a. Cathode ray tubes from computer monitors and television sets are broken inside a "Glass Booth" that was locally manufactured. The booth consists of a frame with vertical vinyl tablets (the type used for refrigerated areas at food stores). Two inmates break CRT s inside the booth with two other inmates feeding CRTs onto a conveyor from outside the booth. The two "glass breakers" inside the booth are protected with ear plugs, disposable coveralls, booties, leather gloves, and Powered Air Purifying Respirators (PAPR) with loose fitting hoods. The two "glass feeders" are protected with ear plugs, disposable coveralls, work gloves, booties, safety glasses and disposable dust masks (filtering face pieces). Glass breaking takes place an average of twice per month, mornings only.

b. The two glass breakers worked side by side using hammers. The first one broke funnels and the second broke the panel glass. Each breaking operation took approximately 30 seconds. The glass fell into large cardboard boxes underneath the conveyor. The metal panel of the CRTs were disposed into a metal box.

c. There were four exhaust systems for the glass breaking operation, one by the glass feeders, and one in front of each of the glass breakers. There was another unit on the extreme left side inside the booth. The airflow of the exhaust systems was measured using an Alnor, model 9850 air velocity meter, serial number 3735, calibrated at the OSHA Cincinnati Technical Center on July 19, 2006. Air flow was measured as 150 feet per minute at the worker positions at the glass feeding location, 200 FPM one foot above the conveyor at the funnel breaking location, and 100 FPM one foot above the conveyor at the panel glass breaking location. The fourth exhaust system measured 100 to 150 FPM two feet in front of the system. In case of malfunction of a ventilation system, a contractor, Empire Tech, would repair. FCI Texarkana management informed Empire Tech of the potential hazard of lead, cadmium, beryllium and barium; Empire Tech is responsible for the safety of its employees. Every Friday afternoon, one glass breaker replaces pre filters while protected by the coveralls, gloves and PAPR. The HEPA filters are replaced once per year.

d. Each of the two glass breakers and one of the glass feeders wore two air sampling pumps, calibrated at 2 liters per minute, with an 8 micron mixed cellulose filter cassette attached to collar. Each worker was monitored for the duration of the operation, between 181 to 186 minutes. The filter cassettes were analyzed at the OSHA Salt Lake Technical Center. One filter cassette of each set was analyzed for ICP metals and the second for barium. **All results were below detection limits.**

e. There is a rest room in the area where inmates can wash their hands. Inmate's uniforms are left in a locker room while glass breaking. The glass breakers are prohibited from leaving the booth with the potentially contaminated coveralls. Used disposable coveralls are disposed into a non-reusable container which is disposed by Safety Kleen.

f. At the end of the glass breaking operation, glass breakers spray Simple Green onto surfaces to fix the dust. The area is swept and (HEPA) vacuumed (see photos).

g. Physical exams:

    a. All inmates that work inside the glass booth receive a respirator medical clearance by the Health Services Administrator and respirator training by the safety manager. Fit testing is not required for loose fitting hooded PAPR. All medical clearances and respirator training are documented.

b. Biological testing. All inmates and staff involved in glass breaking receive biological testing for heavy metals. Only personnel medically approved and listed in a roster can work as glass breakers or feeders.

Inside Facility: This facility tears down computer parts such as CPUs, CD ROM drives and printers plus some small electronic appliances such as cable boxes, VCRs, radios, receivers, etc. There are 90 inmates working in this facility out of 115 authorized.

a. Electronic items are sorted by table (6 tables). The inmates use pneumatic tools to unscrew the components and hammers to loosen the metal circuit boards from the plastic. Plastic and metal are placed in various metal baskets at the end of each table. No CRT breaking is conducted in this area. There is no local exhaust ventilation. Workers use safety glasses, ear plugs, work gloves and aprons.

b. Two inmates that conducted teardown were monitored for metals. Each inmate wore two air sampling pumps, calibrated at 2 liters per minute with 8 micron mixed cellulose ester filter cassettes attached to their collars. One pump to sample ICP metals, the other for barium. Air sampling was conducted during the afternoon, for 150-152 minutes. The filter cassettes were analyzed at the Salt Lake Technical Center. **All results were below detection levels.**

c. There is a break area 23 feet from the teardown tables. The break area is 24 feet wide; there is a soda and a snack vending machine inside the break area, against the east wall (47 feet from the teardown area). Two swipe samples were obtained from the front surfaces and buttons of each machine, one swipe for ICP metals and one for barium. The swipes were analyzed at the Salt Lake Technical Center. **All results were below detection levels.**

d. FCI Texarkana has had air sampling conducted by industrial hygiene consultants on four occasions since 2002. The last two occasions, on May 2005 and May 2006, all air samples were below the OSHA PELs for barium, beryllium, cadmium and lead. Copies of all consultant reports were provided to OSHA.

(See photos taken during the inspection.)

Weather data at time of inspection:

	Actual
Temperature (Outside facility)	19.5 C - 21 C
Humidity (Outside facility)	80-84%
Temperature (Inside facility)	23 C
Humidity (Inside facility)	63%
Precipitation	None

Measurements:

Dimensions of exhaust systems, Glass Booth-22" x 41"
Temperature and relative humidity were measured with a Vista Scientific Corporation psychrometer (dry and wet bulb thermometers)

Closing Conference: An exit conference was conducted by Kennethea Clark on December 14, 2006 with the site management representatives. She explained that a closing conference would be conducted when the results of the air sampling was received.

Alleged safety hazards: No overexposures to toxic metals, including lead, cadmium, beryllium or barium were found.

ATTACHMENTS 2a and 2b

ATTACHMENT 2a

Texarkana Wipe and Bulk Data Table
Samples Collected 3/27/07 to 3/28/07

Field #	Sample Type	Building Name	Surface/Item	Lead		Cadmium	
	W=Wipe B=Bulk			ug/ft2	mg/kg	ug/ft2	mg/kg
032707W -01	W	Warehouse Recycling Camp	HVAC AHU #4 outside booth (Middle on top)	480		79	
032707W -02	W	Warehouse Recycling Camp	Outside booth on floor 70" E from SW corner 10" from curtain	13		1	
032707W -03	W	Warehouse Recycling Camp	Outside booth on floor (West) 80" N from SW corner 10" from curtain	27		1	
032707W -04	W	Warehouse Recycling Camp	[redacted] locker, bottom (top row, 2nd from left)	480		18	
032707W -05	W	Warehouse Recycling Camp	[redacted] locker (top row, 3rd from left)	480		33	
032707W -06	W	Warehouse Recycling Camp	[redacted] ocker (top row, 5h from left)	390		21	
032707B -07	B	Warehouse Recycling Camp	[redacted] glove, bulk thumb		150		40
032707W -08	W	Warehouse Recycling Camp	[redacted] locker 6th from left, bottom	200		7	
032707W -09	W	Warehouse Recycling Camp	[redacted] locker right column, 5th from bottom	520		12	
032707W -10	W	Warehouse Recycling Camp	Top of lockers center	170		34	
032707W -11	W	Warehouse Recycling Camp	Top of AHU #2 Center, 1st inside booth	2,000		220	
032707W -12	W	Warehouse Recycling Camp	Top of AHU#1, Second in line in booth center	2,500		240	
032707W -13	W	Warehouse Recycling Camp	From inside booth near breaking area	7,300		640	
032707W -14	W	Warehouse Recycling Camp	Back of AHU #1 in booth 3" x 48" in groove at bottom behind grille	7,400		2,000	
032707W -15	W	Warehouse Recycling Camp	Back of AHU #2 in booth 3" x 48" in groove at bottom behind grille	17,000		2,700	
032707W -16	W	Warehouse Recycling Camp	Polyethylene flap inside booth 128" N of SW corner metal Post (W side of booth)	50		7	
032707W -17	W	Warehouse Recycling Camp	Polyethylene sheeting inside Booth 80" E of SW corner center	220		18	
032707B -20	B	Warehouse Recycling Camp	Bulk sample from broom box, glass dust at bottom of box.		120		2
032707W -21	W	Warehouse Recycling Camp	Wipe sample from floor inside booth under belt between funnel Gaylord box and panel Gaylord Bar approx 72" from E. wall	210		5	
032707W -23	W	Warehouse Recycling Camp	Wipe sample from Lift-Rite that carries Gaylord boxes inside booth	3,900		500	
032707B -25	B	Warehouse Recycling Camp	Dry sweep of material around disassembly areas		2000		160
032707W -26	W	Warehouse Recycling Camp	Storage room/locker room battery changing shelf approx 4' above floor center	420		40	
032707W -27	W	Warehouse Recycling Camp	Blank (Dock 1)	2		0	
032707B -30- A	B	FCI (Inside Fence)	Cable box inside fence. This is in/near 'old' (former) GB area		3200		7600
032707B -30- B	B	FCI (Inside Fence)	Cable box inside fence. This is in/near 'old' (former) GB area		3300		7700
032707B -31	W	Warehouse Recycling Camp	Dock 2	1		5	
032707B -32	B	Warehouse Recycling Camp	Composite from disassemble desk (metal, plastic bins)		500		180

ATTACHMENT 2b

Texarkana TCLP Data Table
Samples Collected 3/27/07 to 3/28/07

Field #	Sample Type	Building Name	Surface/Item	**Lead**	**Cadmium**
				mg/l (extractable)	mg/l (extractable)
032707B -18	TCLP	Warehouse Recycling Camp	DRMO box under AHU #2 (funnel box glass)	1.4	0.02
032707W -19	TCLP	Warehouse Recycling Camp	Box under AHU #1, panel glass box	55.0	<0.001
032707W -22	TCLP	Warehouse Recycling Camp	Glove from inside PPE waste box inside booth	0.19	0.59
032707W -24	TCLP	Warehouse Recycling Camp	Waste glass box outside booth	0.07	<0.001
032707W -28	TCLP	Warehouse Recycling Camp	Mop rinse after breaking glass and mopping outside and inside booth	0.08	<0.001
032707W -29	TCLP	Warehouse Recycling Camp	Mop rinse from mopping outside glass booth	<0.01	0.04

ATTACHMENT 3

DEPARTMENT OF HEALTH AND HUMAN SERVICES Public Health Service

National Institute for Occupational
Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998

February 9, 2009
HETA 2008-0055

[redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
United States Department of Justice, Suite 13100
Washington D.C. 20530

Dear [redacted]

On November 27, 2007, the National Institute for Occupational Safety and Health (NIOSH) received your request for technical assistance in your health and safety investigation of the Federal Prison Industries (UNICOR) electronics recycling program at Federal Bureau of Prisons (BOP) institutions in Elkton, Ohio; Texarkana, Texas; and Atwater, California. You asked us to assist the United States Department of Justice, Office of the Inspector General (USDOJ, OIG) in assessing the existing medical surveillance program for inmates and staff exposed to lead and cadmium during electronics recycling, and to make recommendations for future surveillance. In addition, you asked us to assess past exposures to lead and cadmium, and to investigate the potential for take home exposure. This interim letter summarizes our findings and provides recommendations to improve the safety and health of the inmates and staff at the Federal Correctional Institution (FCI) in Texarkana, Texas. These findings will be included in a final report that will contain findings from the evaluations at all three institutions identified in your request.

Background

Information available to us indicates that electronics recycling at FCI Texarkana was performed from 2001 until May 2004 without appropriate engineering controls, respiratory protection, medical surveillance, or industrial hygiene monitoring. In late 2001, the glass breaking operation (GBO) commenced in the basement of the FCI. The GBO is where cathode ray tubes (CRTs) from computer monitors or televisions are processed. As reported to us, the first GBO had been retrofitted with an exhaust ventilation system that had been used in the FCI's furniture factory. Large fans used for cooling the work area reportedly disseminated dust from the GBO throughout the basement. In the summer of 2002, the GBO was moved to an old dairy barn at the camp (the lower security part of the FCI) while a containment area was built for the GBO in the factory in the basement of the FCI. This containment consisted of wooden walls topped by a screen, which was designed to decrease dissemination of "silver floating material" in the air from the GBO. Managers, employees, and inmates had no knowledge that lead or cadmium exposure was a potential health hazard. The GBO moved back to the FCI basement in the fall of 2002 and medical surveillance for inmates performing glass breaking and staff in recycling was begun in mid-late 2003. Recycling moved to its current location at the camp in May 2004, where a glass breaking booth was constructed. The booth is reported to have undergone various modifications since its initial construction.

At the time of the NIOSH site visits, the GBO reportedly processed 300 to 400 CRTs per day during two work shifts, which run for three hours in the morning and two hours after lunch. From a pool of approximately eight inmates, four are assigned to work as glass breakers (2) and feeders (2) during each work shift. Each inmate is allowed to work as a glass breaker for a maximum of one shift per day.

Electronics recycling at the camp consists of manual disassembly of computers and other electronics, manual chip recovery, and glass breaking. The glass breaking booth is divided into seven areas, identified as zones 1 through 7 on the enclosed diagram (See Figure 1). Except for the inmate locker area and storage closet which are enclosed by walls, the zones are separated by vinyl strip curtains suspended from the ceiling.

Two stand-alone high efficiency particulate air (HEPA) filtered ventilation units provide local exhaust ventilation (LEV) to control dust emissions at the panel and funnel glass breaking stations in zone 7. Vinyl strip curtains at the face (intake) of each HEPA unit enclose the CRT while it is manually broken. The HEPA units discharge filtered air into the glass breaking booth. Two additional HEPA ventilation units provide general air filtration to remove dust from glass booth air. One of these units is in the feeder area, and the other is along a wall in zone 7. In 2007, air-conditioning was installed in the GBO, and four large exhaust fans were installed on opposite walls of the factory (two fans on each wall).

Two inmate glass breakers, one at each workstation, use hammers to break CRTs. CRTs are provided to the breakers by two inmate feeders, who place intact CRTs onto a manual roller conveyor that allows CRTs to be rolled into the vinyl strip curtain enclosures at each of the breaking stations. At the right breaker station, the funnel glass breaker reaches through the vinyl strip curtain and breaks the funnel glass, which drops into a Gaylord box beneath the conveyor. The panel glass is then rolled into the enclosure at the panel glass station, where the panel glass breaker breaks the panel glass into pieces that drop into a second Gaylord box. The electron gun, frit, and metal components are also removed during the breaking process and are deposited into containers.

At the start of morning and afternoon shifts, glass breakers and feeders take personal protective equipment (PPE) from their lockers and don the PPE in the change-out area in zone 4. Glass breakers and feeders wear hearing protection, Tyvek® suits, Kevlar® sleeves, Kevlar® gloves, and steel-toe footwear. Glass breakers wear hooded powered air-purifying respirators (PAPRs) with HEPA filters as prescribed in the FCI Texarkana Respiratory Protection Program. Feeders (who remain in zone 6) do not wear respiratory protection, but do wear safety glasses in lieu of the protective PAPR facepiece. At the end of the shift, workers return to zone 4 where they remove the PPE. At the time of the two site visits, workers stored PAPRs and other PPE in a single locker. Shortly after the July 2008 sampling visit, new lockers were installed so that workers can store PAPRs separately from other PPE, thereby reducing the chance that residual dust on gloves and other PPE will contaminate PAPRs.

Movement of workers and equipment within the glass booth, and between the booth and areas outside the booth, is controlled to reduce dust carryout on shoes and equipment. Glass breakers are the only workers allowed in zone 7 during glass breaking, and they remain in zone 7 throughout the work shift. The pallet jack that is used in zone 7 never leaves zone 7. Forklifts enter the booth no further than zone 5. Full Gaylord boxes are shrink-wrapped before being moved to the edge of zone 5, where the boxes are removed with a forklift.

At the end of a shift, glass breakers and feeders dry-sweep the GBO floor, then wet mop it with a dilute mixture of Simple Green® and water. A HEPA vacuum cleaner is used to remove dust from various surfaces in zone 7, and from the face of the prefilters on the HEPA units at the glass breaking stations. Workers remain in PPE while performing end-of-shift cleanup. Dry sweeping and shovels are also used to clean the floor after full Gaylord boxes are removed from the GBO.

Prefilters installed in HEPA units are changed weekly. The HEPA filter in each unit is changed annually by inmates wearing PPE. This is accomplished by removing the prefilter, HEPA vacuuming accessible surfaces, removing the HEPA filter, and sliding the filter into a plastic bag which is then double-bagged for disposal.

Assessment

We reviewed the following documents:

- Results of medical surveillance performed between 2003 and 2007 (provided by your office);
- Medical records for two inmates reported to have serious medical problems secondary to work in recycling;
- Results of biologic monitoring (provided by the medical clinic at FCI Texarkana);
- Work instructions for the GBO and maintenance;
- Rosters for inmates working in recycling that provided location and dates of work (provided by the factory manager);
- Timelines for recycling operations (provided by you);
- DOJ interviews with staff and inmates and;
- Results of industrial hygiene sampling performed by consultants to UNICOR.

We conducted a site visit on June 24-25, 2008 with you. During this site visit we held an opening conference with FCI and UNICOR management, American Federation of Government Employees (AFGE) representatives, UNICOR recycling staff, and the health services administrator and regional medical director. After the conference we toured the former recycling locations in the basement of the FCI and in the dairy barn at the camp, and the current recycling operation at the camp. We conducted informational meetings with FCI and UNICOR staff, and inmates. We also met with the safety manager, factory manager, and health services administrator. We ended the site visit with a closing conference where we presented our initial findings and recommendations.

We were told that BOP has had an industrial hygienist on staff for several years, and that UNICOR recently hired one. Neither of these individuals was present during our visit, and it is unclear what, if any role, they may have had in setting-up or monitoring the electronic recycling program.

On July 16, 2008, we conducted an industrial hygiene survey to assess worker exposures to cadmium and lead during glass breaking. Full-shift personal breathing zone (PBZ) air sampling for cadmium and lead was conducted for each worker who performed glass breaking or feeder duties on this date. Area air samples were collected inside and outside the glass breaking booth. Air samples were collected, digested, and analyzed according to NIOSH Method 7303 [NIOSH 2009].

Surface wipe samples were collected in inmate lockers, and from PAPR face shields, the table where inmates don and doff PPE, the floor where the forklift accesses the glass breaking booth, and desktops outside the glass breaking booth. These samples were collected by wiping a 100 square centimeter (cm^2) area (10 cm^2 x 10 cm^2) according to the sampling procedure outlined in NIOSH Method 9102 [NIOSH 2009]. Hand wipe samples were collected according to the dermal sampling procedure outlined in NIOSH Method 9105 [NIOSH 2009] Hand wipe samples were collected after workers had washed their hands at the end of each work shift. All wipe samples were collected using Ghost Wipes, which were digested and analyzed for elements according to NIOSH Method 9102 [NIOSH 2009] with modifications for digestion (a nitric/hydrochloric acid mix was used in place of perchloric acid).

Results and Discussion[1]

Medical surveillance

Inmates

Medical surveillance began in late 2003 for inmates in the GBO. It is performed annually by the FCI clinic and consists of limited biological monitoring, a medical and occupational history questionnaire, and respirator clearance. Preplacement testing is performed on inmates prior to being cleared to work in the GBO, with the exception of those already working there when surveillance began. The inmates are seen by a physician's assistant and their test results are discussed with them. Biological monitoring consists of blood lead levels (BLL), blood cadmium

[1] See *Occupational exposure limits and health effects* in Appendix.

(CdB), urine cadmium (CdU), urine beta-2-microglobulin (B-2-M), and zinc protoporphyrin (ZPP). Paper copies of test results are maintained in the inmate's personal medical record but not with UNICOR management. Each inmate's medical records are transferred with them; no medical records are retained at Texarkana after an inmate is either transferred or released. The results of the available inmate biological monitoring are summarized in the following sections. Because measurements on individual inmates and staff were sporadic and the number tested small, we did no group analyses of the data.

Biological monitoring results were available for 28 inmates, although not all inmates had all tests performed. Preplacement BLLs were available for 13 inmates who performed glass breaking. The laboratory's limit of detection (LOD) for blood lead was either 1.0 microgram per deciliter of whole blood (µg/dL) or 3.0 µg/dL, depending on the lab used. One of the 13 was less than the LOD of 1.0 µg/dL, and the others ranged from 1.1-5.0 µg/dL. Seventeen periodic or termination BLLs were available: seven were less than the LOD of 3.0 µg/dL and one was less than the LOD of 1.0 µg/dL. The remaining nine ranged from 1.2-2.4 µg/dL. One inmate who worked in the GBO since 2001 had a BLL in March 2004 that was less than the LOD of 3.0 µg/dL. Another inmate had a BLL of 5 µg/dL in August 2002, but his start date in GBO was listed as 2004. He likely worked in GBO at two separate times. This BLL reflects exposure prior to the installation of the current GBO in May 2004, but the others do not because the half-life of lead in blood is too short.

Results were available for 24 inmates who had preplacement CdB tests done. The laboratory's LOD for CdB was either 0.5 micrograms per liter (µg/L) or 1.0 µg/L. Seventeen were less than the LOD of 1.0 µg/L and one was less than the LOD of 0.5 µg/L. The remainder ranged from 1.1-6.6 µg/L. The two inmates with the highest levels (2.7 and 6.6) were not cleared to work in GBO. It is unclear if they were evaluated to determine why their levels were high. Twenty-eight periodic or termination CdB tests were available: 20 were less than the LOD of 1.0 µg/L and three were less than the LOD of 0.5 µg/L. The remainder ranged from 0.5-2.5 µg/L. In general, these CdB results do not reflect exposures prior to the installation of the current GBO in 2004 because the half-life of cadmium in blood is too short. However, results were available for three inmates who had worked in the GBO since 2001, although it appears one of them ceased GBO work for a while, then returned to it. The CdB in the two who apparently continued work from 2001 until the time of testing in November 2003 were 1.8 µg/L and 2.5 µg/L. Both smoked at the time. The other inmate's November 2003 testing was noted to be preplacement, and was below the LOD. This inmate was a non-smoker. We cannot determine if the higher levels in the smokers were from exposure to cadmium during glass breaking or from smoking. Smoking is known to increase CdB levels. For example, 10 inmates who smoked had CdB available; only one was less than the LOD and the others averaged 2.3 µg/L. Nonsmokers had lower CdB levels. There were 32 CdB results for nonsmokers, and 30 were less than the LOD.

Twenty-four preplacement CdU test results were available. The LOD was 0.5 µg/L and 14 measurements were below this LOD. If the CdU was above the LOD, then it was adjusted to the urinary concentration of creatinine to control for the variability in urine dilution. The five that were above the LOD ranged from 0.29 micrograms per gram of creatinine (µg/g/Cr) to 2.2 µg/g/Cr. There were 20 periodic or termination CdU results available for review. Fifteen were below the LOD, and the remaining five ranged from 0.3-1.3 µg/g/Cr. These CdU measurements integrate exposure over time because the half-life of cadmium in urine is years to decades.

However, only three of these inmates worked in GBO beginning in 2001; the highest result among these three was 0.61 µg/g/Cr.

There were 38 urinary B-2-Ms and 26 ZPPs and all were normal.

One inmate identified himself to us at the meeting as having been removed from the GBO due to abnormal test results. We obtained his results from the medical clinic, and noted that his CdB in late 2003 was 6.2 µg/L, while CdU and B-2-M were below the LOD. His BLL was 4 µg/dL. His questionnaire noted he had been working for UNICOR over 1 year at the time of these tests. There was a note in the chart to repeat the tests in 6 weeks, but this was never done. It is unclear if this represents significant exposure to cadmium or a laboratory error, especially in consideration of the low CdU result. After our visit, this inmate was retested and his CdB was 1.0 µg/L and CdU was 0.8 µg/g/Cr.

Forty-one initial or annual questionnaires were available for review. None noted any medical complaints that could be related to recycling work. Medical records were reviewed for the two inmates reported to have serious medical problems secondary to work in recycling. One died of causes unrelated to recycling work, and the other inmate's medical issues were clearly not related to recycling work, either.

UNICOR Staff

UNICOR staff see their private physicians for medical surveillance, which is paid for by UNICOR, so their exams are not standardized. There are seven staff that work in recycling, a factory manager, an accountant, and five recycling technicians. Test results were available for seven staff members, each of whom was tested between one and four times. There were emails from several staff members to the factory manager, documenting that they chose not to undergo annual physicals and testing. Sixteen BLL results were available: 14 were below the LOD of 3 µg/dL; one was below the LOD of 1 µg/dL, and one was 2.0 µg/dL. Fifteen CdU results were available: eight were less than the LOD of 0.5 µg/L and the remainder ranged from 0.3-0.7 µg/g/Cr. Fifteen CdB results were available: twelve CdB were less than the LOD of 0.5 µg/L and the remainder ranged from 0.5-1.4 µg/L. The two highest were in a smoker; the rest of the staff were non-smokers. There were 13 ZPP and 15 B-2-M results, and all were normal. Two initial or annual questionnaires were available for review. Neither noted any medical complaints that could be related to recycling work.

In summary, results of biological monitoring of both staff and inmates were generally unremarkable. It is important for medical staff to follow up on abnormal test results in a timely manner. It is standard medical practice to repeat an abnormal test result that is unexpected, for example, the elevated pre-placement CdB noted on more than one inmate. If the test result is still abnormal, then a cause for the abnormality should be sought.

Industrial Hygiene

Records Review

The OIG provided five sampling reports prepared by UNICOR consultants, a letter from the Occupational Safety and Health Administration (OSHA) summarizing OSHA sampling results, and a chart containing Federal Occupational Health (FOH) wipe sample results. No consultant reports or sampling data were provided for the first 9-10 months that glass breaking was reportedly performed in the basement of the factory (October 2001 until July or August 2002).

The first consultant report of air and wipe sampling was in October 2002, following relocation of the GBO from the dairy barn back to the FCI during the previous summer. One of the two PBZ samples collected on October 24, 2002 approached but did not exceed the OSHA action level (AL) for lead during a 480-minute sampling period. Cadmium was not detected in PBZ or area air samples. Low concentrations of lead were detected in the two area samples collected in unidentified locations. Low concentrations of cadmium and lead were detected in wipe samples. A bulk dust sample, collected from an unidentified location, contained 3810 ppm lead by weight; cadmium was not detected in the bulk sample. This report provided no description of sampling locations, the size and duties of the workforce, operations performed by workers, housekeeping procedures, the work area, LEV, other workplace controls, PPE, or housekeeping procedures. Based on the limited data obtained on this date, the consultant concluded that the air concentrations did "not pose an immediate health threat to personnel working in this operation," and recommended using a HEPA vacuum cleaner and wet methods to clean surfaces before installing a ventilation system or modifying the work area.

A different consultant conducted air and wipe sampling for barium, beryllium, cadmium, and lead during 1-day site visits in August 2004, May 2005, December 2006, and December 2007. The report for each of these visits consisted of a boilerplate letter with several appendices containing sampling data. Ventilation assessments, consisting of face velocity measurements at HEPA units and smoke tube visualization of air flow, were conducted during the 2006 and 2007 visits; sound level meter readings were obtained in 2006. These reports contain no recommendations or industrial hygiene guidance, and provide very little descriptive information beyond sampling results.

Reports for site visits conducted in 2004 through 2006 indicate that all barium results were below occupational exposure limits (OELs) established by NIOSH, OSHA, and the American Conference of Governmental Industrial Hygienists (ACGIH®). Beryllium was not detected in any of the samples for this period. Although reported airborne concentrations of lead and cadmium were below OELs, the OSHA AL for cadmium was exceeded in 2004. (Note: the consultant incorrectly reported that the cadmium permissible exposure limit (PEL) had been exceeded in 2004.) It should be noted that NIOSH regards cadmium as a potential occupational carcinogen; therefore, NIOSH recommends that occupational exposure to cadmium be limited to the lowest feasible concentration. Low concentrations of lead and cadmium were detected in most surface wipe samples collected in 2004-2006. Post-shift hand wipe samples collected before and after hand washing indicate that hand washing reduced the amount of metals on workers' hands.

On December 14, 2006, OSHA conducted air sampling for metals during glass breaking and teardown. The results for all metals, including lead and cadmium, were reported to be below the LOD. Likewise, no metals were detected in surface wipe samples collected from the front surfaces and buttons of snack and soda machines in the break area of "the inside facility."

Surface wipe samples collected by FOH in March 2007 detected lead and cadmium on a number of surfaces in the camp glass breaking area. Wipe samples collected behind and on top of HEPA units and "near disassembly tables" indicated lead concentrations of 2,000 to 17,000 micrograms of lead per square foot ($\mu g/ft^2$). Cadmium concentrations in these locations were 200 $\mu g/ft^2$ to 2,700 $\mu g/ft^2$. Lower concentrations were found in other locations, e.g., on top of worker lockers. Wipe samples collected from a cable box in the former FCI glass breaking area indicated lead and cadmium concentrations of 3,300 and 7,700 $\mu g/ft^2$, respectively. Wipe samples collected in both glass breaking areas indicated the presence of lead and cadmium in dust.

NIOSH Exposure Assessment, July 16, 2008

Airborne concentrations of lead and cadmium are presented in Table 1, on page 11 of this letter. These concentrations are calculated over the actual sampling periods, i.e., these results are not reported as 8-hour time-weighted average (8-hr TWA) concentrations.

PBZ samples collected during morning and afternoon shifts on July 16, 2008, indicate that worker exposures were well-below the OSHA ALs for cadmium and lead. Area air samples, collected outside the glass breaking booth during glass breaking did not detect lead or cadmium above the minimum detectable concentrations for either of these elements. Air samples indicate that the HEPA units were effective at removing cadmium- and lead-bearing dust at the point of generation.

The results of wipe samples collected on July 16, 2008 results are presented in Table 2 on page 12. Wipe samples collected from inmate lockers and the table in the change-out area indicated concentrations of cadmium and lead ranging up to 0.89 $\mu g/100\ cm^2$ and up to 59 $\mu g/100\ cm^2$, respectively. Although concentrations inside lockers were generally low, the highest lead concentrations in locker #9 and on the change-out table indicate that some lead is being transported from the glass breaking area.

Wipe samples collected from face shields of PAPRs in two lockers (including locker #9) detected very little contamination. However, it appeared that the potential existed for spreading contamination from other PPE, such as Kevlar gloves and sleeves, to PAPRs stored in lockers. As noted above, new lockers for storing PAPRs separately from reuseable PPE were installed after the NIOSH evaluation.

Wipe samples collected from the floor in and near the forklift traffic area where Gaylord boxes are removed from the glass breaking booth, indicate that some lead and cadmium contamination is being carried out of the glass breaking booth despite work practice controls, such as restricting use of the glass breaking booth pallet jack to zone 7 and not allowing the forklift to enter the booth beyond zone 5. This suggests that although these work practice controls should help limit the amount of carry-out contamination, some lead- and cadmium- containing dust is still being carried out of the glass breaking booth.

Low, but quantifiable concentrations of cadmium and lead were present on the inmate clerk's desk which is located a few feet from the forklift traffic area. A trace amount of lead was detected on a desk in the UNICOR staff office. Although these results do not represent a serious health hazard, they show a need to maintain good housekeeping throughout the glass breaking area.

Hand wipe samples, collected at the end of each shift after hand washing, suggest that hand washing removes most, but not all contaminants. Glass breakers should be encouraged to wash hands carefully to remove as much contamination as possible, especially before going to lunch.

Conclusions

Electronics recycling at FCI Texarkana appears to have been performed from late 2001 until May 2004 without appropriate engineering controls, respiratory protection, medical surveillance, or industrial hygiene monitoring. Because of the sparse biological monitoring and industrial hygiene data, we cannot determine the extent of exposure to lead and cadmium that occurred during that time. Descriptions of work tasks from staff and inmates indicate that exposures during that time frame were likely higher than current exposures. Based on information provided to us, we believe that the current GBO is a significant improvement with respect to controlling worker exposures to cadmium and lead.

Exposures since May 2004 are sufficiently low that the OSHA mandated medical surveillance has not been required since that time. In addition, the results of medical surveillance conducted since 2003 on both inmates and staff were generally unremarkable. It is not possible to determine whether the exposures were high enough to trigger the standard prior to that time. Inmates are advised of the results of their monitoring and do see the physician's assistant; however, records of medical surveillance are not maintained by the employer for the appropriate length of time. Some staff members have refused to participate in medical surveillance paid for by UNICOR at their personal physicians

At this time, after careful review of existing records and current operations, we conclude that medical surveillance can be discontinued for inmates and staff who work in electronics recycling and GBO. UNICOR may choose to continue to perform the limited biological monitoring that is currently in place as an additional safeguard against excessive exposure and to provide reassurance to inmates and staff.

Recommendations

The following recommendations are provided to improve the safety and health of both the staff and inmates involved with electronics recycling at the FCI Texarkana.:

1. Although engineering controls and work practices in the current GBO appear to provide reasonably effective control of worker exposure to cadmium and lead, UNICOR needs to

maintain an ongoing program of environmental monitoring to confirm that engineering and work practice controls are sufficiently protective. Environmental monitoring also provides data needed to determine which provisions of the OSHA cadmium and lead standards should be applied for the GBO.

2. While air sampling in the GBO suggests that the level of protection afforded by PAPRs may not be needed, we feel that continued use of PAPRs provides added protection against exposure to lead- and cadmium- containing dust. Additional periodic air sampling should be conducted to help ensure that exposures remain consistently below all applicable OELs before considering a reduction in the level of respiratory protection in the GBO.

3. Ensure full compliance with all applicable OSHA standards, including the General Industry Lead Standard [29 CFR 1910.1025], the Cadmium Standard [29 CFR 1910.1027], the Hazard Communication Standard [29 CFR 1910.1200], and the Respiratory Protection Standard [29 CFR 1910.134]. This includes record keeping requirements, communication requirements, compliance plans, and medical surveillance.

4. Discontinue dry sweeping. Use a floor squeegee to carefully collect large pieces of debris that cannot be effectively vacuumed from the floor. Whenever possible, use a HEPA-filtered vacuum cleaner and/or wet methods for removing dust from all other surfaces.

5. Ensure that separate storage is provided for non-work uniforms and GBO work apparel/PPE. All potentially-contaminated work clothing and PPE should remain in the "dirty" chamber of the change-out room; non-work clothing should never come in contact with work items. As a minimum requirement, workers should be required to wash hands and all potentially exposed skin after doffing PPE and before putting on uniforms when exiting the GBO. To minimize migration of cadmium-and-lead-contaminated dust to other parts of the institution, work clothes and PPE should never be worn outside the GBO. Laundry personnel should be made aware of the potential exposure to lead and cadmium from work clothes, and take action to minimize exposure to themselves.

6. Carefully evaluate the qualifications and expertise of consultants who are hired to assess occupational or environmental health and safety issues. Anyone can present him/herself as an "industrial hygienist," regardless of education, training, or expertise. One useful benchmark for vetting individuals who provide industrial hygiene services is the designation of Certified Industrial Hygienist (CIH). Certification by the American Board of Industrial Hygiene (ABIH) ensures that prospective consultants have met ABIH standards for education, ongoing training, and experience, and have passed a rigorous ABIH certification examination. The UNICOR and/or BOP industrial hygienists can assist in the selection of your consultants.

7. Perform a detailed job hazard analysis prior to beginning any new operation or before making changes to existing operations. This will allow BOP to identify potential hazards prior to exposing staff or inmates, and to identify appropriate controls and PPE. Involve the BOP and/or UNICOR industrial hygienists in these job hazard analyses. If medical surveillance is needed then BOP should perform pre-placement evaluations of exposed staff and inmates. This medical surveillance should be overseen by an occupational medicine physician.

8. Appoint a union safety and health representative. This individual should be a regular participant on the joint labor-management safety committee that meets quarterly. Since inmates do not have a mechanism for representation on this committee, ensure that they are informed of its proceedings and that they have a way to voice their concerns about and ideas for improving workplace safety and health.

This interim letter will be included in a final report that will include visits to two other BOP facilities. Please post a copy of this letter for 30 days at or near work areas of affected staff and inmates. Thank you for your cooperation with this evaluation. If you have any questions, please do not hesitate to contact us at (513) 841-4382.

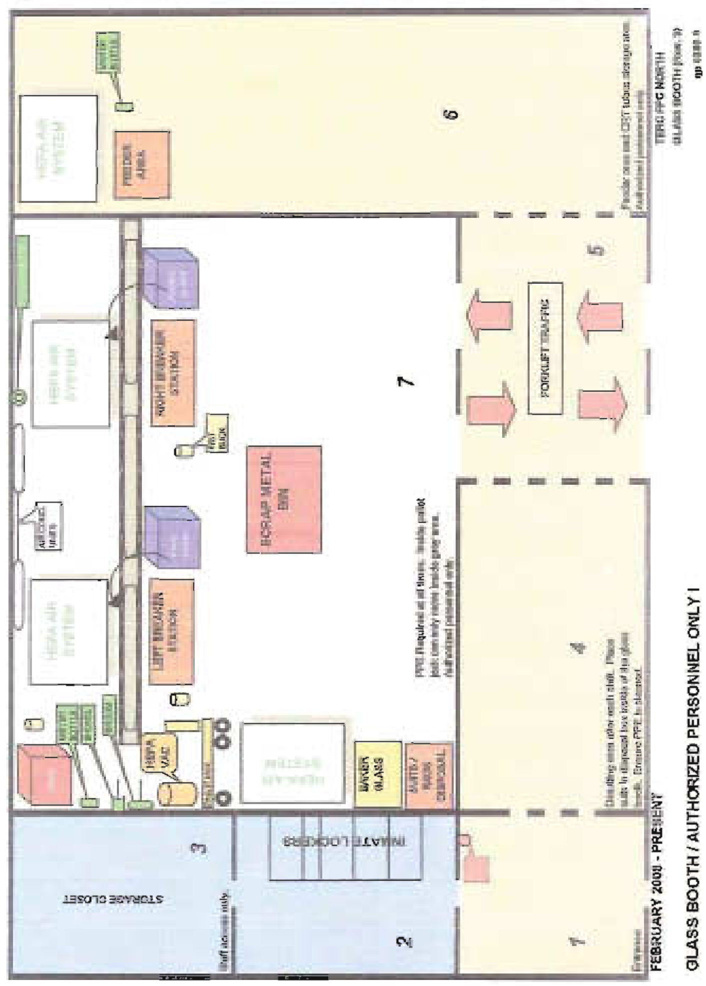
Sincerely yours,

Elena H. Page, M.D., M.P.H.
Medical Officer

David Sylvain, M.S., C.I.H.
Industrial Hygienist
Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

cc:
[redacted] Warden, FCI Texarkana
[redacted], President, AFGE Local 2459
Paul Laird, Assistant Director, UNICOR

Figure 1.


HEPA AIR SYSTEM
FEEDER AREA
6
5
FORKLIFT TRAFFIC
7
RIGHT BREAKER STATION
SCRAP METAL BIN
LEFT BREAKER STATION
HEPA VAC
4
STORAGE CLOSET
3
INMATE LOCKERS
2
1
GLASS BOOTH / AUTHORIZED PERSONNEL ONLY !

Tables

Table 1 HETA 2008-0055
Air sampling, July 16, 2008 Federal Bureau of Prisons
Glass Breaking Area FCI Texarkana

Location	Sampling Period (minutes)	Sample Volume (liters)	Cadmium (μg/m^3)	Lead (μg/m^3)
PBZ*—funnel glass breaker, a.m.	174	345	1.5	3.9
PBZ—panel glass breaker, a.m.	175	350	1.7	6.0
PBZ—feeder, a.m.	174	347	trace¶	trace
PBZ—feeder, a.m.	173	344	trace	trace
PBZ—funnel glass breaker, p.m.	129	256	1.3	7.0
PBZ—panel glass breaker, p.m.	127	253	0.59	4.0
PBZ—feeder, p.m.	125	249	trace	trace
PBZ—feeder,p.m.	124	247	trace	4.5
Area†—top of air handler #4	397	793	0.24	3.0
Area— table in change-out area	426	844	0.25	1.5
Area—forklift traffic area, right side, approx. 5.5' above floor	421	838	0.13	1.8
Area—inmate clerk desk, approx. 3.5' from forklift entry	414	820	nd**	nd
Area—approx. 10' from feeder area, 3' above floor	404	801	nd	nd
Minimum detectable concentration (MDC)‡ – PBZ			0.07	1.
Minimum quantifiable concentration (MQC)§ – PBZ			0.21	2.9
Minimum detectable concentration (MDC) – Area			0.02	0.4
NIOSH REL-TWA			Ca††	50
OSHA PEL-TWA			5	50
ACGIH TLV®			10	50

* PBZ—Personal breathing zone sample

† Area—Area sample

‡ MDC—Minimum detectable concentration. MDC is determined by the analytical limit of detection (LOD) for an analyte and the average sample volume. LOD for cadmium and lead are 0.02 ug/sample and 0.3 ug/sample, respectively. The average sample volumes for PBZ and area samples are 299 liters and 819 liters respectively.

§ MQC—Minimum quantifiable concentration. MQC is determined by the analytical limit of quantitation (LOQ) for an analyte and the average sample volume. LOQ for cadmium and lead are 0.063 ug/sample and 0.86 ug/sample, respectively.

¶ trace—Sample result is between the MDC and MQC.

** nd (not detected)—Sample result is below the MDC.

†† Ca—NIOSH regards cadmium as a potential occupational carcinogen and that exposures should be reduced to the lowest feasible concentration.

See the Appendix for a discussion of NIOSH recommended exposure limits (RELs), OSHA permissible exposure limits (PELs), and ACGIH Threshold Limit Values (TLVs®).

Table 2 — HETA 2008-0055
Surface wipe sampling, July 16, 2008 — Federal Bureau of Prisons
Glass Breaking Area — FCI Texarkana

Surface	Description	Area Wiped	Cadmium	Lead
		cm^2	µg/wipe	µg/wipe
Inmate “A” locker	bottom surface of locker	100	0.89	9.4
Inmate “B” locker	bottom surface of locker	100	0.44	31.
Inmate locker #7	bottom surface of locker #7	100	trace	8.9
Inmate “C” locker #9	bottom surface of locker #9	100	0.33	59.
Inmate “B” PAPR face shield	inside surface	100	trace*	1.8
Inmate “C” PAPR face shield	inside surface; in locker #9	100	nd†	trace
Change out table		100	2.5	57.
Floor	approx. 4’ outside forklift entry	100	1.1	60.
Inmate clerk desk	near forklift entry to booth	100	0.43	6.4
Floor	forklift traffic area	100	1.6	90.
Staff desk	in office	100	nd	trace
Inmate “B” hands	feeder (morning)	-	0.41	4.3
Inmate “A” hands	panel glass breaker (morning)	-	3.1	9.5
Inmate hands	funnel glass breaker(morning)	-	3.5	17.
Inmate hands	feeder (morning)	-	0.35	4.1
Inmate hands	feeder (afternoon)	-	trace	1.9
Inmate “A” hands	feeder (afternoon)	-	0.40	3.4
Inmate “C” hands	funnel glass breaker (afternoon)	-	2.4	21.
Inmate “B” hands	panel glass breaker(afternoon)	-	1.2	16.

Inmates “A,” “B,” and “C,” are three individual workers for whom multiple samples were collected.

* trace—Sample result is between the analytical limits of detection and quantitation. The limits of quantitation for cadmium and lead are 0.29 ug/sample and 1.3 ug/sample, respectively.

† nd (not detected)—Sample result is below the analytical limit of detection. The limits of detection for cadmium and lead are 0.09 ug/sample and 0.4 ug/sample, respectively.

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Appendix

Occupational Exposure Limits and Health effects

In evaluating the hazards posed by workplace exposures, NIOSH investigators use both mandatory (legally enforceable) and recommended occupational exposure limits (OELs) for chemical, physical, and biological agents as a guide for making recommendations. OELs have been developed by Federal agencies and safety and health organizations to prevent the occurrence of adverse health effects from workplace exposures. Generally, OELs suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. However, not all workers will be protected from adverse health effects even if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the exposure limit. Also, some substances can be absorbed by direct contact with the skin and mucous membranes in addition to being inhaled, which contributes to the individual's overall exposure.

Most OELs are expressed as a time-weighted average (TWA) exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday. Some chemical substances and physical agents have recommended short-term exposure limit (STEL) or ceiling values where health effects are caused by exposures over a short-period. Unless otherwise noted, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during a workday, and the ceiling limit is an exposure that should not be exceeded at any time.

In the U.S., OELs have been established by Federal agencies, professional organizations, state and local governments, and other entities. Some OELs are legally enforceable limits, while others are recommendations. The U.S. Department of Labor Occupational Safety and Health Administration's (OSHA) permissible exposure limits (PELs) (29 CFR[2] 1910 [general industry]; 29 CFR 1926 [construction industry]; and 29 CFR 1917 [maritime industry]) are legal limits enforceable in workplaces covered under the Occupational Safety and Health Act. NIOSH

[2] *Code of Federal Regulations.* See CFR in references.

recommended exposure levels (RELs) are recommendations based on a critical review of the scientific and technical information available on a given hazard and the adequacy of methods to identify and control the hazard. NIOSH RELs can be found in the *NIOSH Pocket Guide to Chemical Hazards* [NIOSH 2005]. NIOSH also recommends different types of risk management practices (e.g., engineering controls, safe work practices, worker education/training, personal protective equipment, and exposure and medical monitoring) to minimize the risk of exposure and adverse health effects from these hazards. Other OELs that are commonly used and cited in the U.S. include the threshold limit values (TLVs) recommended by the American conference of Governmental Industrial Hygienists (ACGIH), a professional organization, and the Workplace environmental exposure limits (WEELs) recommended by the American Industrial Hygiene Association, another professional organization. ACGIH TLVs are considered voluntary exposure guidelines for use by industrial hygienists and others trained in this discipline "to assist in the control of health hazards" [ACGIH 2008]. WEELs have been established for some chemicals "when no other legal or authoritative limits exist" [AIHA 2007].

Outside the U.S., OELs have been established by various agencies and organizations and include both legal and recommended limits. Since 2006, the Berufsgenossenschaftlichen Institut für Arbeitsschutz (German Institute for Occupational Safety and Health) has maintained a database of international OELs from European Union member states, Canada (Québec), Japan, Switzerland, and the U.S. [http://www.hvbg.de/e/bia/gestis/limit_values/index.html]. The database contains international limits for over 1250 hazardous substances and is updated annually.

Employers should understand that not all hazardous chemicals have specific OSHA PELs, and for some agents the legally enforceable and recommended limits may not reflect current health-based information. However, an employer is still required by OSHA to protect its employees from hazards even in the absence of a specific OSHA PEL. OSHA requires an employer to furnish employees a place of employment free from recognized hazards that cause or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970 (Public Law 91–596, sec. 5(a)(1))]. Thus, NIOSH investigators encourage employers to make use of other OELs when making risk assessment and risk management decisions to best protect the health of their employees. NIOSH investigators also encourage the use of the traditional hierarchy of controls approach to eliminate or minimize identified workplace hazards. This includes, in order of preference, the use of: (1) substitution or elimination of the hazardous agent, (2) engineering controls (e.g., local exhaust ventilation, process enclosure, dilution ventilation), (3) administrative controls (e.g., limiting time of exposure, employee training, work practice changes, medical surveillance), and (4) personal protective equipment (e.g., respiratory protection, gloves, eye protection, hearing protection). Control banding, a qualitative risk assessment and risk management tool, is a complementary approach to protecting worker health that focuses resources on exposure controls by describing how a risk needs to be managed [http://www.cdc.gov/niosh/topics/ctrlbanding/]. This approach can be applied in situations where OELs have not been established or can be used to supplement the OELs, when available.

Lead

Occupational exposure to lead occurs via inhalation of lead-containing dust and fume and ingestion of lead particles from contact with lead-contaminated surfaces. In cases where careful attention to hygiene (for example, handwashing) is not practiced, smoking cigarettes or eating may represent another route of exposure among workers who handle lead and then transfer it to their mouth through hand contamination. Industrial settings associated with exposure to lead and lead compounds include smelting and refining, scrap metal recovery, automobile radiator repair, construction and demolition (including abrasive blasting), and firing range operations [ACGIH 2001]. Occupational exposures also occur among workers who apply and/or remove lead-based paint or among welders who burn or torch-cut metal structures.

Acute lead poisoning, caused by intense occupational exposure to lead over a brief period of time can cause a syndrome of abdominal pain, fatigue, constipation, and in some cases alteration of central nervous system function [Moline and Landrigan 2005]. Symptoms of chronic lead poisoning include headache, joint and muscle aches, weakness, fatigue, irritability, depression, constipation, anorexia, and abdominal discomfort [Moline and Landrigan 2005]. These symptoms usually do not develop until the blood lead level (BLL) reaches 30-40 micrograms per deciliter of whole blood (µg/dL)[Moline and Landrigan 2005]. Overexposure to lead may also result in damage to the kidneys, anemia, high blood pressure, impotence, and infertility and reduced sex drive in both sexes. Studies have shown subclinical effects on heme synthesis, renal function, and cognition at BLLs <10 µg/dL [ATSDR 2007]. Inorganic lead is reasonably anticipated to cause cancer in humans [ATSDR 2007].

In most cases, an individual's BLL is a good indication of recent exposure to lead, with a half-life (the time interval it takes for the quantity in the body to be reduced by half its initial value) of 1-2 months [Lauwerys and Hoet 2001; Moline and Landrigan 2005; NCEH 2005;]. The majority of lead in the body is stored in the bones, with a half-life of years to decades. Bone lead can be measured using x-ray techniques, but these are primarily research based and are not widely available. Elevated zinc protoporphyrin (ZPP) levels have also been used as an indicator of chronic lead intoxication, however, other factors, such as iron deficiency, can cause an elevated ZPP level, so the BLL is a more specific test for evaluating occupational lead exposure.

In 2000, NIOSH established an REL for inorganic lead of 50 micrograms per cubic meter of air (µg/m3) as an 8-hour TWA. This REL is consistent with the OSHA PEL, which is intended to maintain worker BLLs below 40 µg/dl; medical removal is required when an employee has a BLL of 60 µg/dL, or the average of the last 3 tests at 50 µg/dL or higher [29 CFR 1910.1025; 29 CFR 1962.62]. NIOSH has conducted a literature review of the health effects data on inorganic lead exposure and finds evidence that some of the adverse effects on the adult reproductive, cardiovascular, and hematologic systems, and on the development of children of exposed workers can occur at BLLs as low as 10 µg/dl [Sussell 1998]. At BLLs below 40 µg/dl, many of the health effects would not necessarily be evident by routine physical examinations but represent early stages in the development of lead toxicity. In recognition of this, voluntary standards and public health goals have established lower exposure limits to protect workers and their children. The ACGIH TLV for lead in air is 50 $\mu g/m^3$ as an 8-hour TWA, with worker

BLLs to be controlled to ≤ 30 µg/dl. A national health goal is to eliminate all occupational exposures that result in BLLs >25 µg/dl [DHHS 2000]. The Third National Report on Human Exposure to Environmental Chemicals (TNRHEEC) found the geometric mean blood lead among non-institutionalized, civilian males in 2001-2002 was 1.78 µg/dL [NCEH 2005].

OSHA requires medical surveillance on any employee who is or may be exposed to an airborne concentration of lead at or above the action level, which is 30 µg/m^3 as an 8-hour TWA for more than 30 days per year [29 CFR 1910.1025]. Blood lead and ZPP levels must be done at least every 6 months, and more frequently for employees whose blood leads exceed certain levels. In addition, a medical examination must be done prior to assignment to the area, and should include detailed history, blood pressure measurement, blood lead, ZPP, hemoglobin and hematocrit, red cell indices, and peripheral smear, blood urea nitrogen (BUN), creatinine, and a urinalysis. Additional medical exams and biological monitoring depend upon the circumstances, for example, if the blood lead exceeds a certain level.

Cadmium

Cadmium is a metal that has many industrial uses, such as in batteries, pigments, plastic stabilizers, metal coatings, and television phosphors [ACGIH 2001]. Workers may inhale cadmium dust when sanding, grinding, or scraping cadmium-metal alloys or cadmium-containing paints [ACGIH 2001]. Exposure to cadmium fume may occur when materials containing cadmium are heated to high temperatures, such as during welding and torching operations; cadmium-containing solder and welding rods are also sources of cadmium fume. In addition to inhalation, cadmium may be absorbed via ingestion; non-occupational sources of cadmium exposure include cigarette smoke and dietary intake [ACGIH 2001]. Early symptoms of cadmium exposure may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or cough. Short-term exposure effects of cadmium inhalation include cough, chest pain, sweating, chills, shortness of breath, and weakness [Thun et al. 1991]. Short-term exposure effects of ingestion may include nausea, vomiting, diarrhea, and abdominal cramps [Thun et al. 1991]. Long-term exposure effects of cadmium may include loss of the sense of smell, ulceration of the nose, emphysema, kidney damage, mild anemia, and an increased risk of cancer of the lung, and possibly of the prostate [ATSDR 1999].

The OSHA PEL for cadmium is 5 µg/m^3 TWA [29 CFR 1910.1027]. The ACGIH has a TLV for total cadmium of 10 µg/m^3 (8-hour TWA), with worker cadmium blood level to be controlled at or below 5 µg/dL and urine level to be below 5 µg/g creatinine, and designation of cadmium as a suspected human carcinogen [ACGIH 2008]. NIOSH recommends that cadmium be treated as a potential occupational carcinogen and that exposures be reduced to the lowest feasible concentration [NIOSH 1984].

Blood cadmium levels measured while exposure is ongoing reflect fairly recent exposure (in the past few months). The half-life is biphasic, with rapid elimination (half-life approximately 100 days) in the first phase, but much slower elimination in the second phase (half-life of several years) [Lauwerys and Hoet 2001; Franzblau 2005]. Urinary cadmium levels are reflective of body burden and have a very long half-life of 10-20 years [Lauwerys and Hoet 2001].

OSHA requires medical surveillance on any employee who is or may be exposed to an airborne concentration of cadmium at or above the action level, which is 2.5 µg/m^3 as an 8-hour TWA for more than 30 days per year [29 CFR 1910.1027]. A preplacement examination must be provided, and shall include a detailed history, and biological monitoring for urine cadmium (CdU) and beta-2-microglobulin (B-2-M), both standardized to grams of creatinine (g/Cr), and blood cadmium (CdB), standardized to liters of whole blood (lwb). OSHA defines acceptable CdB levels as < 5 µg/L, CdU as < 3 µg/g/Cr, and B-2-M as < 300 µg/g/Cr. NHANES III found geometric mean CdB of 0.4 µg/L among men in 1999-2000. The geometric mean CdU for men in 2001-2002 was 0.2 µg/g/Cr. Smokers can have CdB levels double that of nonsmokers [Lauwerys and Hoet 2001]. Periodic surveillance is also required one year after the initial exam and at least biennially after that. Periodic surveillance shall include the biological monitoring, history and physical examination, a chest x-ray (frequency to be determined by the physician after the initial x-ray), pulmonary function tests, blood tests for BUN, complete blood count (CBC), and Cr, and a urinalysis. Men over 40 years of age require a prostate examination as well. The frequency of periodic surveillance is determined by the results of biological monitoring and medical examinations. Biological monitoring is required annually, either as part of the periodic surveillance or on its own. We recommend that the preplacement examination be identical to the periodic examinations so that baseline health status may be obtained prior to exposure. Termination of employment examinations, identical to the periodic examinations, are also required. The employer is required to provide the employee with a copy of the physician's written opinion from these exams and a copy of biological monitoring results within 2 weeks of receipt.

Biological monitoring is also required for all employees who may have been exposed at or above the action level unless the employer can demonstrate that the exposure totaled less than 60 months. In this case it must also be conducted one year after the initial testing. The need for further monitoring for previously exposed employees is then determined by the results of the biological monitoring.

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ATTACHMENT 4

U.S. ENVIRONMENTAL PROTECTION AGENCY

RESOURCE CONSERVATION & RECOVERY ACT
COMPLIANCE EVALUATION INSPECTION REPORT

Facility Name: **TEXARKANA FEDERAL CORRECTIONAL INSTITUTION**

EPA ID Number: **TX0151909132** Inspection Date: **November 18-19, 2008**

Facility Location: **4001 Leopard Drive**
Texarkana, Texas 75505

Facility Mailing Address: **P.O. Box 9500**
Texarkana, Texas 75505

Type of Industry: **NAICS Codes: 922140**

[redacted]

Telephone: [redacted]

Facility Description: **Texarkana Federal Correctional Institution (FCI) is a low security federal prison housing male inmates.**

Type of Ownership: X Federal __State __County __Municipal __Private

Did facility request a copy of the report? X YES __NO

HW Activities:	X Gen	__Treatment	__Storage (<90d)
	__Storage	__Disposal	__Transporter

Inspect. Type:	X Lead	__Overview	__Subpart CC
	X CEI	__CDI	__Sampling
	__PCE	__Land Ban	__BIF
	__Multi-Media		__Maquiladora

Inspection Participants: (name and phone number)

EPA Lead Inspector: **Ryan Rosser** **(214) 665-2247**

Facility Representatives: [redacted]

See Attachment A for list of Facility Representatives

Other Participants:

Joyce Johnson (EPA Region 6)	**(214) 665-8548**
Paul James (EPA Region 6)	**(214) 665-6445**
Randall Humm (DOJ OIG)	**(202) 353-0332**

Checklists Completed: (Indicate number attached.)

X_Generator	___TSD	___Transporter	___Generator Supplement
___Containers	___Incinerator	___Landfill	___Surface Impoundments
___Tanks	___Land Ban	___Groundwater	___Land Treatment
___Used Oil	___BIF	___Waste Piles	___Thermal Treatment
___Subpart CC	___LOIS	___Closure	___Post Closure
___Subpart BB	___Subpart AA		
X_Photographs	___Chemical, Physical, Biological Treatment		
X_Attachments (facility documents)			

Apparent violations noted during out briefing: **See Narrative - Areas of Concern Section**

Reviewed by: [signature] Date: 1/23/09

TEXARKANA FEDERAL CORRECTIONAL INSTITUTION - NARRATIVE

Introduction

On Tuesday and Wednesday, November 18-19, 2008, the U.S. Environmental Protection Agency (EPA) conducted a Resource Conservation & Recovery Act (RCRA) compliance evaluation inspection (CEI) at the Texarkana Federal Correctional Institution (Texarkana FCI), located in Texarkana, Texas. The purpose of the inspection was to observe and review the facility's solid and hazardous waste management practices, specifically as they pertain to RCRA.

The lead EPA Inspector, Mr. Ryan Rosser, accompanied by EPA Inspectors, Ms. Joyce Johnson, and Mr. Paul James (Inspectors) and the Office of the Inspector General (OIG) for the U.S. Department of Justice (DOJ) representative, [redacted] arrived at the Texarkana FCI the morning of November 18, 2008 to begin the CEI. The lead EPA Inspector presented the correctional officer stationed at the main entrance with his credentials, announced the purpose of the visit, and requested to see the facility environmental manager. The correctional officer contacted [redacted], the warden for the Texarkana FCI. Shortly thereafter, the EPA Inspectors and Mr. Humm adjourned to a conference room to meet with [redacted] and other Texarkana FCI staff. Attachment A provides the list of names present during the entrance meeting. During the entrance meeting, the lead EPA Inspector showed [redacted] his credentials, handed him a xeroxed copy of the RCRA Section 3007, and explained the EPA's authority to conduct inspections and the reason for the CEI. The entrance meeting continued with [redacted] and his staff discussing Texarkana FCI operations and processes, and solid/hazardous waste management practices with the EPA Inspectors.

Background/History

The Texarkana FCI is a low security federal prison that opened in 1940, occupying approximately 320 acres and housing roughly 1,700 male inmates. The Texarkana FCI also includes a satellite camp located on the outside of the prison. The satellite camp provides additional housing and work space for inmates to breakdown electronic waste (e-waste) for recycling and product recovery for profit. The inmates are supervised and managed by UNICOR. UNICOR, also referred to as Federal Prison Industries, is a wholly-owned government corporation created by Congress in June of 1934 for the purpose of training and providing job skills to inmates. UNICOR started at the Texarkana FCI in 1950.

Operations/Processes

The Texarkana FCI has two main inmate work programs. One inmate work program is e-waste breakdown and recycling and the other is constructing industrial air-filters. Additional inmate work programs include but are not limited to; providing general vehicle maintenance, machine shop activities, and painting activities. The inmates work under the hours of 0700 to 1000, and 1200 to1400 Central Standard Time (CST), five (5) days per week. Prior to conducting the EPA CEI, the Texarkana FCI was reporting as a Conditionally Exempt Small Quantity Generator (CESQG), however, the lead EPA Inspector determined the Texarkana FCI to be a Small Quantity Generator (SQG).

The e-waste breakdown and recycling operations are conducted in the UNICOR warehouse located in the Texarkana FCIs satellite area outside the prison walls, and the Texarkana FCI Recycling Factory which is located inside of the prison walls on the floor below the Industrial Filter Factory. Additionally, the UNICOR warehouse includes a glass breaking room for computer monitor breakdown activities. According to the Texarkana FCI staff, UNICOR trucking contractors transport in 53' tractor trailers of Gaylor boxes and/or shrink wrapped e-waste on wooden pallets. E-waste includes but is not limited to; used computers, telephones, mobile phones, recorders, routers, and printers generated from schools, private industries, and other governmental agencies. The pallets are offloaded into the UNICOR warehouse where they are weighed and then sorted. The inmates begin the process by sorting and separating the working electronics from the non-working electronics. Working electronics are sold via internet and non-working electronics are dismantled for commodity parts and recycling. According to Texarkana FCI staff, the prison discards between 0% and 1% of e-waste trucked in to the UNICOR warehouse.

Used computer monitors that contain cathode ray tubes (CRT) are taken to the glass breaking room. The glass breaking room is encompassed with clear plastic stripping. Computer screens are inserted into the glass breaking room through a small, pull-back opening in the stripping onto a narrow track table with rollers to help push the computer screen along. The computer screens are previously separated by sorting funnel glass from panel glass. There are two work stations along the track table operated by inmates. One work station is used for breaking funnel glass and the other for panel glass. As the inmate breaks the glass with a hammer, the glass pieces and shards fall through multiple openings in the track table and into large cardboard Gaylor boxes. Once the Gaylor box is full, it is closed and stored in the Pole Barn until it is sold to a glass recycler.

According to Texarkana FCI staff, approximately 300 to 400 computer screens are broken per day. There are three (3) hepavac filter units inside of the glass breaking room and one (1) just outside of the glass breaking room. The hepavac filter units are utilized to filter out dust particulates generated from the glass breaking activities. The spent hepavac filters are replaced with new filters weekly. The spent hepavac filters are placed and stored in large cardboard Gaylor boxes for disposal along with spent personal protective equipment (PPE). New analytical data provided by the Texarkana FCI showed the spent hepavac filters to be characteristically hazardous for lead. According to manifests reviewed during the CEI, the Gaylor boxes used for storing spent hepavac filters and PPE were collected by Safety-Kleen and transported to the Safety-Kleen Systems, Inc. facility (TXD077603371) located in Denton, Texas for disposal. Additionally, manifest reviewed during the CEI reported the contents as non regulated solids.

Another inmate work program includes inmates constructing industrial air filters in the Texarkana FCI Industrial Filter Factory. The Industrial Filter Factory lies directly above the Recycling Factory. According to Texarkana FCI staff, inmates put together industrial air filters for the U.S. Government. Materials such as wire mesh, glue, and media are transported in and stored in the Industrial Filter Factory warehouse until used in the construction of air filters. There are between thirty-two (32) and thirty-four (34) inmates working at any one time. The inmates operate a laminate machine to mesh the materials together. The industrial filters are then pushed through a pleater machine. According to Texarkana FCI staff, inmates dispose of excess materials in the municipal trash bins not used in the construction of industrial filters.

Inmates also provide general vehicle maintenance activities in the Texarkana FCI garage. General vehicle maintenance activities include changing out used oil, used oil filters, used transmission fluid and used antifreeze. According to Texarkana FCI staff, the garage generates approximately two (2) 55-gallon containers of used oil per month and one spent car battery per month. The garage also houses two (2) – 3,000 gallon underground storage tanks (USTs) for fuel. According to Texarkana FCI documents reviewed during the CEI, used oil is collected by Safety-Kleen Systems (TXD000747378) located in Longview, Texas and spent batteries are collected and replaced by Napa Auto Parts in Texarkana, Texas. The Texarkana FCI garage also has three (3) Safety-Kleen parts washers. According to Texarkana FCI staff, Safety-Kleen Systems services the parts washers.

The Texarkana FCI has an electrical shop that houses supplies used for providing electrical maintenance for the entire Texarkana FCI. A Texarkana FCI staff member accompanied by inmates will conduct electrical maintenance work requested for the Texarkana FCI. Spent fluorescent bulbs are stored in the electrical shop until collected for recycling. According to Texarkana FCI staff, the spent bulbs are collected by a contractor, CED. Additionally, inmates also work in the Texarkana FCI machine shop. According to Texarkana FCI staff, the machine shop provides general activities for the Texarkana FCI such as welding and sandblasting for repairing old metal parts. Inmates also conduct painting operations for Texarkana FCI. Solvents generated from cleaning spray guns are containerized and collected by Safety-Kleen Systems for disposal.

The Texarkana FCI was determined to be a SQG at the time of the CEI which generate between 220 lbs and 2,200 lbs of hazardous waste per month. At the time of the CEI, the Texarkana FCI generated spent hepavac filters and PPE from their glass breaking operations that were analyzed for lead above RCRA regulatory requirements. The Texarkana FCI also generated spent car batteries, spent fluorescent bulbs, paint and paint related waste, used oil, used oil filters, solvent from 3-parts washers and spent sand from sand blasting operations. According to manifests reviewed and Texarkana FCI staff interviewed during the CEI, spent hepavac filters and PPE were collected by Safety-Kleen Systems and transported to the Safety-Kleen Systems facility (TXD077603371) in Denton, Texas. The Texarkana FCI generated approximately 290 lbs per month. The Texarkana FCI generated about one spent car battery per month. Documentation reviewed during the CEI showed that spent car batteries were collected by Bumper to Bumper Auto parts and Napa Auto Parts located in Texarkana, Texas. According to Texarkana FCI staff, spent fluorescent bulbs are collected by CED. At the time of the inspection, it was unclear how many spent fluorescent lamps the Texarkana FCI generates per month. The Texarkana FCI generated approximately sixty (60) gallons of paint related waste per month. Texarkana FCI staff stated Safety-Kleen collects paint related waste for disposal. Additionally, Safety-Kleen collects used oil, used oil filters and services the parts washers for the Texarkana FCI. The prison generates about 110-gallons of used oil per month. At the time of the inspection, it was unclear how much spent solvent is generated per month from the parts washers. It was also unclear how much spent sand is generated from sand blasting operations.

Site Tour

After the EPA Inspectors, Mr. Humm, and the Texarkana FCI staff completed discussing the prisons processes and inmate work programs, the lead EPA Inspector requested to conduct a site tour of the prison. The EPA Inspectors, [redacted] and Texarkana FCI staff left the conference room and arrived at the UNICOR warehouse which is located at the satellite camp outside of the prison walls.

The UNICOR warehouse provides workspace for inmates to breakdown used electronics for recycling and resale. The used electronics are transported to the Texarkana FCI via tractor trailer and stored in Gaylor boxes wrapped in shrink wrap prior to being broken down. The EPA Inspector observed several rows of boxed and shrink wrapped used electronics (Photograph #1). The Texarkana FCI staff explained the breakdown process of the used electronics to the lead EPA Inspector. According to the Texarkana FCI staff, the used electronics are tested by the inmates to determine whether there working or non-working. Working electronics are re-sold via internet. Non-working electronics are broken down and sold as recyclable parts. During the breakdown process, inmates separate the panel glass and the funnel glass from the computer monitors. The funnel glass and panel glass are taken to the glass breaking room inside of the UNICOR warehouse. Attachment D provides a site map of the glass breaking room. At the time of the inspection, the lead EPA Inspector observed a corner area of the UNICOR warehouse encompassed with clear plastic stripping from floor to ceiling. The plastic stripping had a sign that posted, "Hazardous Area" (Photograph #2). During the inspection, the lead EPA Inspector observed the work area for the glass breaking activities (Photograph #3). Cardboard boxes are used to catch the broken glass which is later sold to glass recyclers. Large hepavac filters are utilized to capture dust particulates from the glass breaking activities (Photograph #4). As a result of lead in the cathode ray tubes in funnel glass, the hepavac filters were analyzed to be characteristically hazardous. At the time of the inspection, the lead EPA Inspector observed a cardboard Gaylor Box inside of the glass breaking room (Photograph #5). According to Texarkana FCI staff, the Gaylor Box contained spent hepavac filters and spent PPE generated from glass breaking operations. The lead EPA Inspector did not observe any hazardous waste labels or markings and/or accumulation dates on the Gaylor Box.

Next, the EPA Inspectors, [redacted] and Texarkana FCI staff left the UNICOR warehouse and arrived at the Industrial Filter Factory. The lead EPA Inspector observed the storage area first. The storage area contained multiple rows of cardboard boxes stacked on wooden pallets (Photograph #6). According to the Texarkana FCI staff, the storage area houses raw materials and supplies used for making industrial air filters. Immediately adjacent to the storage area was the production floor. The production floor provides work space for inmates to construct the industrial air filters. At the time of the inspection, the lead EPA Inspector observed spray bottles labeled "3-36". According to Texarkana FCI staff, the 3-36 spray bottles are used as a solvent to clean the machines used in the construction of industrial filters. The spent rags generated from cleaning activities are disposed of in the municipal trash. The material safety data sheet (MSDS) for 3-36 is provided in Attachment D.

Next, the EPA Inspectors, [redacted], and Texarkana FCI staff left the Filter Factory and arrived at the Pole Barn. According to Texarkana FCI staff, the Pole Barn is utilized for storing incoming and outgoing electronics. The lead EPA Inspector observed electronic items either stored in cardboard boxes or shrink wrapped on wooden pallets (Photograph #7). Electronics that were sold and about to be shipped offsite contained an identification label providing the contents of the outgoing shipment. The lead EPA Inspector observed two separate identification labels for outgoing shipments. One identification label read CRT panel glass and the second read CRT funnel glass (Photographs #8-9). At the time of the inspection, the lead EPA Inspector did not observe any RCRA hazardous waste being generated and/or stored.

After inspecting the Pole Barn, the EPA Inspectors, [redacted], and Texarkana FCI staff arrived back at the UNICOR warehouse. Through discussions between the lead EPA Inspector and Texarkana FCI staff on incoming electronics, the lead EPA Inspector learned the prison sometimes receives used electronic components containing mercury. According to Texarkana FCI staff, the components are packaged back up and collected by Federal Express. At the time of the inspection, the Texarkana FCI had one 5-gallon plastic bucket ready for collection (Photograph #10). The package was labeled as universal waste (Photograph #11).

Next, the EPA Inspectors, [redacted], and the Texarkana FCI staff arrived at the prison's maintenance garage. According to Texarkana FCI staff, the maintenance garage is used by inmates to conduct general vehicle maintenance. At the time of the inspection, the lead EPA Inspector observed twelve (12) 55-gallon steel containers located in a small concrete bermed corner of the garage (Photograph #12). Texarkana FCI staff stated the contents of the 55-gallon containers included unused motor oil, unused hydraulic fluid, and used oil. Three (3) 55-gallon containers were storing used oil at the time of the inspection and were labeled used oil. The maintenance garage also contained a parts washer. According to Texarkana FCI staff, the parts washer is serviced by Safety-Kleen Systems. At the time of the inspection the lid to the parts washer was open (Photograph #13). The lead EPA Inspector informed the Texarkana FCI staff the lid to the parts washer should remain closed when not in use. Immediately after, Texarkana

FCI staff closed the lid to the parts washer. The lead EPA Inspector also observed one sand blasting machine. According to Texarkana FCI staff, the sand blasting machine is used twice about every six months.

After inspecting the maintenance garage, the EPA Inspectors, [redacted], and Texarkana FCI staff arrived at the old prison Milk Barn. According to Texarkana FCI staff, the old prison Milk Barn was used in the past as a dairy farm worked by the inmates and then as workspace for glass breaking operations. Currently, the old prison Milk Barn is used as a storage place for incoming e-waste. At the time of the inspection, the lead EPA Inspector observed cardboard boxes and shrink wrapped pallets of used electronics.

Next, the EPA Inspectors, [redacted], and Texarkana FCI staff arrived at the Recycling Factory. The Recycling Factory is the floor located directly below the Industrial Filter Factory. According to Texarkana FCI staff, the Recycling Factory provides inmates work space for dismantling e-wastes for resale and/or recycling. However, Texarkana FCI staff stated that no computer monitors are dismantled in this area anymore and that all glass breaking activities are conducted in the glass breaking room located in the UNICOR warehouse. Waste generated from activities conducted in the Recycling Factory is stored in the hot room. Inside the Recycling Factory hot room, the lead EPA Inspector observed multiple steel and plastic containers. One 55-gallon container was labeled "Hepavac" (Photograph #14). According to Texarkana FCI staff, the contents of the container included spent hepavac filters, spent rags, and spent PPE generated from dismantling electronic wastes. The lead EPA Inspector also observed a 30-gallon steel container with no labels and/or markings (Photograph #15). According to Texarkana FCI staff, the container was currently storing used oil. The Recycling Factory also contains a gated break room. Texarkana FCI staff stated the break room was formerly used for glass breaking activities. The lead EPA Inspector observed a hole in the ceiling that was previously used as a vent shaft (Photograph #16).

The EPA Inspectors, [redacted], and Texarkana FCI staff next arrived at the prison's Facilities Area. The Facilities Area contained one parts washer, one sand blasting machine, painting booth and hot room. At the time of the inspection, the lead EPA Inspector observed "black beauty" sand inside the sand blasting machine. According to Texarkana FCI staff, the spent black beauty sand is disposed of in the municipal trash and no analytical has been conducted on the spent sand to determine the presence of RCRA hazardous constituents. The lead EPA Inspector also observed the paint booth. At the time of the inspection, no waste was observed in the paint booth; however, Texarkana FCI staff stated spent paint filters generated from painting operations are disposed of in the municipal trash. Directly adjacent to the paint booth was the Facilities Area hot room. The lead EPA Inspector observed two (2) steel containers with no labels and/or markings (Photograph #17). According to Texarkana FCI staff, the containers were currently storing spent xylene and paint waste generated from paint spray gun cleaning activities.

The EPA Inspectors, [redacted] and Texarkana FCI staff concluded the site tour by observing the prison's Municipal Trash Area and Power Plant. At the time of the inspection, the lead EPA Inspector did not observe any RCRA related waste in the Municipal Trash Area and/or the Power Plant. At the completion of the CEI, the EPA Inspectors, Mr. Humm, and Texarkana FCI staff arrived back at the main conference room to finalize the list of documents needed for the records review.

Records Review

During the entrance interview and site tour, the lead EPA Inspector requested a list of documents for review. Of the requested documents, the Texarkana FCI was unable to provide documentation for their disposal methods for spent fluorescent bulbs at the time of the CEI. However, within a few days after the CEI, copies of the documentation was mailed to and received by the lead EPA Inspector. Attachment D provides copies of the documents requested for the records review. After reviewing the requested documents, the EPA Inspector conducted an exit briefing with the Texarkana [redacted] and additional Texarkana FCI staff. During the exit briefing, the lead EPA Inspector outlined areas of concern. The areas of concern are listed in the section titled, "Areas of Concern".

Areas of Concern

1.) During the inspection, it was noted by the lead EPA Inspector that spent hepavac filters generated from the glass breaking operations in the UNICOR warehouse had been disposed of as non-hazardous waste prior to conducting a Toxicity Characteristic Leaching Procedure (TCLP) on the spent hepavac filters. TCLP analytical data showed the spent hepavac filters to be characteristically hazardous for lead (D008) and chromium (D007).

2.) During the inspection, the lead EPA Inspector observed an open cardboard Gaylor Box located inside of the glass breaking room of the UNICOR warehouse storing spent hepavac filters and spent personal protective equipment (PPE). Based on analytical data and process knowledge, the contents of the Gaylor Box were characteristically hazardous for lead (D008) and/or chromium (D007). The Gaylor Box did not have any labels and/or markings with the words "Hazardous Waste" and did not have accumulation dates.

- In accordance with 40 CFR 265.173(a) – a container holding hazardous waste must always be closed during storage, except when necessary to add or remove waste.
- In accordance with 40 CFR 262.34 (a)(2) – a generator may accumulate hazardous waste on-site for 180 days or less without a permit provided the date upon which each period of accumulation begins is clearly marked and visible for inspection of each container.
- In accordance with 40 CFR 262.34 (a)(3) – a generator may accumulate hazardous waste on-site for 180 days or less without a permit provided that while being accumulated on-site, each container is labeled or marked clearly with the words "Hazardous Waste".

3.) During the inspection, the lead EPA Inspector observed an unlabeled and/or unmarked 30-gallon steel container located in the hot room of the Recycling Factory. Texarkana FCI staff stated the container was storing used oil.

- In accordance with 40 CFR 279.22(c)(1) – containers and aboveground tanks used to store used oil at generator facilities must be labeled or marked clearly with the words "Used Oil".

4.) During the inspection, the lead EPA Inspector observed two (2) unlabeled and/or unmarked 30-gallon steel containers located in the hot room of the Facilities Area. Texarkana FCI staff stated the containers were storing spent xylene and paint waste.

- In accordance with 30 TAC (Texas Administrative Code) Section 335.262(c)(2)(F) – Universal paint Waste – container, multiple container package unit, tank, transport vehicle or vessel must be labeled or marked with the words "Universal Waste – Paint and Paint Related Wastes".

5.) During the inspection, the lead EPA Inspector observed a sand blasting machine. The sand blasting machine contained "black beauty". Texarkana FCI staff stated the spent black beauty is disposed of in the municipal trash and no analytical to determine the presence of RCRA hazardous constituents has been performed.

- In accordance with 40 CFR 262.11 – a person who generates a solid waste as defined in 40 CFR 261.2 must determine if that waste is a hazardous waste and in accordance with 40 CFR 261.2(a)(1) – A solid waste is any discarded material that is not excluded by 261.4(a) or that is not excluded by variance granted under 260.30 and 260.31.

Index to the Attachments

A. RCRA CEI Participants

- Sign in Sheet

B. Photographic Documentation

- Photographic Log

C. Inspection Checklist

- Generators Checklist

D. Documents Submitted by Texarkana FCI

- Site Map of Glass Breaking Room
- Analytical Data for Spent Hepavac Filters
- Manifest for Used PPE
- Spent Batteries Receipts
- Used Oil Receipts
- Mercury Recycling Receipts
- Material Safety Data Sheet – (3-36) Cleaner

ATTACHMENT A

RCRA CEI PARTICIPANTS

11/18/08

Name	Agency	Phone
Paul James	EPA	[redacted]
[redacted]	BOP [redacted]	[redacted]
	BOP	[redacted]
	BOP	[redacted]
	BOP [redacted]	[redacted]
Joyce Johnson	EPA	[redacted]
[redacted]	BOP	[redacted]
Randall Humm	OIG	[redacted]
[redacted]	BOP	[redacted]
Ryan Rosser	EPA	[redacted]
[redacted]	AFGE 2459 [redacted]	[redacted]
	BOP/Unicor [redacted]	
	BOP [redacted]	[redacted]
	BOP/[redacted]	[redacted]

* FBOP – Texarkana – Pre Inspection Report

POST INSPECTION REPORT 11/19/08 – FBOP TEXARKANA

NAME	AGENCY	PHONE	
PAUL JAMES	US EPA	[redacted]	
RYAN ROSSER	US EPA	[redacted]	
JOYCE JOHNSON	US EPA	[redacted]	
[redacted]	BOP		[redacted].bop.gov
	BOP		
	BOP		
	BOP		
	BOP	[redacted]	

ATTACHMENT B

PHOTOGRAPHIC DOCUMENTATION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

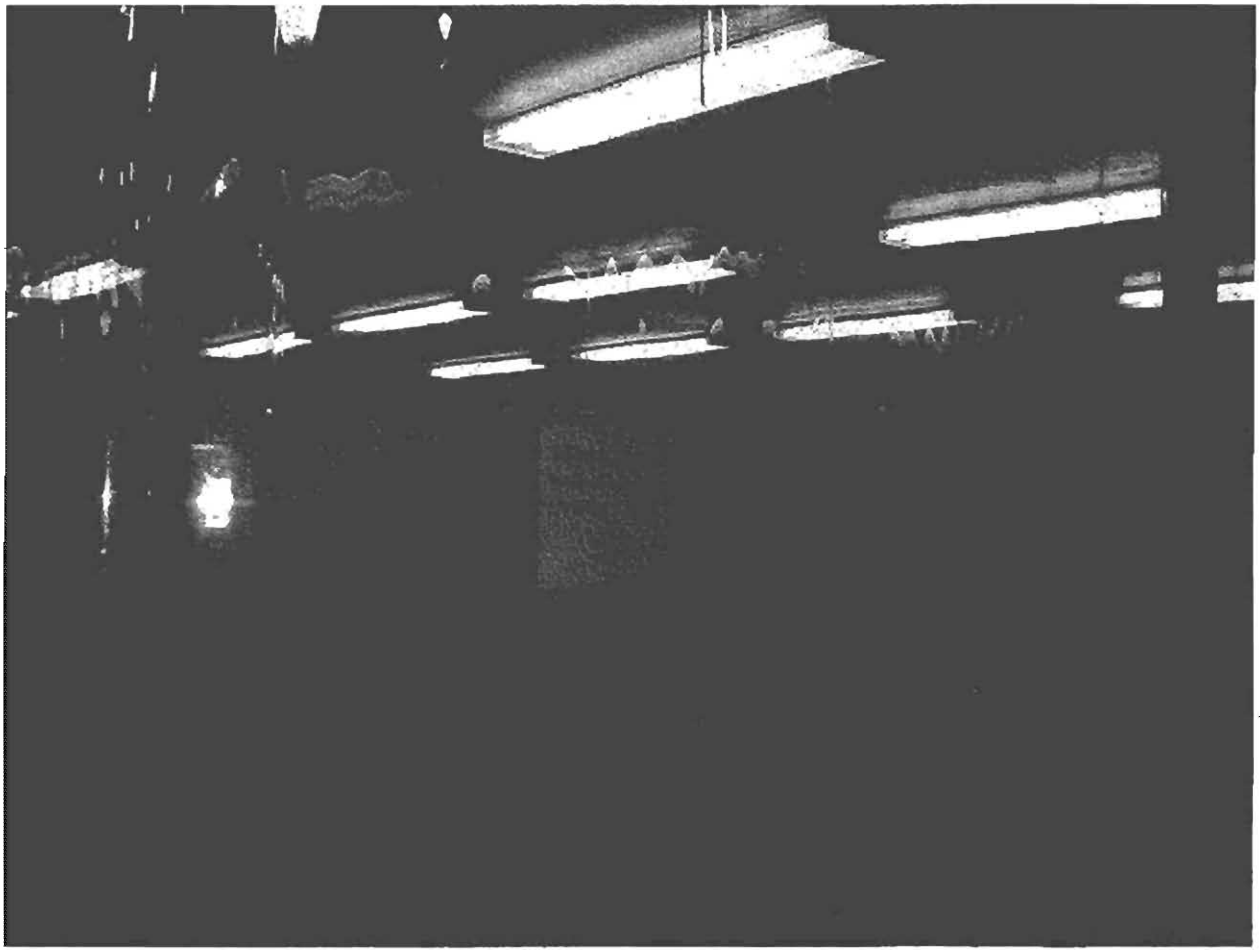
Photo # 1

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Staging area for incoming electronic waste within the UNICOR Warehouse. Used computers and other used electronic devices are trucked and offloaded into this warehouse. The used electronics are disassembled and sorted according to usable versus non-usable parts. According to UNICOR personnel, the warehouse receives on average, one truck load per day. Note that several used computer monitors trucked into the warehouse contain cathode-ray-tubes (CRTs) with hazardous amounts of lead and barium.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 2

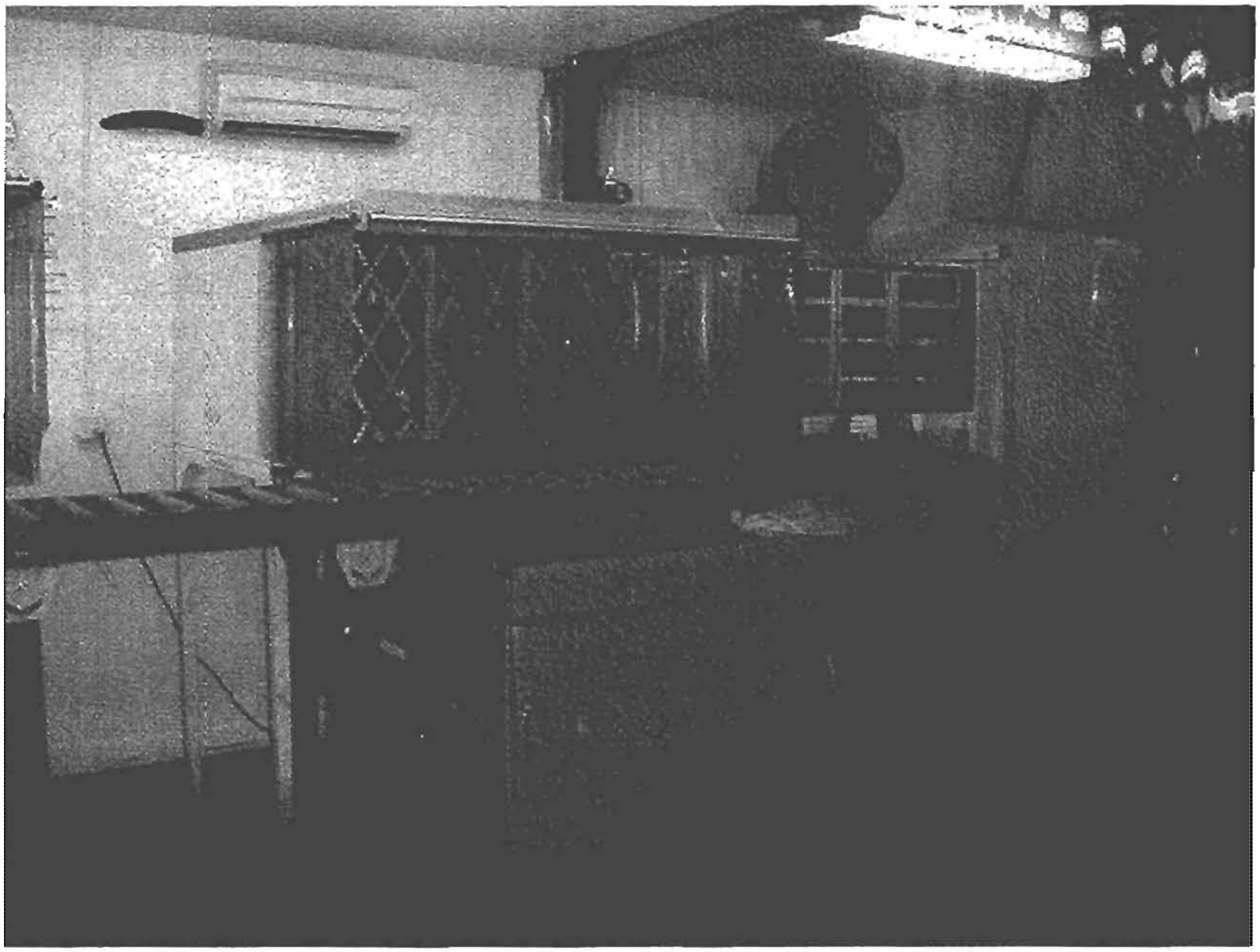


Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: View of the glass breaking room within the UNICOR warehouse. According to UNICOR personnel, the glass breaking room is used to break glass on used computer monitor screens. Used computer monitor screens are pushed and slid through a small opening in the curtain down a table with rollers. Once the used computer screen has been slid inside the glass breaking room, the computer screen panel glass is separated from the computer screen funnel glass. Each piece of glass is placed over a large card board container used for catching broken glass during glass breaking activities. When the card board container has reached maximum capacity of broken glass, it is transported to the Pole Barn until it is sold and transported offsite.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 3

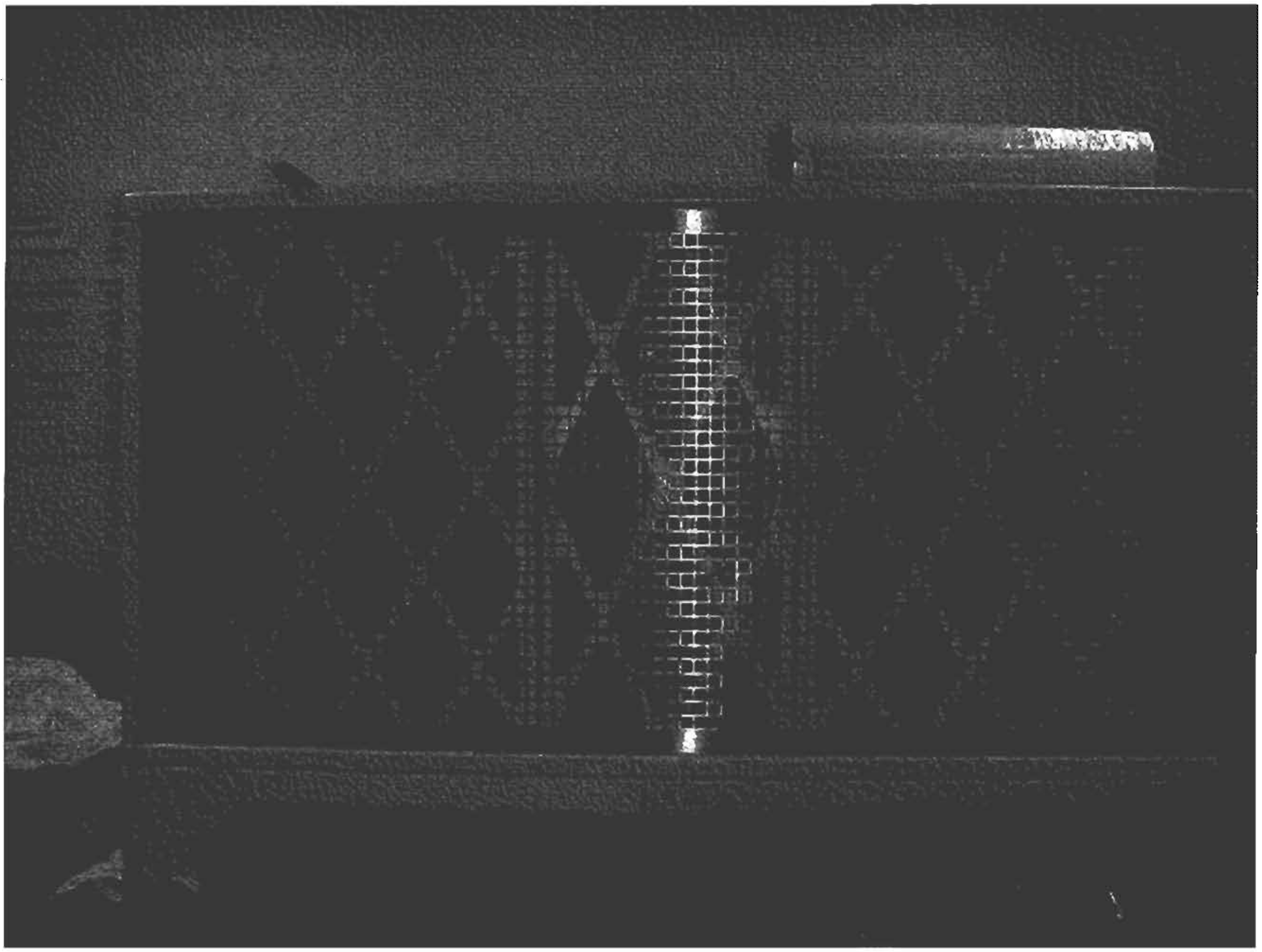


Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Cardboard box used to catch broken glass generated from breaking computer monitor funnel and/or panel glass. According to facility personnel, the cardboard box of broken glass will be sold for recycling. Note: The hepavac filter located in the filter box behind the clear plastic stripping is replaced and disposed of by Safety-Kleen.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 4



Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Close up view of hepavac filter inside of filter box. Note: According to facility personnel, the filter is changed weekly.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

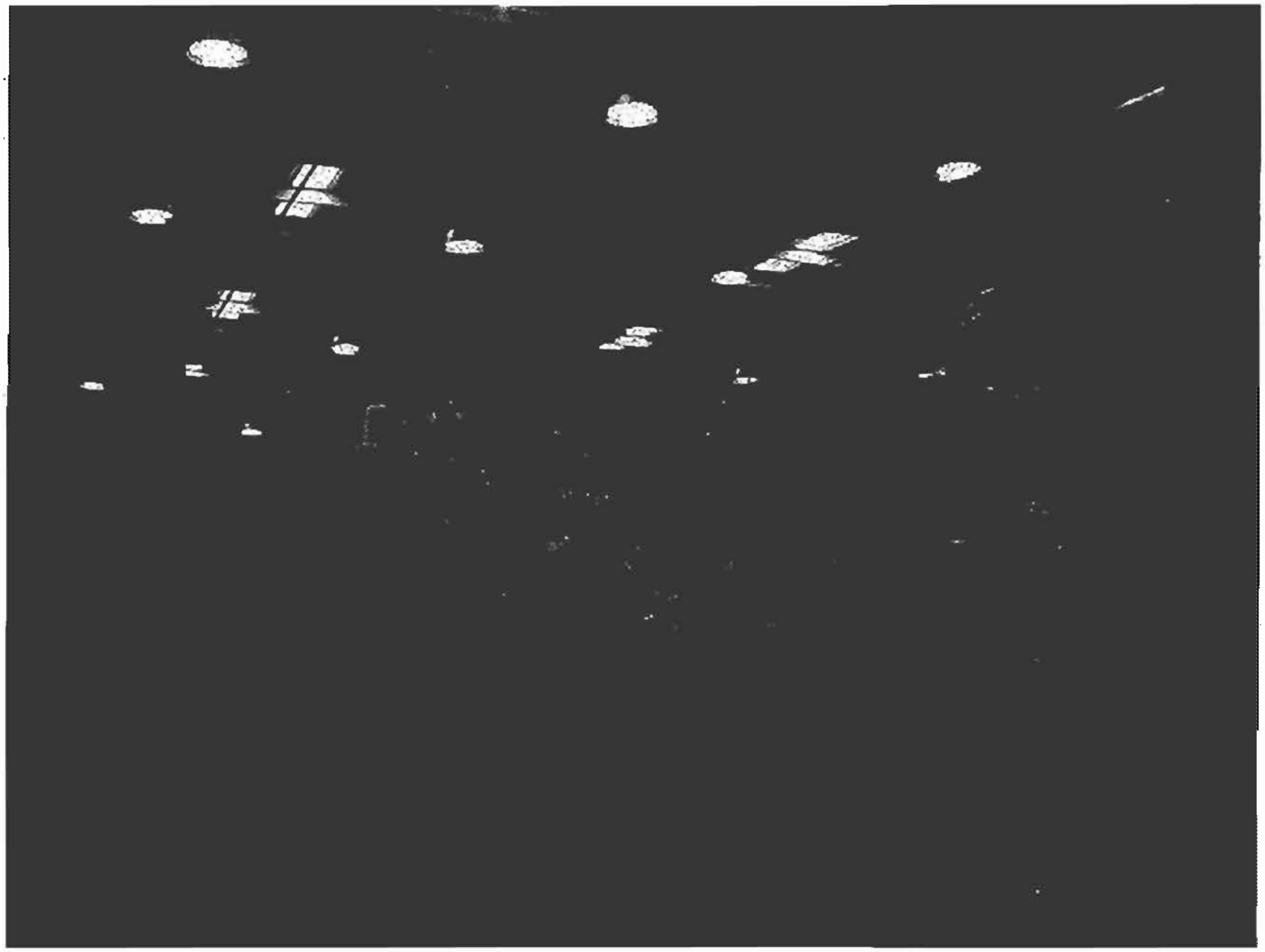
Photo # 5

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Close up view of cardboard Gaylor Box used to store spent hepavac filters and personal protective equipment (PPE) prior to disposal. According to facility personnel, the Gaylor Box is collected and disposed of by Safety-Kleen Systems, Inc. located in Denton, Texas. Note: At the time of the inspection, the EPA Inspector did not observe any hazardous waste labels and/or accumulation dates on the Gaylor Box.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 6



Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: View of Industrial Filter Factory storage area. According to facility personnel, this area is used to house materials and supplies for constructing industrial air filters. Inmates are employed by UNICOR to construct the air filters.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 7

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Staging area of the Pole Barn. According to facility personnel, the Pole Barn is used to stage incoming and outgoing electronics. The Pole Barn has a covered overhead structure but is not enclosed. Incoming electronics are broken down for usable parts and recycling. Outgoing electronic parts are sold and recycled.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 8

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Close up view of label on shrink wrapped package staged in the outgoing area of the Pole Barn. The label identifies the contents of the package as panel glass from a computer screen monitor. According to facility personnel the package has been sold for glass recycling.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 9

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Close up view of label on shrink wrapped package staged in the outgoing area of the Pole Barn. The label identifies the contents of the package as funnel glass from a computer screen monitor. According to facility personnel the package has been sold for glass recycling.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

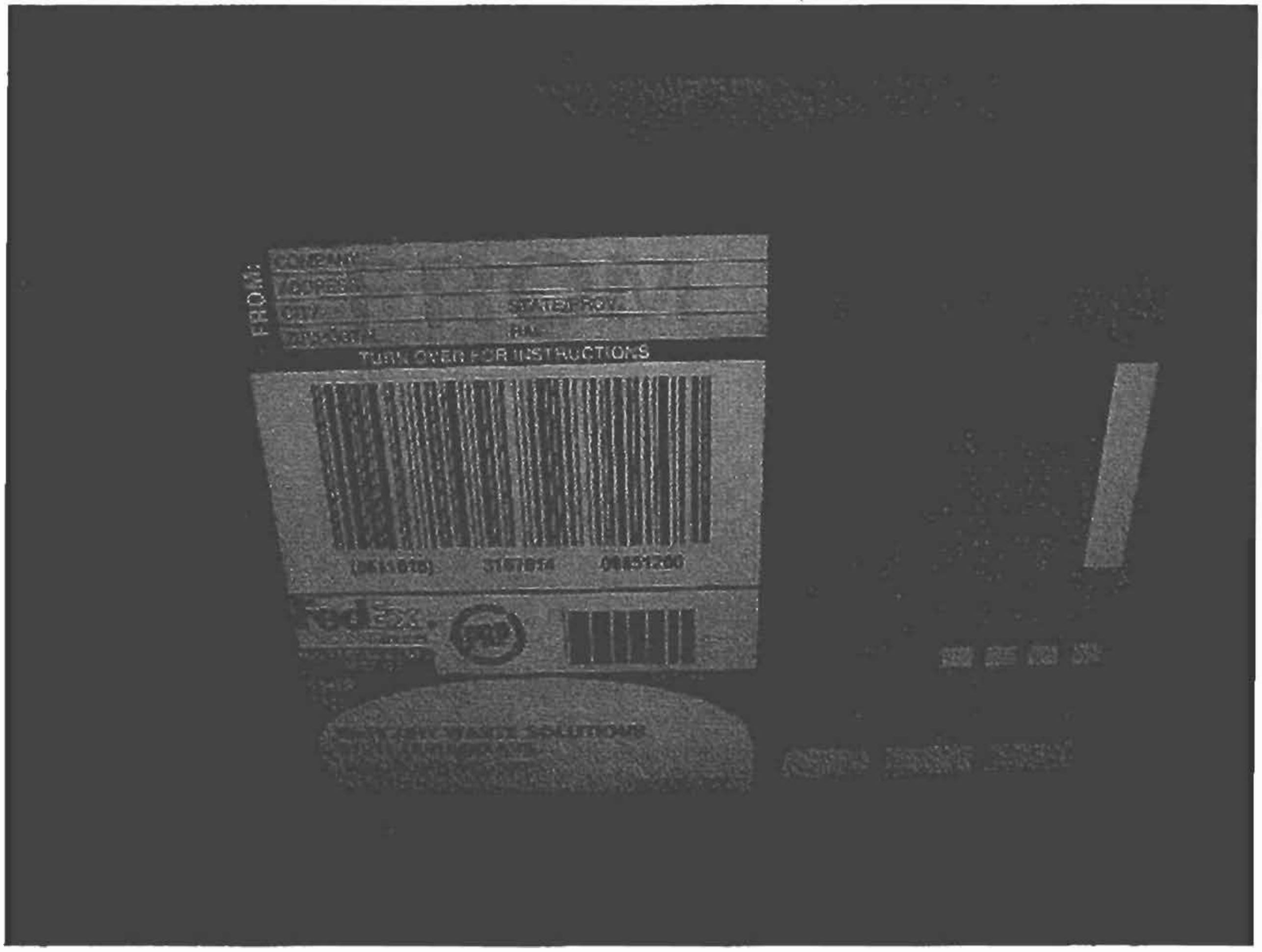
Photo # 10

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Five (5) gallon plastic bucket used to store electronic components from a communication server containing mercury. According to facility personnel, the container will be collected by Federal Express.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 11

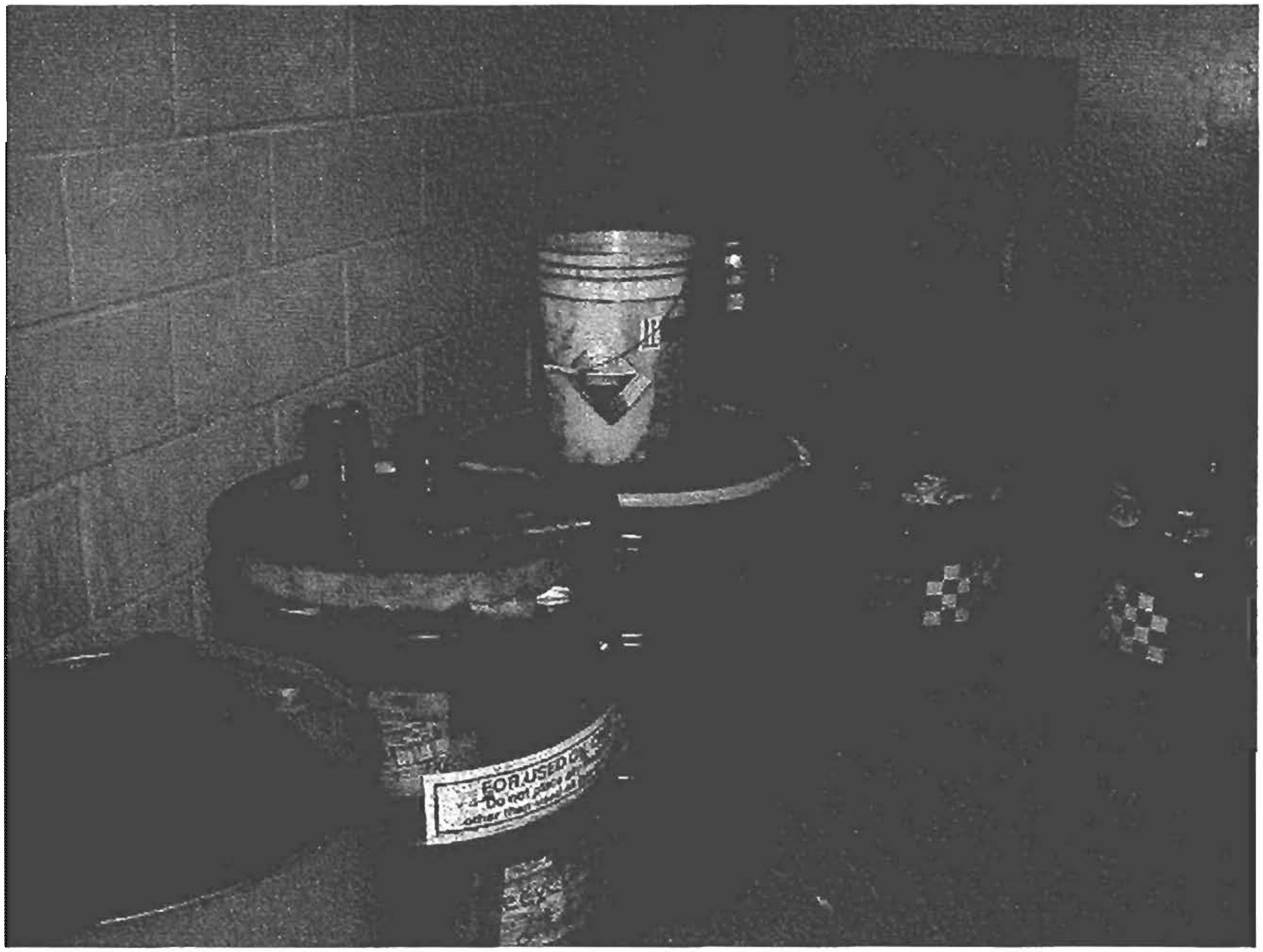


Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Close up view Federal Express label on container storing used electronic components from communication servers containing mercury. See photograph #10.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 12



Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Facility maintenance garage used oil area used for storing spent oil filters, used oil, and product motor oil. The area contained in with a concrete floor and berm (not pictured). According to facility personnel, the used oil and spent oil filters are generated from facility vehicle maintenance. At the time of the inspection, the used oil storage area included three (3) product motor oil containers, three (3) product hydraulic containers, three (3) used oil containers and three (3) empty containers.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 13

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Machine parts washer located in the facility maintenance garage. At the time of the inspection, the lid to the parts washer was open. The EPA Inspector informed the facility that the lid to the parts washer should remain closed when not in use. The facility immediately closed the lid to the parts washer.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

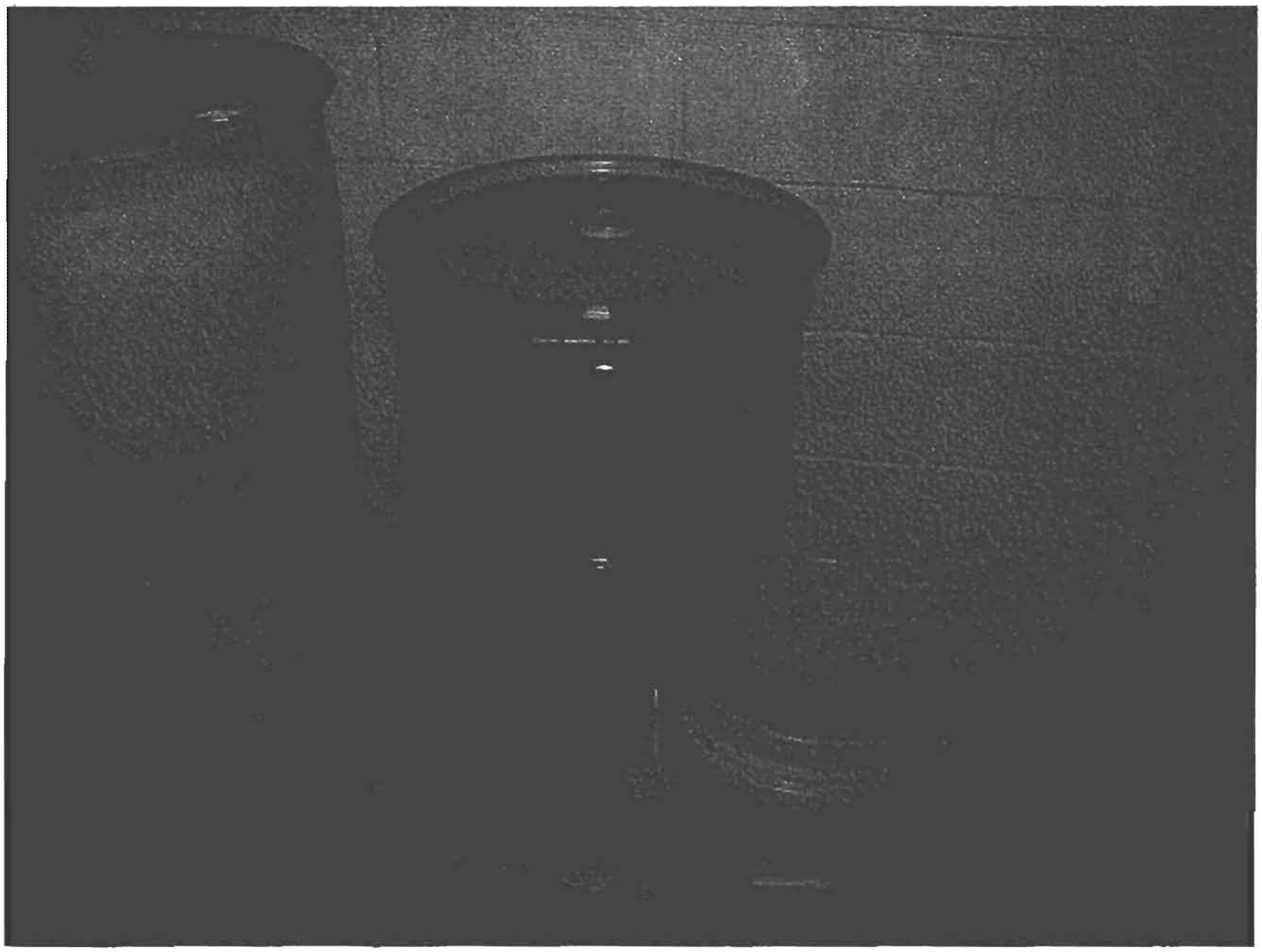
Photo # 14

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Fifty five (55) gallon steel container labeled "hepavac" observed in the hot room of the FCI Recycling Factory. According to facility personnel, the container was currently storing spent gloves, spent rags and spent hepavac filters. The FCI Recycling Factory conducts computer and electronic equipment breakdown activities. Facility personnel also stated there is no glass breaking activities currently conducted in this building.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 15



Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Steel container with no labels and/or markings indicating the contents of the container located in the hot room of the FCI Recycling Factory. According to facility personnel, the container was storing used oil at the time of the inspection.		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 16

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Hole observed in the ceiling of the break room of the FCI Recycling Factory. According to facility personnel, the hole was part of a vent shaft from a glass breaking operation. The operation has since been moved to the UNICOR warehouse (See Photograph #2).		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Official Photograph Log

Photo # 17

Photographer: Ryan Rosser	Date: 11/18/2008	Time:
City/County: Texarkana, Bowie County		State: TX
Location: Texarkana Federal Correctional Institution		
Subject: Two (2) steel containers with no labels and/or markings located in the hot room of the Facilities Area. According to facility personnel, the containers are currently storing spent Xylene and paint waste. The spent Xylene is used for spray gun cleaning activities.		

ATTACHMENT C

INSPECTION CHECKLIST

TEXARKANA FCI
EPA ID# TXφ151909132

FACILITY NAME: ________
EPA ID NUMBER: ________

RCRA COMPLIANCE INSPECTION REPORT
GENERATORS CHECKLIST

NOTE: On multiple part questions, circle those not in compliance.

EPA Identification NO. (262.12)

1. Does the Generator have an EPA I.D. No.? ✓ Yes ___ No
A. If yes, what is that number?

TXφ151909132

Hazardous Waste Determination (262.11)

1. Does the generator generate hazardous waste(s) listed in Subpart D? (261.30 - 261.33 - List of Hazardous Waste) ✓ Yes ___ No

a. If yes, list wastes and quantities on attachment (Include EPA Hazardous Waste Number, waste name and description).

LEAD - D008
CHROMIUM - D007

2. Does the generator generate solid waste(s) that exhibit hazardous characteristics? (circle those applicable - corrosivity, ignitability, reactivity, TC toxicity) (261.20 - 261.24 - Characteristics of Hazardous Waste). ___ Yes ___ No

a. If yes, list wastes and quantities on attachment (Include EPA Hazardous Waste Number, Waste Name and Description.)

b. Does the generator determine characteristics by testing or by applying knowledge of process?

TCLP

i. If determined by testing, did the generator use test methods in Part 261, Subpart C (or Equivalent)? ✓ Yes ___ No

ii. If equivalent test were methods used, attach copy of equivalent methods used.

3. Are there any other solid wastes deemed non-hazardous generated by the generator? (i.e. process waste streams, collected matter from air pollution control equipment, water treatment

sludge, etc.) X Yes ___ No

a. If yes, did the generator determine non-hazardous characteristics by testing or knowledge of process?

NEITHER FOR THE SPENT SAND FROM SAND BLASTING OPERATIONS.
↳ NO HAZARDOUS WASTE DETERMINATION HAS BEEN MADE AT TIME OF INSPECTION.

FACILITY NAME:________
EPA ID NUMBER:________

i. If determined by testing, did the generator use test methods in Part 261, Subpart C (or Equivalent)? ___Yes___No

ii. If equivalent test methods were used, attach copy of equivalent methods used.

b. List wastes and quantities deemed non-hazardous or processes from which non-hazardous wastes were produced. (Use narrative explanations sheet)

4. Are any wastes recycled, reused or reclaimed on-site? ___Yes___No

If yes, use narrative sheet to describe the type and quantity of the waste and the method used for reclamation.

5. Are any wastes shipped off-site for reclamation? ___Yes___No

If yes, use narrative to describe the type and quantity of the waste and its destination. Also give a description of storage prior to shipment.

6. Is the total quantity of hazardous wastes generated?

a. Less than 100 kg/month? ___Yes___No

b. More than 1000 kg/month? ___Yes___No

c. More than 100 but less than 1000 kg/month? ___Yes___No

Manifest

1. Does the generator ship hazardous waste off-site? X Yes___No

a. If no, do not fill out Section C and D. → SHIPPING AS NON HAZARDOUS WASTE

b. If yes, identify primary off-site facility(s). (Use narrative explanations sheet)

2. Has the generator shipped hazardous waste off-site since November 19, 1980? ___Yes X No

3. Is the generator exempted from regulation because

FACILITY NAME:________
EPA ID NUMBER:________

of:

Small quantity generator (261.5 - Special requirements) ___Yes___No

NOT CONDITIONALLY EXEMPT

OR

Produces only non-hazardous solid waste at this time (261.4 - Exclusions) ___Yes X No

* NOTE: ANALYTICAL SHOWS SPENT HEPAVAC FILTERS GENERATED IN GLASS BREAKING ROOM ARE HAZARDOUS FOR LEAD.

4. If the generator is exempted as a small quantity generator are the following requirements met?

a. The waste is reclaimed under a contractual agreement in which:

i. The type of waste and frequency of shipments specified in the agreement? ___Yes___No

ii. The vehicles used to transport the waste to the recycling facility and to deliver regenerated material back to the generator is owned and operated by the reclaimer of the waste? ___Yes___No

b. The generator maintains a copy of the reclamation agreement in his files for a period of at least three years after termination or expiration of the agreement? ___Yes___No

Required Information (262.21)

5. If not exempted does the generator use manifest? ___Yes___No E-WASTE

- GENERATOR JUST RECENTLY HAD ANALYTICAL PROVIDING MATERIAL WAS HAZARDOUS, BUT GENERATOR HAS MANIFESTED OTHER HAZARDOUS WASTE IN THE PAST.

a. If yes, does manifest include the following information (262.21 - Required information) ___Yes___No

(Circle those <u>not</u> on manifest)

i. Manifest Document No.

ii. Generators Name, Mailing Address, Tele. No.

iii. Generator EPA I.D. No.

iv. Transporter(s) Name and EPA I.D. No.

v. Facility Name, Address and EPA I.D. No.

vi. DOT description of the waste

vii. a. Quantity (weight or volume)

b.Containers (type and number)

viii.Emergency Information (optional)
(Special handling instructions,
Phone No.)

ix.Waste minimization certification

x. Is the following certification on each manifest form? ___Yes___No

This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the EPA.

Uses of the Manifest (263.23)

6. Does the generator retain copies of manifests? X Yes___No

(Check completed manifests at random. Indicate how many manifests were inspected, how many violations were noted and the type of violation.) → INSPECTED LAST 3 YEARS WORTH AT TIME OF INSPECTION.

If yes, complete a through e. If questions contain more than one item, circle those not in compliance.

a. i. Did the generator sign and date all manifests inspected? X Yes___No

ii. Who signed for the generator? FOR MANIFEST DATED 02/08/08
Name: [redacted]
Title:
I.D. Number TX0151909132

b. i. Did the generator obtain handwritten signature and date of acceptance from initial transporter? X Yes___No

ii. Who signed for the tra[redacted] FOR MANIFEST DATED 02/08/08
Name: [redacted]
Title:
I.D. Number: TXD000747378

c. Does the generator retain one copy of manifest signed by generator and transporter? X Yes___No

d. Do returned copies of manifest include facility owner/operator signature and date of acceptance? X Yes___No

e. If copy of manifest from facility was not returned within 45 days, did the generator file an exception report? (262.42 - Exception reporting) ___Yes___No (N/A)

i. If yes, did it contain the following information:

Legible copy of manifest ___Yes___No (N/A)

AND

Cover letter explaining generators efforts to locate waste. ___Yes___No (N/A)

f. Does (will) the generator retain copies for 3 years? X Yes___No

Pre-Transport Requirements

1. Does the generator package waste? X Yes___No

If no, skip to question 9.
If yes, complete the following questions.

Inspect containers ready for immediate shipment. If there are no such containers, skip to question 8.

2. Does the generator package waste in accordance with 49 CFR 173, 178, and 179? (DOT requirements) (262.30 - Packaging) ___Yes X No – BEEN SHIPPING H.W. AS NON-HAZARDOUS

3. Are containers to be shipped leaking, corroding or bulging? – UNKNOWN ___Yes___No

Use narrative explanations sheet to describe containers and condition.

4. Does the generator use DOT labeling requirements in accordance with 49 CFR 172 when containers are offered for shipment? (262.31 - Labeling) ___Yes___No – SEE #2

5. Does the generator mark each package in accordance with 49 CFR 172 when containers are offered for shipment? (262.32 - Marking) ___Yes___No – SEE #2

6. a. Is each container of 110 gallons or less marked with the following label when containers are offered for shipment? ___Yes X No – SEE #2

HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.

Generator's Name and Address ____________________

Manifest Document Number ____________________________

b. If other labels exist, list in narrative.

7. If there are any vehicles present on site loading or unloading hazardous waste, inspect for presence of placards. Note this instance on narrative explanation sheet.

FACILITY NAME: ________
EPA ID NUMBER: ________

8. Satellite Accumulation (effective June 20, 1985)

a. Does the generator accumulate waste in containers at or near "Satellite" generation points? X Yes ___ No

If no, skip to question 9.
If yes, complete the following.

b. Are containers in good condition? X Yes ___ No

c. Is the waste compatible with the containers? X Yes ___ No

d. Is waste transferred from leaking containers or otherwise managed to control leakage? ___ Yes ___ No

e. Are containers closed? ___ Yes X No – SEE AOC IN CEI REPORT

f. Are containers marked with the words "hazardous waste" or identification of the contests? ___ Yes X No

g. Has waste accumulation exceeded one (1) quart of acutely hazardous waste (261.33 e.) or 55 gallons of other hazardous waste? ___ Yes X No

If yes,

i. Has the container holding the excess amount been marked with the date the excess began accumulating? ___ Yes ___ No

ii. Have excess amounts remained in the satellite accumulation area longer than three (3) days? ___ Yes ___ No

9. Accumulation Time (262.34 - Accumulation Time for Small Quantity Generators)

a. Is waste generated > 100 kg/month, but < 1000 kg/month? X Yes ___ No

If yes, answer rest of question #9.
If no, skip to question #10.

b. Is hazardous waste shipped offsite within 180 days? X Yes ___ No

c. Has the quantity of waste accumulated on-site exceeded 6000 kilograms? ___Yes X No

d. Does the generator comply with the requirements of Part 265 Subpart C, Preparedness and Prevention? X Yes ___No

FACILITY NAME:________
EPA ID NUMBER:________

10. Accumulation Time (262.34 - Accumulation Time)

a. Is the site a permitted/interim status storage facility? ___Yes X No

FOR LQG's, NOT APPLICABLE

If yes, skip to Section E, and complete and attach the TSD checklist and appropriate supplemental checklists. If no, answer rest of question #8.

b. Is hazardous waste shipped offsite within 90 days? ___Yes___No

c. Is waste stored in containers or tanks? ___Yes___No

d. Is the beginning date of accumulation time clearly indicated on each container? ___Yes___No

e. Is each container or tank marked with the words "Hazardous Waste"? ___Yes___No

f. Complete and attach the containers/tanks supplemental checklists as appropriate.

g. If the generator accumulates waste on-site for less than 90 days, complete RCRA Generators Checklist Supplement.

Recordkeeping and Reporting

1. Is the generator keeping the following reports for a minimum of three (3) years? (262.40 - Recordkeeping):

a. Manifests and signed copies from designated facilities? X Yes___No

b. Biennial reports (or reports as required by state agencies) ___Yes___No N/A

c. Exception Reports X Yes___No

d. Test results, where applicable. X Yes___No

2. Where are records kept (at facility or elsewhere)?

AT FACILITY

FACILITY NAME:________
EPA ID NUMBER:________

3. Who is in charge of keeping the records?

Name: UNICOR EMPLOYEES

Title:

FACILITY NAME:________
EPA ID NUMBER:________

Special Condition

1. Has the generator received from or transported to a foreign source any hazardous waste? (262.50 - International Shipments) ___Yes___No NOT APPLICABLE

   If yes,

   a. Has a note been filed with the R.A.? ___Yes___No

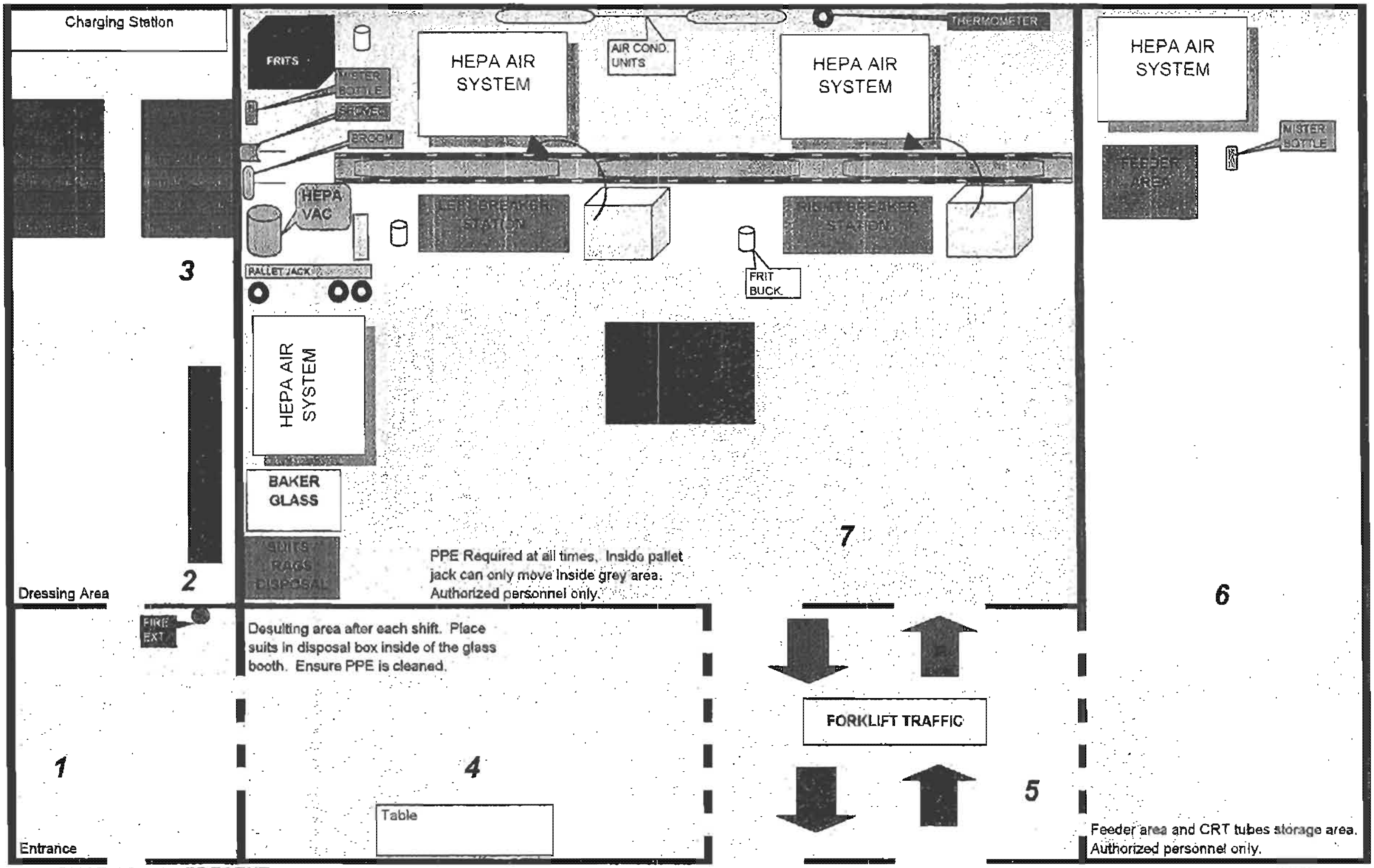
   b. Is this waste manifested and signed by Foreign Consignee? ___Yes___No

   c. If the generator transported wastes out of the country has he received confirmation of delivered shipment? ___Yes___No

   d. Has the generator filed an annual report (by March 1 of each year) giving the type, quantity, frequency and destination of all exported hazardous waste? (Per HSWA 1984) ___Yes___No

ATTACHMENT D

DOCUMENTS SUBMITTED BY TEXARKANA FCI



FEBRUARY 2008 - PRESENT

TERC FPC NORTH
GLASS BOOTH (Rev. 4)

GLASS BOOTH / AUTHORIZED PERSONNEL ONLY !

qp 6300-8(H)

SAFETY-KLEEN
WASTE MATERIAL PROFILE

Customer #: 1989344 Analytical Part #: 82110 : METALS PROFILE #: 3418874
Sales Name: [redacted] Employee #: 436664 Rep Email: LOB #: ☐28 ☐26 ☒24 ☐20 ☐19 Location/Branch #: 619401

A. CUSTOMER INFORMATION

☐ Check if Billing Same

Generator: UNICOR
Facility Address (No P.O. Box): 4001 LEOPARD DR
City/State/Zip: TEXARKANA, TX
Technical Contact: [redacted]
Phone: [redacted] FAX:
NAICS #: 9223 ☒CESQG ☐SQG ☐LQG EPA ID#: TX0151909132 State ID#: CES96

Billing Company:
Billing Address:
City/State/Zip:
Billing Contact:
Phone: FAX:
Email:

B. SHIPPING INFORMATION

US DOT Shipping Name:
Hazardous Class/Division #: UN/NA #: Packing Group: RQ:
Size: CYB Container Type: CF Quantity: 1 Frequency: 8WK

C. GENERAL MATERIAL & REGULATORY INFORMATION

Name of Material: FILTER
Process Generating the Material: USED ~~[illegible]~~ AIR FILTER

Yes	No		Yes	No	
☐	☒	Regulated or Licensed Radioactive Waste	☐	☒	Contains UHCs/Constituents of Concern: List in section D
☐	☒	Regulated Medical/Infectious Waste	☐	☒	Exempt Waste: If yes, list ref. 40 CFR
☐	☒	Waste Subject to Benzene NESHAP regulations	☐	☒	*For Artesia, MS:* Does waste material contain, or is derived from, dioxin-listed wastes with F020-F023 or F027 waste codes?
☐	☒	TSCA Regulated PCB Waste: List PCB level in section D	☒	☐	State Hazardous Waste: List Codes TX 3191
☐	☒	Regulated Ozone Depleting Substance	☐	☒	EPA Hazardous Waste: List Codes NONE
☐	☒	CERCLA Regulated (Superfund) Waste			Source Code G 09 Form Code W002 Mgt. Method H

D. MATERIAL COMPOSITION (Range Total > or = 100%) or ppm

Filter	100%

☐ MSDS Attached Total: 100%

E. REACTIVE CHARACTERISTICS

Yes☐ No☒ React. Sulfides ____ ppm
Yes☐ No☒ React. Cyanides ____ ppm
Yes☐ No☒ Water/Air (Pyrophoric) React.
Yes☐ No☒ Oxidizer
Yes☐ No☒ Shock/Explosive
Yes☐ No☒ Polymerizable
Yes☐ No☒ Other-Comments

Elemental Constituents (ppm):

☒ No detectable Elements Sb ___ As ___ Ba ___
Be ___ Cd ___ Cr ___ Pb ___ Hg ___
Ni ___ Se ___ Ag ___ Tl ___ V ___

Metals Data based on: ☐TCLP ☐Total Analysis ☒Generator Knowledge (no testing)

F. PHYSICAL CHARACTERISTICS

Flash Point: ____ °F (if <73°F)
☐ 73-<100 ☐ 100-141 ☐ 142-<200 ☒ ≥200
pH Range: ☐≤2 ☐>2-4 ☒>4-10 ☐>10-<12.5 ☐≥12.5
Phases: 1 % Liquid: ____ Viscosity cps: 750,000
% Sludge: ____ % Solid: 100 % Halogens: ____
BTU's/lb: 712,000 Specific Gravity: 1

G. COMMENTS

THIS FILTER FILTERS THE AIR FROM A ROOM WHERE THE CUSTOMER BREAKS TV TUBES IN A RECYCLE CENTER

Customer Restrictions: ☐ Yes ☒ No

H. GENERATOR'S CERTIFICATION

I hereby certify that I am an authorized agent of the generator, and warrant on behalf of the generator that the information supplied on this form and on any attachments or supplements hereto is complete and accurate, and that all known or suspected hazards of the material(s) described herein have been disclosed. I agree that if the sample test results indicate a discrepancy with any information supplied on this form, that either Safety-Kleen or the generator may initiate further testing and evaluation in accordance with the terms and conditions of the contract between Safety-Kleen and the generator and that this profile certification may be amended accordingly.

Generator Signature: [redacted] Printed Name and Title: [redacted] Recycle Tech Date: 8/19/08

Rev: 02/28/05

METHODS SUMMARY

C8J290229

PARAMETER	ANALYTICAL METHOD	PREPARATION METHOD
Inductively Coupled Plasma (ICP) Metals	SW846 6010B	SW846 1311/3010
Mercury in Liquid Waste (Manual Cold-Vapor)	SW846 7470A	SW846 1311/7470

References:

SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

SAMPLE SUMMARY

CBJ290229

WO #	SAMPLE#	CLIENT SAMPLE ID	SAMPLED DATE	SAMP TIME
K1VJF	001	3418874	10/28/08	10:30

NOTE(S):

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

SK,Cust: UNICOR

Lab Name:	Pittsburgh	**Lot Number:**	C8J290229
Client Name:	Safety-Kleen Systems, Inc.	**Date Received:**	10/29/2008
Matrix:	SOLID	**Date Sampled:**	10/28/2008

Metals

Client Sample ID: 3418874		Sample Number	Analysis Date	Method Reference	Reg Limit	Result
EPA Waste #	Analyte	001			mg/L	mg/L
D009	Mercury		10/31/2008	SW846 7470A	0.2	<0.00020

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

ANALYTICAL REPORT

Gloves/
Sleeves

PROJECT NO. 619401/3418872

SK,Cust: UNICOR

Lot #: C8J290233

Safety-Kleen

Safety-Kleen Systems, Inc
PO Box 7813
Ocala, FL 34478-7813

TESTAMERICA LABORATORIES, INC.

[redacted]
Project Manager

November 4, 2008

CASE NARRATIVE

Safety-Kleen

Lot # C8J290233

Sample Receiving:
TestAmerica's Pittsburgh laboratory received one sample on October 29, 2008. The sample was received at ambient temperature.

TCLP Metals:
There were no problems with the analysis.

TCLP CHAIN-OF-CUSTODY RECORD

Send To: ~~STL-Pittsburgh~~ TEST AMERICA
~~450 William Pitt Way~~ 301 ALPHA DR.
Pittsburgh, PA 15238
FAX: 412-~~820-2080~~ 963 - 2468

SAMPLE ID #	GENERATOR NAME & SAMPLING LOCATION	DATE	TIME	DESCRIPTION OF SAMPLE	NO. OF CONTAINERS & SIZE	SIGNATURE OF COLLECTOR
3418872	UNICOR 4001 LEOPARD DR TEXARKANA, TX 75501	10/28/08	10:30 Am	GLOVES	(1)	K. [signature]

Was sample kept chilled until relinquished for shipment to lab? (Circle One) YES NO

If No, Explain:

___ FULL TCLP ONLY (TCLP Metals, TCLP Volatiles, and TCLP Semi-volatiles)

X PARTIAL TCLP - METALS ONLY

___ PARTIAL TCLP - VOLATILES ONLY

Branch #: 619401
Branch Address 202 MICHAEL PL LONGVIEW, TX 75603
Branch Fax # (903) 753-0114

Sales Specialist [redacted]
Branch/Sales Specialist e-mail address
[redacted] @ SAFETY-KLEEN.COM

PO # CREDIT CARD

Has a sample of this waste already been submitted for a prequal analysis? (Circle One) YES NO
If yes, what is the Profile #? 4006092 Control #? 2231782 (No Sample Generator Knowledge)

RELINQUISHED BY	DATE	TIME	RECEIVED BY	DATE	TIME
			[redacted]	10/29/08	0945

TEMPERATURE WHEN RECEIVED Ambient °C
SAMPLE KIT OPENED AND CHECKED IN BY [redacted] AT 09 : 45 ON 10 / 29 / 08
C.O.C. SEALS SIGNED, DATED, AND INTACT ON ALL SAMPLES JARS? YES ___ NO ✓ IF NO, EXPLAIN: ___

TCLPCOC.xls, 3/30/04

HMS-9387D

SAFETY-KLEEN
WASTE MATERIAL PROFILE

Customer #: 1989364 | Analytical Part #: 82110 : METALS | PROFILE #: 3418872
Sales Name: [redacted] | Employee #: 43664 | Rep Email: | LOB #: ☐28 ☐26 ☒24 ☐20 ☐19 | Location/Branch #: 619401

A. CUSTOMER INFORMATION ☐ Check if Billing Same

Generator: UNICOR | Billing Company:
Facility Address (No P.O. Box): 4001 LEOPARD DR | Billing Address:
City/State/Zip:
City/State/Zip: TEXARKANA TX | Billing Contact:
Technical Contact: [redacted] | Phone: | FAX:
Phone: [redacted] FAX: | Email:
NAICS #: 9223 ☒CESQG ☐SQG ☐LQG EPA ID#: TX0151909132 State ID#: CESQG

B. SHIPPING INFORMATION

US DOT Shipping Name:
Hazardous Class/Division #: UN/NA #: Packing Group: RQ:
Size: CYB Container Type: CF Quantity: 1 Frequency: 8WK

C. GENERAL MATERIAL & REGULATORY INFORMATION

Name of Material: GLOVES
Process Generating the Material: USED GLOVES

Yes	No		Yes	No	
☐	☒	Regulated or Licensed Radioactive Waste	☐	☒	Contains UHCs/Constituents of Concern: List in section D
☐	☒	Regulated Medical/Infectious Waste	☐	☒	Exempt Waste: If yes, list ref. 40 CFR
☐	☒	Waste Subject to Benzene NESHAP regulations	☐	☒	*For Artesia, MS:* Does waste material contain, or is derived from, dioxin-listed wastes with F020-F023 or F027 waste codes?
☐	☒	TSCA Regulated PCB Waste: List PCB level in section D	☒	☐	State Hazardous Waste: List Codes TX 3191
☐	☒	Regulated Ozone Depleting Substance	☐	☒	EPA Hazardous Waste: List Codes None
☐	☒	CERCLA Regulated (Superfund) Waste			Source Code G 07 Form Code W 002 Mgt. Method H

D. MATERIAL COMPOSITION (Range Total > or = 100%) or ppm

Gloves	100%

☐ MSDS Attached Total: 100%

E. REACTIVE CHARACTERISTICS

Yes☐ No☒ Oxidizer
Yes☐ No☒ React. Sulfides ___ ppm | Yes☐ No☒ Shock/Explosive
Yes☐ No☒ React. Cyanides ___ ppm | Yes☐ No☒ Polymerizable
Yes☐ No☒ Water/Air (Pyrophoric) React. | Yes☐ No☒ Other-Comments

Elemental Constituents (ppm):

☒ No detectable Elements Sb ___ As ___ Ba ___
Be ___ Cd ___ Cr ___ Pb ___ Hg ___
Ni ___ Se ___ Ag ___ Tl ___ V ___

Metals Data based on: ☐TCLP ☐Total Analysis ☒Generator Knowledge (no testing)

F. PHYSICAL CHARACTERISTICS

Flash Point: ___ °F (If <73°F) | pH Range: ☐≤2
☐ 73-<100 ☐ 100-141 | ☐ >2-4 ☒ >4-10
☐ 142-<200 ☒ >200 | ☐ >10-<12.5 ☐ ≥12.5
Phases: 1 | % Liquid: | Viscosity cps: 750,000
% Sludge: | % Solid: 100 | % Halogens:
BTU's/lb: > 5000 | Specific Gravity: 1

G. COMMENTS Gloves Are Worn while Breaking TV Tubes

Customer Restrictions: ☐ Yes ☒ No

H. GENERATOR'S CERTIFICATION

I hereby certify that I am an authorized agent of the generator, and warrant on behalf of the generator that the information supplied on this form and on any attachments or supplements hereto is complete and accurate, and that all known or suspected hazards of the material(s) described herein have been disclosed. I agree that if the sample test results indicate a discrepancy with my information supplied on this form, that either Safety-Kleen or the generator may initiate further testing and evaluation in accordance with the terms and conditions of the contract between Safety-Kleen and the generator and that this profile certification may be amended accordingly.

Generator Signature: [redacted] Printed Name and Title: [redacted] Recycle Tech Date: 8/19/05

Rev: 02/28/05

METHODS SUMMARY

C8J290233

PARAMETER	ANALYTICAL METHOD	PREPARATION METHOD
Inductively Coupled Plasma (ICP) Metals	SW846 6010B	SW846 1311/3010
Mercury in Liquid Waste (Manual Cold-Vapor)	SW846 7470A	SW846 1311/7470

References:

SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

SAMPLE SUMMARY

C8J290233

WO #	SAMPLE#	CLIENT SAMPLE ID	SAMPLED DATE	SAMP TIME
K1VJR	001	3418872	10/28/08	10:30

NOTE(S):

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

SK,Cust: UNICOR

Lab Name: Pittsburgh
Client Name: Safety-Kleen Systems, Inc.
Matrix: SOLID

Lot Number: C8J290233
Date Received: 10/29/2008
Date Sampled: 10/28/2008

Metals in TCLP Leachate

Client Sample ID: 3418872 EPA Waste #	Analyte	Sample Number 001	Analysis Date	Method Reference	Reg Limit mg/L	Result mg/L
D004	Arsenic		11/3/2008	SW846 6010B	5	<0.50
D005	Barium		11/3/2008	SW846 6010B	100	<10.0
D006	Cadmium		11/3/2008	SW846 6010B	1	0.12
D007	Chromium		11/3/2008	SW846 6010B	5	28.2
D008	Lead		11/3/2008	SW846 6010B	5	6.8
D010	Selenium		11/3/2008	SW846 6010B	1	<0.25
D011	Silver		11/3/2008	SW846 6010B	5	<0.50

SK,Cust: UNICOR

Lab Name: Pittsburgh
Client Name: Safety-Kleen Systems, Inc.
Matrix: SOLID

Lot Number: C8J290233
Date Received: 10/29/2008
Date Sampled: 10/28/2008

Metals

Client Sample ID: 3418672		Sample Number	Analysis Date	Method Reference	Reg Limit	Result
EPA Waste #	Analyte	001			mg/L	mg/L
D009	Mercury		10/31/2008	SW846 7470A	0.2	<0.00020

BILL OF LADING/MANIFEST	1. Shipper's US EPA ID No. (If Applicable) TX0151909132	Document No. 15699	2. Page 1 of 1

3. Shipper's Name and Mailing Address
UNICOR
4001 LEOPARD DRIVE
ATTN RECYCLE DEPARTMENT
TEXARKANA TX 75505

015699
CESQG

Shipper's Phone ([redacted])

5. Transporter 1 Company Name	6. US EPA ID Number	A. Transporter's Phone
SAFETY-KLEEN SYSTEMS, INC	TXD000747378	903 757-9187
7. Transporter 2 Company Name	8. US EPA ID Number	B. Transporter's Phone
SAFETY-KLEEN SYSTEMS, INC	TXR000050930	800 669-5840
9. Designated Facility Name and Site Address 000618 SAFETY-KLEEN SYSTEMS, INC. 1722 COOPER CREEK ROAD DENTON, TX 76208	10. US EPA ID Number TXD077603371	C. Facility's Phone 940 483-5200

607028
81109

	HM	11. Shipping Name and Description	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
a.		NON REGULATED SOLID	2	CF	865	P
b.						
c.						
d.						

SHIPPER

15. Special Handling Instruction and Additional Information

MFST R/T#109752615 0001-9893-84
EMERGENCY RESP 800-468-1760(24 HR). A) NONE
SK CORP AUTH'D TO USE SUBSEQUENT CARRIERS: 40343,41038,81681,82739,86256
TWC CESQ3191

SKDOT# A: 25383 B: C: D:

CESQ3191 H141

USE 16A OR 16B

16a. US DOT HAZARDOUS MATERIALS SHIPPER'S CERTIFICATION: "This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Printed/Typed Name — Signature required here if US DOT regulated — Month Day Year

16b. NON-REGULATED SHIPPER'S CERTIFICATION: I certify the materials described above on this form are not subject to federal regulations for Transportation or Disposal.

Printed/Typed Name X [redacted] — Sign here if material is not DOT regulated X [redacted] — Month Day Year 7 25 08

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
[redacted] [redacted] Month Day Year 7 25 08

18. Transporter 2 Acknowledgement of Receipt of Materials
[redacted] Month Day Year 7 31 08

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of materials covered by this form except as noted in Item 19.

Printe[redacted] Signatur[redacted] Month Day Year 7 31 08

IN EVENT OF EMERGENCY CALL 1-800-468-1760 (24 hours)

ORIGINAL-RETURN TO GENERATOR

FORM NO. 90291 (11/96)

SK,Cust: UNICOR

Lab Name:	Pittsburgh	**Lot Number:**	C8J290229
Client Name:	Safety-Kleen Systems, Inc.	**Date Received:**	10/29/2008
Matrix:	SOLID	**Date Sampled:**	10/28/2008

Metals in TCLP Leachate

Client Sample ID: 3418874 EPA Waste #	Analyte	Sample Number 001	Analysis Date	Method Reference	Reg Limit mg/L	Result mg/L
D004	Arsenic		11/3/2008	SW846 6010B	5	<2.5
D005	Barium		11/3/2008	SW846 6010B	100	40.4
D006	Cadmium		11/3/2008	SW846 6010B	1	<0.50
D007	Chromium		11/3/2008	SW846 6010B	5	<0.50
D008	Lead		11/3/2008	SW846 6010B	5	432
D010	Selenium		11/3/2008	SW846 6010B	1	<1.2
D011	Silver		11/3/2008	SW846 6010B	5	<2.5

BILL OF LADING/MANIFEST

1. Shipper's US EPA ID No. (If Applicable)	TX0151909132
Document No.	15699
2. Page 1 of	1

3. Shipper's Name and Mailing Address
UNICOR
4001 LEOPARD DRIVE
ATTN RECYCLE DEPARTMENT
TEXARKANA TX 75505

Shipper's Phone ([redacted]

5. Transporter 1 Company Name: SAFETY-KLEEN SYSTEMS, INC	6. US EPA ID Number: TXD000747378	A. Transporter's Phone: 903 757-9187
7. Transporter 2 Company Name: SAFETY-KLEEN SYSTEMS, INC	8. US EPA ID Number: TXR000050930	B. Transporter's Phone: 800 669-5840
9. Designated Facility Name and Site Address 000618 SAFETY-KLEEN SYSTEMS, INC. 1722 COOPER CREEK ROAD DENTON, TX 76208	10. US EPA ID Number: TXD077603371	C. Facility's Phone: 940 483-5200

	HM	11. Shipping Name and Description	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol
a.		NON REGULATED SOLID	2	CF	865	P
b.						
c.						
d.						

SHIPPER

15. Special Handling Instruction and Additional Information

MFST R/T#109752615 0001-9893-84
EMERGENCY RESP 800-468-1760(24 HR). A) NONE
SK CORP AUTH'D TO USE SUBSEQUENT CARRIERS: 40343,41038,81681,82739,86256
TWC CESQ3191

SKDOT# A: 25383 B: C: D:

USE 16A OR 16B

16a. US DOT HAZARDOUS MATERIALS SHIPPER'S CERTIFICATION: *This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Printed/Typed Name | Signature required here if US DOT regulated | Month | Day | Year

16b. NON-REGULATED SHIPPER'S CERTIFICATION: I certify the materials described above on this form are not subject to federal regulations for Transportation or Disposal.

Printed/Typed Name X | Sign here if material is not DOT regulated X | Month 7 | Day 25 | Year 05

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

[redacted] | [redacted] | Month | Day | Year

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name | Month | Day | Year

FACI

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of materials covered by this form except as noted in Item 19.

Printed/Typed Name | Signature | Month | Day | Year

IN EVENT OF EMERGENCY CALL
1-800-468-1760 (24 hours)

GENERATOR'S COPY

FORM NO. 90291 (11/96)

CUSTOMER

Safety-Kleen
5400 Legacy Drive, Cluster II, B3
Plano, Tx 75024
800-669-5740
www.safety-kleen.com

WE CARE

DUNS NO. 05-397-6551 FED. ID NO. 396090019

FOR SERVICE CALL	BRANCH MANAGER	DOC. EXP.	SCHEDULED SERVICE WEEK	SCHEDULED TERR	REFERENCE NUMBER
903-75 87	MARK LESTER		08		M005015699

CUSTOMER NO. 1 9 8 9 3 8 4

GENERATOR

Unicore
4001 Leopard Dr.
Texarkana, TX
75505

BILL TO

CREDIT CODE	PREVIOUS BALANCE	BAL. OVER 60 DAYS

CUSTOMER SEGMENT	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C

LOCATION	TAX EXEMPTION NO.
619401	

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	DATE EQPT/PROD ORDERED	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
7-25-08	435340				PW			

	DEPT	SERVICE/ PRODUCT	SERIAL NUMBER	REMARKS/ UNIT PRICE	QUAN.	CHARGE	SALES TAX	TOTAL CHARGE	WASTE MIN.	CLEAN	SPENT	# OF CONT.	SK DOT	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS)(INITIAL)	CHANGE SCH. DATE (Y/W)	INV. CODE	PROMO NO.		MSDS GIVEN
1		88889	400509721	998.00	2	1996.00	—	1996.00					25383								☐
2																					☐
3																					☐
4																					☐
5																					☐
6																					☐
7																					☐
8																					☐
9																					☐
10																					☐
11																					☐
12																					☐

TOTAL-SERVICE/PRODUCTS

CHECK APPROPRIATE BOXES

	GOOD	POOR		YES	NO		YES	NO
MACHINE CONDITION & CLEANLINESS	☐	☐	DECALS IN PLACE AND LEGIBLE	☐	☐	MACHINE PROPERLY GROUNDED	☐	☐
			FUSIBLE LINK INSTALLED	☐	☐	LOCAL PHONE NO. STICKER AFFIXED TO MACHINE	☐	☐
LAMP ASSEMBLY CONDITION	☐	☐	EMERGENCY CLOSING OF LID UNOBSTRUCTED	☐	☐	SPENT SOLVENT MEETS ACCEPTANCE CRITERIA	☐	☐

USEPA TRANSPORTER 1 ID NO.	USEPA TRANSPORTER 2 ID NO.	GENERATOR USEPA ID NO.	GENERATOR STATE ID NO.
TXD000747378			

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
WASTE COMBUSTIBLE LIQUID, N.O.S. (PETROLEUM NAPHTHA) NA1993 PGIII(D001,D018,D039,D040) (ERG#128) 6.7LBS/GAL					704
WASTE COMBUSTIBLE LIQUID, N.O.S. (PETROLEUM NAPHTHA) NA1993 PG III RQ (D001) (ERG#128)6.7 LBS/GAL (D018,D039,D040)					801
CLEANING COMPOUNDS (PETROLEUM NAPHTHA) (NOT USDOT REGULATED)(CONTINUED USE)					60
PPE Non Regulated Solid	2	DF	865	P	25383

5165055

I CERTIFY THAT MY TOTAL WASTE STREAMS ARE WITHIN ONE OF THE FOLLOWING CATEGORIES.

0 TO 220 LBS./MONTH ______ INITIALS

220 LBS. TO 2,200 LBS./MONTH X DT INITIALS

GREATER THAN 2,200 LBS./MONTH ______ INITIALS

DESIGNATED FACILITY NAME AND ADDRESS SAFETY-KLEEN SYSTEMS, INC.

I CERTIFY THAT NO MATERIAL CHANGE HAS OCCURRED EITHER IN THE CHARACTERISTICS OF THE WASTE MATERIALS OR IN THE PROCESS GENERATING THE WASTE MATERIALS.

USA EPA ID NO.

STATE ID NO.

PAYMENT RECEIVED SECTION

CASH ☐	TOTAL RECEIVED	APPLY PAYMENT TO:
CHECK NUMBER		☐ TODAY'S SERVICE/SALE ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO

CREDIT CARD NO. AMEX VISA MC EXP. DATE

CUSTOMER REFERENCE INFORMATION

MANIFEST NO.

LDR MESSAGE

MANIFEST CODE	SEQ #
	7 D

IN THE EVENT OF AN EMERGENCY CALL 1-800-468-1760 (24 hours)

I AGREE TO PAY THE ABOVE CHARGES AND TO BE BOUND BY THE TERMS AND CONDITIONS SET FORTH ABOVE AND ON THE REVERSE SIDE OF THIS DOCUMENT. PLEASE CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION. THE INDIVIDUAL SIGNING THIS DOCUMENT IS DULY AUTHORIZED TO SIGN AND BIND CUSTOMER TO ITS TERMS.

"This is to certify that the above-named materials are properly classified, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation."

X [redacted]
Print Customer Name

By X [redacted]
Customer's Authorized Representative

VISA MasterCard AMERICAN EXPRESS

TOTAL CHARGE (FROM ABOVE)	1996.00
WASTE MIN. (FROM ABOVE)	
TOTAL DUE	1996.00

DO NOT WRITE IN THE AREA BELOW

M005015699
435340

THIS AGREEMENT CONTINUES ON THE REVERSE SIDE

SERVICE AND SALES ACKNOWLEDGMENT
PART 01-1366 (Rev. 05/07)

OUTBOUND TRUCK SHIP BACKUP LOG
UNICOR- TEXARKANA, TEXAS

FPI#: 127-08 DATE: 7-25-08

SHIPPED TO: Safety Kleen Longview, TX

CARRIER: SAME SEAL#: NONE

TRAILER #: NONE STAFF SIGNATURE

	WEIGHT	ITEMS	COUNT		WEIGHT	ITEMS	COUNT
SKID 1	355	White Suit	1 Box	SKID 19			
SKID 2				SKID 20			
SKID 3				SKID 21			
SKID 4				SKID 22			
SKID 5				SKID 23			
SKID 6				SKID 24			
SKID 7				SKID 25			
SKID 8				SKID 26			
SKID 9				SKID 27			
SKID 10				SKID 28			
SKID 11				SKID 29			
SKID 12				SKID 30			
SKID 13				SKID 31			
SKID 14				SKID 32			
SKID 15				SKID 33			
SKID 16				SKID 34			
SKID 17				SKID 35			
SKID 18				SKID 36			

TOTAL WEIGHT: 355

TRUCK DRIVERS SIGNATURE

Formulik gp 7100-6
Rev. 1

TERC

OUTBOUND TRUCK SHIP BACKUP LOG
UNICOR- TEXARKANA, TEXAS

FP#: 122-08 DATE: 7-21-08

SHIPPED TO: Safety Kleen Longview, TX

CARRIER: SAME SEAL#: NONE

TRAILER #: NONE STAFF SIGNATURE:

	WEIGHT	ITEMS	COUNT		WEIGHT	ITEMS	COUNT
SKID 1	510	White Suits	1	SKID 19			
SKID 2				SKID 20			
SKID 3				SKID 21			
SKID 4				SKID 22			
SKID 5				SKID 23			
SKID 6				SKID 24			
SKID 7				SKID 25			
SKID 8				SKID 26			
SKID 9				SKID 27			
SKID 10				SKID 28			
SKID 11				SKID 29			
SKID 12				SKID 30			
SKID 13				SKID 31			
SKID 14				SKID 32			
SKID 15				SKID 33			
SKID 16				SKID 34			
SKID 17				SKID 35			
SKID 18				SKID 36			

TOTAL WEIGHT: 510 TRUCK DRIVERS SIGNATURE:

Form#: op 7100-6

TERC Rev. 1

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

W L
6 1/8 x 9 →
7 3/4 x 5

No.________
Warehouse Use

VENDOR NAME: BUMPER TO BUMPER AUTO PARTS PHONE NUMBER: 903-794-0094
DEPARTMENT: CMS GARAGE
CARD HOLDER NAME: [redacted] DATE: 05-28-08
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	2	GAL	BRAKE FLUID	9.58	19.16
	2	GAL.	WESLEY'S BLEACH WHITE	8.49	16.98
	2	CSE	CASTROL GTX 5W20	37.20	74.40
	4	EA.	12V Lawn Mower Batteries	30.00	120.00
			FOR: HYBRID MOBILES		
			24.00 CORE ⇒ Credit		
			TOTAL AMOUNT		230.54

COST CENTER: P2 PROJECT: ________ YREGDOC#: HV-P210114

114
6/3/08

Card Holder Signature: [redacted] DATE 6-3-08

Cost Center Manager: [redacted] DATE 6-3-08

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer: ________ Date: ________	Computer Spec.: ________ Date: ________
Captain: ________ Date: ________	Safety Manager: ________ Date: ________

Warehouse: ________________ Date: ________

SPECIAL/EMERGENCY INSTRUCTION: ________________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
~~TEXARKANA, TEXAS~~
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

No.________
Warehouse Use

VENDOR NAME: BUMPER TO BUMPER AUTO PARTS PHONE NUMBER: 903-794-0094
DEPARTMENT: CMS GARAGE
CARD HOLDER NAME: [redacted] DATE: 05-20-08
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	10" 12V BATTERY		61.00
			FOR: J-114TEX		
			TOTAL AMOUNT		61.00

COST CENTER: 122 PROJECT: [redacted] YREGDOC#: 14V-PZ10124

Card Holder Signature: [redacted] DATE 6-17-08

Cost Center Manager: [redacted] DATE 6-17-08

124
6-18-08

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:________ Date:________	Computer Spec.:________ Date:________
Captain:________ Date:________	Safety Manager:________ Date:________

Warehouse:________________________ Date:________

SPECIAL/EMERGENCY INSTRUCTION:________________________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

order

No.________
Warehouse Use

VENDOR NAME: BUMPER TO BUMPER AUTO PARTS PHONE NUMBER: 903-794-0094
DEPARTMENT: CMS GARAGE
CARD HOLDER NAME: [redacted] DATE: 11-28-07
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	3	EA	12" 760CCA BATTERIES	59.13 57.13	171.39
	2	EA	10" 675CCA BATTERIES	49.99 54.87	109.74
	2	BX	CJ8 SPARK PLUGS	13.10	26.20
	2	BX	3157 TAIL LIGHT BULBS	12.30	24.60
	2	BX	3156 TAIL LIGHT BULBS	18.00	36.00
	2	RIB.	BATTERY TERMINALS	8.90	17.80
	1	BX	#2 HOSE CLAMPS		3.70
	4	EA	22" WIPER ARMS	3.99	15.96
	4	EA	19" WIPER ARMS	3.99	15.96
			TOTAL AMOUNT		~~[illegible]~~

417.71

COST CENTER: 12 PROJECT: ____ YREGDOC#: HV-P210043

43

Card Holder Signature: [redacted] DATE 12-6-07

Cost Center Manager: [redacted] DATE Dec 6, 2007

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:____ Date:____	Computer Spec.:____ Date:____
Captain:____ Date:____	Safety Manager:____ Date:____

Warehouse:________ Date:________

SPECIAL/EMERGENCY INSTRUCTION:________

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

No.________
Warehouse U

VENDOR NAME: BUMPER TO BUMPER AUTO PARTS **PHONE NUMBER:** 794-0094
DEPARTMENT: CMS GARAGE
CARD HOLDER NAME: [redacted] **DATE:** 08-07-07

(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	10" BATTERY		59.00
			FOR: LINCOLN WELDER		
			TOTAL AMOUNT		59.00

COST CENTER: PD **PROJECT:**______ **YREGDOC#:** P21-GV0137

Card Holder Signature: [redacted] **DATE** 8-9-07

Cost Center Manager: [redacted] **DATE** 8-9-07

TOOL AUTHORIZATION
Tool Room Officer:________ **Date:**______
Captain:________ **Date:**______

COMPUTER RELATED SUPPLIES/SAFETY
Computer Spec.:________ **Date:**______
Safety Manager:________ **Date:**______

Warehouse:________ **Date:**______

SPECIAL/EMERGENCY INSTRUCTION:________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

No.________
Warehouse U

VENDOR NAME: BUMPER TO BUMPER AUTO PARTS **PHONE NUMBER:** 903-794-0094
DEPARTMENT: CMS GARAGE
CARD HOLDER NAME: [redacted] **DATE:** 07-30-07

(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
7527	1	EA	12" BATTERY		~~59.00~~
			FOR: FORK#6 (FOOD-S)		
			TOTAL AMOUNT		~~59.00~~ 65.00

COST CENTER: P2 **PROJECT:**______ **YREGDOC#:** P21-GV0134

34

Card Holder Signature: [redacted] **DATE** 7-31-07

Cost Center Manager: [redacted] **DATE** 7-31-07

TOOL AUTHORIZATION	**COMPUTER RELATED SUPPLIES/SAFETY**
Tool Room Officer:______ **Date:**______	**Computer Spec.:**______ **Date:**______
Captain:______ **Date:**______	**Safety Manager:**______ **Date:**______

Warehouse:________________ **Date:**______

SPECIAL/EMERGENCY INSTRUCTION:________________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

No.________
Warehouse U:

VENDOR NAME: BUMPER TO BUMPER PHONE NUMBER: 838-7563
DEPARTMENT: CMS-GARAGE
CARD HOLDER NAME: [redacted] DATE: 07-11-07
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	BATTERY	67.00	67.00
	1	EA	T-STAT/GASKET	20.00	20.00
			TOTAL AMOUNT		~~87.00~~ 62.98

COST CENTER: P2 PROJECT:________ YREGDOC#: P21-GV0121
Card Holder Signature: [redacted] DATE 7/11/07 121
Cost Center Manager: [redacted] DATE RC

TOOL AUTHORIZATION
Tool Room Officer:____________ Date:________
Captain:____________ Date:________

COMPUTER RELATED SUPPLIES/SAFETY
Computer Spec.:____________ Date:________
Safety Manager:____________ Date:________

Warehouse:____________ Date:________
SPECIAL/EMERGENCY INSTRUCTION:____________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

No.________
Warehouse U

VENDOR NAME: BUMPER TO BUMPER AUTO PARTS **PHONE NUMBER:** 903-794-0094
DEPARTMENT: CMS GARAGE
CARD HOLDER NAME: [redacted] **DATE:** 06-13-07

(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	10" BATTERY		54.00
			FOR: TRAC# 11 (FOOD-S)		
			TOTAL AMOUNT		54.00

COST CENTER: P2 **PROJECT:**________ **YREGDOC#:** P21-GV0113

116

Card Holder Signature: [redacted] **DATE** 6-19-07

Cost Center Manager: [redacted] **DATE** 6-19-07

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:____________ Date:________	Computer Spec.:____________ Date:________
Captain:____________ Date:________	Safety Manager:____________ Date:________

Warehouse:________________________________ **Date:**__________

SPECIAL/EMERGENCY INSTRUCTION:________________________________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

No.________
Warehouse U

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774-5147
DEPARTMENT: CMS GARAGE
CARD HOLDER NAME: [redacted] DATE: 05-07-07
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	LEGEND 75 BATTERY 10"		54.00
			FOR: J-128TEX (FOODSERVICE PU)		
			2ND Request		
			TOTAL AMOUNT		54.00

COST CENTER: P2 PROJECT:________ YREGDOC#: P21-GV0112 115

Card Holder Signature: [redacted] DATE 6-19-07

Cost Center Manager: [redacted] DATE 6-19-07

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:________ Date:________	Computer Spec.:________ Date:________
Captain:________ Date:________	Safety Manager:________ Date:________

Warehouse:________ Date:________

SPECIAL/EMERGENCY INSTRUCTION:________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

No.________
Warehouse (

VENDOR NAME: BUMPER TO BUMPER AUTO PARTS **PHONE NUMBER:** 903-794-0094
DEPARTMENT: CMS GARAGE
CARD HOLDER NAME: [redacted] **DATE:** 06-12-07

(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	10" 600 CCA BATTERY		54.00
			FOR: TRAC#3 (M/F 1020)		
			TOTAL AMOUNT		54.00

COST CENTER: 22 **PROJECT:**________ **YREGDOC#:** 121-GV0110

Card Holder Signature: [redacted] **DATE** 6-19-07

113

Cost Center Manager: [redacted] **DATE** 6-19-07

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:____________ Date:______	Computer Spec.:____________ Date:______
Captain:____________ Date:______	Safety Manager:____________ Date:______

Warehouse:______________________________ **Date:**________

SPECIAL/EMERGENCY INSTRUCTION:______________________________

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

No.________
Warehouse U:

Bumper Bumper

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774-5147
DEPARTMENT: CAMP FOODSERVICE
CARD HOLDER NAME: [redacted] DATE: 04-02-07
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	13" MARINE BATTERY 800CCA		84.00
			FOR: 2002 WABASH REFER (J-147TEX)		
			TOTAL AMOU		84.00

TAX WAS Credited BACK in MAY

TAX

0066

COST CENTER: P2 PROJECT:________

Card Holder Signature: [redacted]

Cost Center Manager: [redacted]

TOOL AUTHORIZATION
Tool Room Officer:____________ Date:________

Captain:________________ Date:______

'ETY
Date:________

Date:________

Warehouse:______________________________ Date:________

SPECIAL/EMERGENCY INSTRUCTION:______________________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

No._________
Warehouse Use

VENDOR NAME: ~~NAPA AUTO PARTS~~ Bumper Bumper. PHONE NUMBER: 774-5147
DEPARTMENT: CMS GARAGE
CARD HOLDER NAME: [redacted] DATE: 03-05-07
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	12" 600CCA BATTERY		69.00
			FOR: TRAC#11 (JD 5200)		
					69.00

TOTAL AMOUNT ~~$69.00~~ 71.41

COST CENTER: 22 PROJECT: ______ VREGDOC#: 121-GV0060 0063

Card Holder Signature: [redacted] DATE 4-2-07

Cost Center Manager: [redacted] DATE 4-2-07

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer: ______ Date: ______	Computer Spec.: ______ Date: ______
Captain: ______ Date: ______	Safety Manager: ______ Date: ______

Warehouse: ______ Date: ______

SPECIAL/EMERGENCY INSTRUCTION: ______

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

No.________
Warehouse Use

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774-5147
DEPARTMENT: CMS CAMP GARAGE
CARD HOLDER NAME: [redacted] DATE: 11-06-06
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	LEGEND 75 10" BATTERY		57.95
			FOR: J-120TEX (CAMP FOODSERVICE)		
					57.95

59.95
TOTAL AMOUNT: ~~$57.95~~

COST CENTER: 22 [redacted] PROJECT:______ YREGDOC#: P21-6V0044
Card Holder Signature: [redacted] DATE 2-20-07 $\boxed{0046}$

Cost Center Manager [redacted] DATE 2-20-07

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:______ Date:____	Computer Spec.:______ Date:____
Captain:______ Date:____	Safety Manager:______ Date:____

Warehouse:__________ Date:______

SPECIAL/EMERGENCY INSTRUCTION:__________

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

No:________
Warehouse Use

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774-5147
DEPARTMENT: CMS CAMP GARAGE
CARD HOLDER NAME: [redacted] DATE: 11-06-06
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	LEGEND 75 10" BATTERY		57.95
			FOR: J-120TEX (CAMP FOODSERVICE)		
					57.95

TOTAL AMOUNT: $57.95

COST CENTER: P2 [redacted] PROJECT:________ YREGDOC#: P21-6V0044

0046

Card Holder Signature: [redacted] DATE 2-20-07

Cost Center Manager: [redacted] DATE 2-20-07

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:________ Date:________	Computer Spec.:________ Date:________
Captain:________ Date:________	Safety Manager:________ Date:________

Warehouse:________ Date:________

SPECIAL/EMERGENCY INSTRUCTION:________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

No.____________
Warehouse Use

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774-5147
DEPARTMENT: CMS CAMP GARAGE
CARD HOLDER NAME: [redacted] DATE: 05-24-06
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	2	EA	LEGEND 75 BATTERIES	57.45 ~~56.00~~	115.90 ~~112.00~~
			FOR: TRAC#13 & TRAC# 3		
			Need core		
					115.90 ~~112.00~~

TOTAL AMOUNT ~~$112.00~~ 115.90

COST CENTER: P2 PROJECT:__________ YREGDOC#: P21-FV0153
Card Holder Signature: [redacted] DATE 6/5/06
Cost Center Manager: [redacted] DATE 6/5/06

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:__________ Date:______	Computer Spec.:__________ Date:______
Captain:__________ Date:______	Safety Manager:__________ Date:______

Warehouse:________________________________ Date:__________

SPECIAL/EMERGENCY INSTRUCTION:________________________________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

No.________
Warehouse Use

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774-5147
DEPARTMENT: CMS CAMP GARAGE
CARD HOLDER NAME: [redacted] DATE: 04-17-06
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	2	EA	LEGEND 75 BATTERIES	56.00	112.00
			FOR: WATER PUMP (FOODSERVICE)		
					115.90

TOTAL AMOUNT: 115.90

COST CENTER: P2 PROJECT:______ VREGDOC#: P21-FY0114

0122

Card Holder Signature: [redacted] DATE 4/18/06

Cost Center Manager: [redacted] DATE 4/18/06

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:________ Date:______	Computer Spec.:________ Date:______
Captain:________ Date:______	Safety Manager:________ Date:______

Warehouse:______________________ Date:________

SPECIAL/EMERGENCY INSTRUCTION:______________________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

No.__________
Warehouse Use

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774-5147
DEPARTMENT: CMS CAMP GARAGE
CARD HOLDER NAME: [redacted] DATE: 02-08-06
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	13" BATTERY 800CCA	100.00	$100.00
	1	EA	OIL DRAIN PLUG	15.00	$15.00
			FOR: TRAC#14 (KUBOTA F/S)		
			J-143TEX (UNICOR DUMP)		
				TOTAL	$115.00

TOTAL AMOUNT: 74.41
COST CENTER: P2 PROJECT:________ YREGDOC#: P21-FV0072
Card Holder Signature: [redacted] DATE: 2/10/06
Cost Center Manager: [redacted] DATE 2/10/06
C078

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:__________ Date:______	Computer Spec.:__________ Date:______
Captain:__________ Date:______	Safety Manager:__________ Date:______

Warehouse:______________________________ Date:__________

SPECIAL/EMERGENCY INSTRUCTION:______________________________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

No.__________
Warehouse Use

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774--5147
DEPARTMENT: CMS CAMP GARAGE
CARD HOLDER NAME: [redacted] DATE: 10-25 05
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	2	EA	12" BATTERIES	59 00	118 00
			FOR: GRADER#1		
					~~118 00~~

TOTAL AMOUNT: ~~$118 00~~ $ 113,50

COST CENTER: P2 PROJECT:________ YREGDOC#: P21 - FV0032
Card Holder Signature: [redacted] DATE 11/30/05 0036
Cost Center Manager: [redacted] DATE 11/30/05

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:__________ Date:______	Computer Spec.:__________ Date:______
Captain:__________ Date:______	Safety Manager:__________ Date:______

Warehouse:______________________________ Date:__________

SPECIAL/EMERGENCY INSTRUCTION:______________________________

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

No.________
Warehouse Use

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774-5147
DEPARTMENT: CMS CAMP GARAGE
CARD HOLDER NAME: [redacted] DATE: 11-09-05
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	10" BATTERY		56.00
			FOR: J-105TEX (BUCKET TRUCK)		
			price change 52.95		
					~~56.00~~

TOTAL AMOUNT: ~~$56.00~~

COST CENTER: P2 PROJECT:______ YREGDOC#: P21-FV0016

6019

Card Holder Signature: [redacted] DATE 11/14/05

Cost Center Manager: [redacted] DATE 11/14/05

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:______ Date:______	Computer Spec.:______ Date:______
Captain:______ Date:______	Safety Manager:______ Date:______

Warehouse:____________ Date:______

SPECIAL/EMERGENCY INSTRUCTION:____________

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

No.________
Warehouse Use

VENDOR NAME: O'REILLY AUTO PARTS PHONE NUMBER: 793-6920
DEPARTMENT: CMS CAMP GARAGE
CARD HOLDER NAME: [redacted] DATE: 10-11-05
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	57 SERIES BATTERY		49.00
			FOR:GEN# 10 (PRAMAC S7500)		
					49.00

TOTAL AMOUNT $49.00

COST CENTER: P2 PROJECT: ____ YREGDOC#: P21-FV0004

0004

Card Holder Signature: [redacted] DATE 10/17/05

Cost Center Manager: [redacted] DATE 10/17/05

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer:____ Date:____	Computer Spec.:____ Date:____
Captain:____ Date:____	Safety Manager:____ Date:____

Warehouse:____ Date:____

SPECIAL/EMERGENCY INSTRUCTION:____

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $2500.00)

2

No.________
Warehouse Use

VENDOR NAME: NAPA AUTO PARTS PHONE NUMBER: 774-5147
DEPARTMENT: CMS CAMP GARAGE
CARD HOLDER NAME: [redacted] DATE: 09-26-05
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	4	EA	72 SERIES BATTERIES 10"	53.00	212.00
	1	BX	ASSORTED O-RINGS		70.61
	1	BX	ASSORTED E-CLIPS		11.49
	2	EA	VALVE STEM WRENCHES	13.79	27.58
	1	SET	WIPER BLADES 14"		6.01
	1	EA	3/8"ON 1/4" DRIVE SWIVEL SOCKET		17.49
			BROKEN TOOL REPLACEMENT		
			FOR: GARAGE		
					345.18

TOTAL AMOUNT 344.58

COST CENTER: Pg PROJECT: ______ YREGDOC#: P21-5V0195
Card Holder Signature: [redacted] DATE 9-29-05
Cost Center Manager: [redacted] DATE 9-29-05

0214

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFET
Tool Room Officer:______ Date:____	Computer Spec.:______ Date:___
Captain:______ Date:____	Safety Manager:______ Date:___

Warehouse:________ Date:____

SPECIAL/EMERGENCY INSTRUCTION:________

"LOCAL REPRODUCTION AUTHORIZED"

THIS PURCHASE MEETS YEAR-END SPENDING CRITERIA, AS PER P.S. 4100.04, PART 7.104-70

204

Control No. 5369348

NAPA AUTO PARTS - TEXARKANA
870-774-5147 Y OCR Y
REF________VER________
TEXARKANA 71854

8000035852004430

REMIT PAYMENT TO:
PO BOX 848033
DALLAS TX 75284-8033 [redacted]
RECEIVED BY X

ALL GOODS RETURNED MUST BE ACCOMPANIED BY THIS INVOICE

ACCT. NO.	SOLD TO
182-01830	FEDERAL PRISON INDUSTRIES
	PO BOX 9500
(12)	TEXARKANA, TX 75505-0000

0-0
13:42

DATE	INVOICE NO.	STORE NO.	EMP	SR
9/14/05	200443	03585	4	39

TIME	PURCHASE ORDER NO.	ATTENTION
13:42	.	

DELIVER INVOICE TYPE → M/C

QUANTITY	PART NUMBER	LINE	DESCRIPTION	PRICE	NET	TOTAL	CODE
1.00	7558	BAT	BATTERY-1	81.990	52.950	52.95	
1.00	7558	BAT	CORE DEPO		10.000	10.00	D
1.00-	7558	BAT	CORE DEPO		10.000	10.00CR	D

SUB TOTAL	MISC.		% TAX		TOTAL	
52.95	0.00	10.000	0.00		52.95	CASH

NAPA AUTO PARTS #243
201 E M L KING BLVD
TEXARKANA, AR 71854
870-774-5147

BATCH 440

SEP 14, 05 13:50:56

TOTAL $52.95*

[redacted] EXP: XX/XX

CARDMEMBER ACKNOWLEDGES RECEIPT OF GOODS AND/OR SERVICES IN THE AMOUNT OF THE TOTAL SHOWN HEREON AND AGREES TO PERFORM THE OBLIGATIONS SET FORTH BY THE ...ER'S AGREEMENT WITH THE ISSUER

X [redacted]

TOP COPY-MERCHANT BOTTOM COPY-CUSTOMER

Safety-Kleen

Elgin, Illinois 60123-7857

CUSTOMER NO.

0	0	0	2	-	2	5	0	4	-	6	8

FOR SERVICE CALL	TRANSPORTER	DOC. EXP.	SCHEDULED SERVICE WEEK	SCHEDULED TERRITORY	REFERENCE NUMBER
903-757-9187	DAN DURST	05/11/02	02-11	02	0020451854

CUSTOMER / GENERATOR:
US DOJ FER COR INST TEXARK
FCI RD AT CITY LIMITS (GAR
[redacted]
TEXARKANA TX 75501

BILL TO:
0001-5153-80
SAFETY KLEEN CORP.
920 DAVIS RD., 4TH FLOOR
ATTN: CONNIE MCGOWAN-SLS SUPPORT
ELGIN IL 60123

CREDIT CODE	PREVIOUS BALANCE	BAL. OVER 60 DAYS
F		

BUSINESS TYPE	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C
10	9914	YES	0794	0001

LOCATION	TAX EXEMPTION NUMBER
619401	

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	HANDLING CODE		ASSOC. CODE	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
5-15-02	2329		[redacted]	44-057-7602		OR				0825

	DEPT	SERVICE/ PRODUCT	UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	HALOGEN TESTER PASS	HALOGEN TESTER FAIL	CHLOR-D-TECT RESULTS (PPM)	TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS)(INITIAL)	CHANGE SCH. DATE (YY WW)	PROMO NO.	RELEASE NO.
1	00	100001	2.9000	0				☐	☐						0			
2	00	66661		100	18.00		18.00	☒	☐				850		16			
3								☐	☐									
4								☐	☐									
5								☐	☐									
6								☐	☐									
7								☐	☐									
8								☐	☐									
9								☐	☐									

TOTAL SERVICE/PRODUCTS: 18.00

TANK CAPACITY

TRANSPORTER — DATE 5/15/02
PRINT NAME: Tobi Greene — SIGNATURE: X [signature]

FACILITY — DATE / /
PRINT NAME — SIGNATURE: X

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION *	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☐ 1	☐ 3
SQG/LQG	☒ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO.	USEPA TRANSPORTER ID NO.
XXXXX	TXD000747378
GENERATOR USEPA ID NO.	**GENERATOR STATE ID NO.**
TX0151909132	73275

	11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
A.	USED OIL (NOT USDOT HAZARDOUS MATERIAL)	1	TT	100	G	850
B.						
C.						
D.						

WE CARE — We Recycle — We Use Safety-Kleen Environmental Services

OIL RECOVERY SERVICE/

INTERMEDIATE FACILITY NAME AND ADDRESS: SAFETY-KLEEN SYSTEMS, INC.
202 MICHAEL PLACE LONGVIEW, TX 75602

USA EPA ID NO. TXD000747378
STATE ID NO. 67028

PAYMENT RECEIVED SECTION

CASH ☐ — TOTAL RECEIVED — APPLY PAYMENT TO:
CHECK NUMBER — ☐ TODAY'S SERVICE/SALE — ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO →

CREDIT CARD NO. — AMEX VISA MC — EXP. DATE

CUSTOMER REFERENCE INFORMATION

MANIFEST CODE	SEQ #
NR	1 D

IN THE EVENT OF AN EMERGENCY CALL 1-800-468-1760 (24 hours)

CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION.
SEE ADDITIONAL TERMS AND CONDITIONS ON REVERSE SIDE AND MADE A PART HEREOF.

*This is to certify that the above-named materials are properly classified, described, packaged, marked, and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation

Print [redacted] SENTATIVE SIGNATURE

TOTAL DUE

DO NOT WRITE IN THE AREA BELOW

0020451854

0002-2504-68 -1

SEE REVERSE SIDE FOR IMPORTANT INFORMATION

safety-kleen.

1301 Gervais Street - Suite 300
Columbia, South Carolina 29201

WE CARE

CUSTOMER NO.

0	0	0	2	-	2	5	0	4	-	6	8

CUSTOMER GENERATOR

US DOJ FER COR INST TEXARK
FCI RD AT CITY LIMITS (GAR
[redacted]
TEXARKANA TX 75501

BILL TO

0001-5153-80
SAFETY KLEEN CORP.
920 DAVIS RD., 4TH FLOOR
ATTN: CONNIE MCGOWAN-SLS SUPPORT
ELGIN IL 60123

DUNS NO. 05-397-6551 FED. ID NO. 75-2178928

FOR SERVICE CALL	BRANCH MANAGER	DOC. EXP.
903-757-9187	DAN DURST	08/24/02

CUSTOMER

SCHEDULED SERVICE WEEK	SCHEDULED TERRITORY	REFERENCE NUMBER
02-26	01	0021231721

CREDIT CODE	PREVIOUS BALANCE	BAL. OVER 60 DAYS
E		

BUSINESS TYPE	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C
10	9914	YES	0794	0001

LOCATION	TAX EXEMPTION NUMBER
619401	

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	HANDLING CODE	ASSOC. CODE	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
			[redacted]	44-057-7602	OR				.0825

	DEPT	SERVICE/ PRODUCT		UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	CHLORINE TEST RESULTS HALOGEN TESTER PASS	FAIL	CHLOR-D-TECT RESULTS (PPM)	TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS)(INITIAL)	CHANGE SCH. DATE (YY WW)	PROMO NO.	RELEASE NO.
1	00	10000		2.9000					☐	☐					0				
2	00	66661							☐	☐			850		8				
3									☐	☐									
4									☐	☐									
5									☐	☐									
6									☐	☐									
7									☐	☐									
8									☐	☐									
9									☐	☐									

TOTAL SERVICE/PRODUCTS

TANK CAPACITY

TRANSPORTER	DATE / /
PRINT NAME	X SIGNATURE

FACILITY	DATE / /
PRINT NAME	X SIGNATURE

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION *	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☐ 1	☐ 3
SQG/LQG	☐ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO.	USEPA TRANSPORTER ID NO.
XXXXX	TXD000747378
GENERATOR USEPA ID NO.	**GENERATOR STATE ID NO.**
TX0151909132	73275

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
USED OIL (NOT USDOT HAZARDOUS MATERIAL)		TT		G	850

WE CARE

INTERMEDIATE FACILITY NAME AND ADDRESS SAFETY-KLEEN SYSTEMS, INC.
202 MICHAEL PLACE LONGVIEW, TX 75602

USA EPA ID NO.	TXD000747378
STATE ID NO.	67028

OIL RECOVERY SERVICE/ SALES ACKNOWLEDGMENT

PAYMENT RECEIVED SECTION

CASH ☐ CHECK NUMBER	TOTAL RECEIVED	APPLY PAYMENT TO: ☐ TODAY'S SERVICE/SALE ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO →

CREDIT CARD NO. AMEX VISA MC EXP. DATE

MANIFEST CODE	SEQ #
NR	2 D

IN THE EVENT OF AN EMERGENCY CALL

CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION.

Customer certifies that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the U.S. Environmental Protection Agency and the U.S. Department of Transportation.

ADDITIONAL TERMS AND CONDITIONS ON THE REVERSE SIDE OF THIS DOCUMENT ARE INCORPORATED HEREWITH MADE A PART HEREOF.

Prin[redacted]
Nan
X

TOTAL DUE	nk

DO NOT WRITE IN THE AREA BELOW

0021231721

0002-2504-68 -1

Safety-Kleen

CUSTOMER NO. 2 2 5 0 9 6 8

CUSTOMER / GENERATOR: US DOJ FED COR INST TEXARK FCI AT CITY LIMIT CAR TEXARKANA TX

BILL TO

903-757-9187 MARK LESTER

SERVICE WEEK	TERRITORY	NUMBER
05		M002756311

CREDIT CODE	PREVIOUS BALANCE	BAL. OVER 60 DAYS

BUSINESS TYPE	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C

LOCATION	TAX EXEMPTION NUMBER
619401	

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	HANDLING CODE	ASSOC. CODE	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
5-2-05	430520				OR				

	DEPT	SERVICE/ PRODUCT	SURVEY NUMBER	UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	HALOGEN PASS	TESTER FAIL	CHLOR-D-TECT RESULTS (PPM)	TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS)(INITIAL)	CHANGE SCH. DATE (YY WW)	PROMO NO.	RELEASE NO.
1	00	64441			220	11.00		11.00	☑	☐									
2									☐	☐									
3									☐	☐									
4									☐	☐									
5									☐	☐									
6									☐	☐									
7									☐	☐									
8									☐	☐									
9									☐	☐									
TOTAL-SERVICE/PRODUCTS					220	11.00		11.00	TANK CAPACITY										

TRANSPORTER DATE / /

PRINT NAME — X SIGNATURE

FACILITY DATE / /

PRINT NAME — X SIGNATURE

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION *	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☑ 1	☐ 3
SQG/LQG	☐ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO.	USEPA TRANSPORTER ID NO.
	TXD000747378
GENERATOR USEPA ID NO.	**GENERATOR STATE ID NO.**

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
USED OIL (NOT USDOT HAZARDOUS MATERIAL)	1	TT	220	G	850
USED OIL AND WATER MIXTURE (NOT USDOT HAZARDOUS MATERIAL)					927
USED ANTIFREEZE (NOT USEPA OR USDOT REGULATED)					1176

WE CARE. We Recycle.

OIL RECOVERY SERVICE/ SALES ACKNOWLEDGEMENT

INTERMEDIATE FACILITY NAME AND ADDRESS SAFETY-KLEEN SYSTEMS, INC.
202 Michael Place Longview TX 75603 AB5233

USA EPA ID NO. TXD000747378
STATE ID NO. 67028

PAYMENT RECEIVED SECTION

CASH ☐	TOTAL RECEIVED	APPLY PAYMENT TO:
CHECK NUMBER		☐ TODAY'S SERVICE/SALE ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO →

CREDIT CARD NO. — AMEX VISA MC — EXP. DATE

CUSTOMER REFERENCE INFORMATION

MANIFEST CODE	SEQ #
	3-D

IN THE EVENT OF AN EMERGENCY CALL 1-800-468-1760 (24 hours)

CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION.

Customer certifies that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the U.S. Environmental Protection Agency and the U.S. Department of Transportation.

ADDITIONAL TERMS AND CONDITIONS ON THE REVERSE SIDE OF THIS DOCUMENT ARE INCORPORATED HEREWITH MADE A PART HEREOF.

Print Name [redacted]

X [redacted]

GENERATOR/SHIPPER DESIGNATED REPRESENTATIVE SIGNATURE

VISA MasterCard AMERICAN EXPRESS

TOTAL DUE 11.00

DO NOT WRITE IN THE AREA BELOW

M002756311

005781

SEE REVERSE SIDE FOR IMPORTANT INFORMATION

CUSTOMER NO.

0 0 0 2 - 2 5 0 4 - 6 8

GENERATOR / CUSTOMER

US DOJ FED COR INST TEXARK
FCI RD AT CITY LIMITS GAR
ATTN [redacted]
TEXARKANA TX 75501

903-757-9167 MARK LESTER 05/15/04

0025841436

PREVIOUS BALANCE | BAL. OVER 60 DAYS

BILL TO
0001-5153-80
SAFETY KLEEN CORP.
920 DAVIS RD., 4TH FLOOR
ATTN: CONNIE MCGOWAN-SLS SUPPORT
ELGIN IL 60123

BUSINESS TYPE | CHAIN | OUTER COUNTY | SVC. P/C | PROD. P/C | LOCATION | TAX EXEMPTION NUMBER

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	HANDLING CODE	ASSOC. CODE	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
3/23/04	43A570								

	DEPT	SERVICE/ PRODUCT	SURVEY NUMBER	UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	HALOGEN TESTER PASS	HALOGEN TESTER FAIL	CHLOR-D-TECT RESULTS (PPM)	TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS) (INITIAL)	CHANGE SCH. DATE (YY WW)	PROMO NO.	RELEASE NO.
1					150				☑	☐									
2		350001		0.0500					☐	☐			850		0				
3									☐	☐									
4									☐	☐									
5									☐	☐									
6									☐	☐									
7									☐	☐									
8									☐	☐									
9									☐	☐									
	TOTAL-SERVICE/PRODUCTS				150			7.50	TANK CAPACITY										

TRANSPORTER DATE 3/23/04

PRINT NAME Johnny Sommers SIGNATURE X John Sommers

FACILITY DATE / /

PRINT NAME SIGNATURE X

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION *	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☑ 1	☐ 3
SQG/LQG	☐ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO.	USEPA TRANSPORTER ID NO.
XXXXX	TXD000747378
GENERATOR USEPA ID NO.	GENERATOR STATE ID NO.
TX0151909132	73275

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
A. USED OIL (NOT USDOT HAZARDOUS MATERIAL)	1	TT	150	G	850
B.					
C.					
D.					

WE CARE.

OIL RECOVERY SERVICE/

INTERMEDIATE FACILITY NAME AND ADDRESS
SAFETY-KLEEN SYSTEMS, INC. A85233
1202 MICHAEL PLACE LONGVIEW, TX 75602

USA EPA ID NO. TXD000747378
STATE ID NO. 67028

PAYMENT RECEIVED SECTION

CASH ☐ | TOTAL RECEIVED | APPLY PAYMENT TO:
CHECK NUMBER | ☐ TODAY'S SERVICE/SALE | ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO →

CREDIT CARD NO: AMEX VISA MC EXP. DATE

CUSTOMER REFERENCE INFORMATION

MANIFEST CODE	SEQ #
NR	1 D

IN THE EVENT OF AN EMERGENCY CALL 1-800-468-1760 (24 hours)

CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION.

Customer certifies that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the U.S. Environmental Protection Agency and the U.S. Department of Transportation.

ADDITIONAL TERMS AND CONDITIONS ON THE REVERSE SIDE OF THIS DOCUMENT ARE INCORPORATED HEREWITH MADE A PART HEREOF.

Print Name [redacted]

X [redacted]

GENERATOR/SHIPPER DESIGNATED REPRESENTATIVE SIGNATURE

VISA MasterCard

SEE REVERSE SIDE FOR IMPORTANT INFORMATION

TOTAL DUE 7.50

DO NOT WRITE IN THE AREA BELOW

0025841436

0002-2504-68 -1

Safety-Kleen. Columbia, South Carolina 29201
CUSTOMER NO. 2 2 5 0 9 6 8

GENERATOR: US DOJ FED COR INST TEXARK
FCI RD City Limits
TEXARKANA, TX 75501

BILL TO

FOR SERVICE CALL	BRANCH MANAGER	DOC. EXP.	SCHEDULED SERVICE WEEK	SCHEDULED TERRITORY	REFERENCE NUMBER
903-757-9187 MARK LESTER			04		M002461593

CREDIT CODE	PREVIOUS BALANCE	BAL. OVER 60 DAYS

BUSINESS TYPE	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C

LOCATION	TAX EXEMPTION NUMBER

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	HANDLING CODE	ASSOC. CODE	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
11-10-04	436526					OR	610401		

	DEPT	SERVICE/ PRODUCT	SURVEY NUMBER	UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	HALOGEN TESTER PASS	HALOGEN TESTER FAIL	CHLOR-D-TECT RESULTS (PPM)	TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS)(INITIAL)	CHANGE SCH. DATE (YY WW)	PROMO NO.	RELEASE NO.
1	20	666661		.05	300	15.00		15.00	☑	☐									
2									☐	☐									
3									☐	☐									
4									☐	☐									
5									☐	☐									
6									☐	☐									
7									☐	☐									
8									☐	☐									
9									☐	☐									

TOTAL-SERVICE/PRODUCTS 15.00 TANK CAPACITY

TRANSPORTER DATE 11/10/04
Johnny Sammon PRINT NAME X John Sammon SIGNATURE

FACILITY DATE / /
PRINT NAME X SIGNATURE

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☑ 1	☐ 3
SQG/LQG	☐ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO.	USEPA TRANSPORTER ID NO.
	TXD000747378

GENERATOR USEPA ID NO.	GENERATOR STATE ID NO.

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
USED OIL (NOT USDOT HAZARDOUS MATERIAL)	1	TT	300	G	850
USED OIL AND WATER MIXTURE (NOT USDOT HAZARDOUS MATERIAL)					927
USED ANTIFREEZE (NOT USEPA OR USDOT REGULATED)					1176

WE CARE.

OIL RECOVERY SERVICE/ SALES ACKNOWLEDGMENT

INTERMEDIATE FACILITY NAME AND ADDRESS SAFETY-KLEEN SYSTEMS, INC.
202 Michael Place Longview TX 75603 A85233

USA EPA ID NO. TXD000747378
STATE ID NO. 67029

PAYMENT RECEIVED SECTION

CASH ☐ | TOTAL RECEIVED | APPLY PAYMENT TO:
CHECK NUMBER | ☐ TODAY'S SERVICE/SALE
☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO. →

CREDIT CARD NO. AMEX VISA MC EXP. DATE

CUSTOMER REFERENCE INFORMATION

MANIFEST CODE	SEQ #
	1 D

IN THE EVENT OF AN EMERGENCY CALL 1-800-468-1760 (24 hours)

CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION.
Customer certifies that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the U.S. Environmental Protection Agency and the U.S. Department of Transportation.
ADDITIONAL TERMS AND CONDITIONS ON THE REVERSE SIDE OF THIS DOCU[redacted]MADE A PART HEREOF.
Print Name [redacted]
X [redacted]
GENERATOR/SHIPPER DESIGNATED REPRESENTATIVE SIGNATURE

VISA MasterCard AMERICAN EXPRESS

TOTAL DUE 15.00

DO NOT WRITE IN THE AREA BELOW
M002461593
430529

SEE REVERSE SIDE FOR IMPORTANT INFORMATION

safety-kleen.

CUSTOMER NO.

2 2 5 0 4 6 8

CUSTOMER / GENERATOR

US DOJ FED COR INST TEXARK
FCI RD AT CITY LIMITS GAK
TEXARKANA TX

BILL TO

FOR SERVICE CALL	BRANCH MANAGER	DOC. EXP.	SERVICE WEEK	TERRITORY	NUMBER

CREDIT CODE	PREVIOUS BALANCE	BAL. OVER 60 DAYS

BUSINESS TYPE	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C

LOCATION	TAX EXEMPTION NUMBER

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	HANDLING CODE	ASSOC. CODE	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
9-1-05	430329								

	DEPT	SERVICE/PRODUCT	SURVEY NUMBER	UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	CHLORINE TEST RESULTS: HALOGEN TESTER PASS	FAIL	CHLOR-D-TECT RESULTS (PPM)	TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS) (INITIAL)	CHANGE SCH. DATE (YY WW)	PROMO NO.	RELEASE NO.
1	05	666601			200	10.00		10.00	☑	☐			850		8				
2									☐	☐									
3									☐	☐									
4									☐	☐									
5									☐	☐									
6									☐	☐									
7									☐	☐									
8									☐	☐									
9									☐	☐									

TOTAL SERVICE/PRODUCTS 200 10.00 10.00

TANK CAPACITY

TRANSPORTER DATE 9/1/05

Johnny Sammons X J. Sammons
PRINT NAME SIGNATURE

FACILITY DATE / /

X
PRINT NAME SIGNATURE

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION *	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☑ 1	☐ 3
SQG/LQG	☐ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO.	USEPA TRANSPORTER ID NO.
	TXD000747378

GENERATOR USEPA ID NO.	GENERATOR STATE ID NO.

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
USED oil NOT USDOT HAZARDOUS material	1	TT	200	G	850
			200		

WE CARE. We Recycle

OIL RECOVERY SERVICE/

INTERMEDIATE FACILITY NAME AND ADDRESS Safety Kleen
207 Michael Place Longview TX 75603 A85277

USA EPA ID NO. TXD000747378
STATE ID NO. 67028

PAYMENT RECEIVED SECTION

CASH ☐ CHECK NUMBER | TOTAL RECEIVED | APPLY PAYMENT TO: ☐ TODAY'S SERVICE/SALE ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO →

CREDIT CARD NO. AMEX VISA MC EXP. DATE

CUSTOMER REFERENCE INFORMATION

MANIFEST CODE	SEQ #

IN THE EVENT OF AN EMERGENCY CALL 1-800-468-1760 (24 hours)

CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION.

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ADDITIONAL TERMS AND CONDITIONS ON THE REVERSE SIDE OF THIS DOCUMENT ARE INCORPORATED HEREWITH MADE A PART HEREOF.

Print Name [redacted]

X [redacted]

GENERATOR/SHIPPER DESIGNATED REPRESENTATIVE SIGNATURE

VISA MasterCard AMERICAN EXPRESS

TOTAL DUE 10.00

DO NOT WRITE IN THE AREA BELOW

SEE REVERSE SIDE FOR IMPORTANT INFORMATION

Safety-Kleen.

CUSTOMER NO.

FOR SERVICE CALL	BRANCH MANAGER	DOC. EXP.	SERVICE WEEK	TERRITORY	NUMBER
903-757-9187	MARK LESTER		06		M003280691

CREDIT CODE	PREVIOUS BALANCE	BAL OVER 60 DAYS

BUSINESS TYPE	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C

LOCATION	TAX EXEMPTION NUMBER
619401	

CUSTOMER / GENERATOR

F.C.I (GARAGE) US.DOJ.

TEXARKANA, TX

BILL TO

EXT 358

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	HANDLING CODE		ASSOC. CODE	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
2-17-06	5002		903-838-4587			OR				

	DEPT	SERVICE/ PRODUCT	SURVEY NUMBER	UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	CHLORINE TEST RESULTS: HALOGEN PASS	TESTER FAIL	CHLOR-D-TECT RESULTS (PPM)	TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS) (INITIAL)	CHANGE SCH. DATE (YY WW)	PROMO NO.	RELEASE NO.
1		66661		.05	150				☑	☐			850						
2									☐	☐									
3									☐	☐									
4									☐	☐									
5									☐	☐									
6									☐	☐									
7									☐	☐									
8									☐	☐									
9									☐	☐									

TOTAL SERVICE/PRODUCTS

TANK CAPACITY

TRANSPORTER DATE 2/17/06

Allen E Fowler — PRINT NAME

X [signature] — SIGNATURE

FACILITY DATE / / /

PRINT NAME

X — SIGNATURE

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☑ 1	☐ 3
SQG/LQG	☐ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO.	USEPA TRANSPORTER ID NO.
	TXD000747378

GENERATOR USEPA ID NO.	GENERATOR STATE ID NO.

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
USED OIL (NOT USDOT HAZARDOUS MATERIAL)	1	TT	150	G	850
USED OIL AND WATER MIXTURE (NOT USDOT HAZARDOUS MATERIAL)					927
USED ANTIFREEZE (NOT USEPA OR USDOT REGULATED)					1176

We Recycle. WE CARE. Safety-Kleen Environmental Services

OIL RECOVERY SERVICE/ SALES ACKNOWLEDGMENT

INTERMEDIATE FACILITY NAME AND ADDRESS SAFETY-KLEEN SYSTEMS, INC. A85233

202 Michael Place Longview TX 75602

USA EPA ID NO. TXD000747378

STATE ID NO. 67028

PAYMENT RECEIVED SECTION

CASH ☐ | TOTAL RECEIVED | APPLY PAYMENT TO:

CHECK NUMBER

☐ TODAY'S SERVICE/SALE
☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO →

CREDIT CARD NO. | AMEX VISA MC | EXP. DATE

CUSTOMER REFERENCE INFORMATION

MANIFEST CODE	SEQ #
	3 D

IN THE EVENT OF AN EMERGENCY CALL 1-800-468-1760 (24 hours)

CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION.

Customer certifies that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the U.S. Environmental Protection Agency and the U.S. Department of Transportation.

ADDITIONAL TERMS AND CONDITIONS ON THE REVERSE SIDE OF THIS DOCUMENT ARE INCORPORATED HEREWITH MADE A PART HEREOF.

Print Name

X [redacted]

GENERATOR/SHIPPER DESIGNATED REPRESENTATIVE SIGNATURE

VISA MasterCard AMERICAN EXPRESS

SEE REVERSE SIDE FOR IMPORTANT INFORMATION

TOTAL DUE

DO NOT WRITE IN THE AREA BELOW

M003280691

005002

CUSTOMER NO. | SERIAL 30 63 00 | 903-757-9187 MARK LESTER | MARK LESTER PW

SERVICE WEEK	TERRITORY	NUMBER
05		M003149699

CREDIT CODE	PREVIOUS BALANCE	BAL OVER 60 DAYS

BUSINESS TYPE	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C

LOCATION	TAX EXEMPTION NO.
619401	

GENERATOR:
FCI/TEXARKANA
GARAGE
4001 LEOPARD DR
TEXARKANA, Tx 75501

BILL TO

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	HANDLING CODE	ASSOC. CODE	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
12/7/05	27586				PW				

DEPT	SERVICE/ PRODUCT	SERIAL NUMBER	REMARKS/ UNIT PRICE	QUAN.	CHARGE	SALES TAX	TOTAL CHARGE	WASTE MIN.	CLEAN	SPENT	# OF CONT.	SK DOT	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS)(INITIAL)	CHANGE SCH. DATE (YY WW)	INV. CODE	PROMO NO.	MSDS GIVEN
	22555											1476							
	3395		115.00	2	230.00		230.00												
	83395			2	N/C		N/C												

TOTAL-SERVICE/PRODUCTS 230.00

CHECK APPROPRIATE BOXES →

	GOOD	POOR
MACHINE CONDITION & CLEANLINESS	☐	☐
LAMP ASSEMBLY CONDITION	☐	☐

	YES	NO
DECALS IN PLACE AND LEGIBLE	☐	☐
FUSIBLE LINK INSTALLED	☐	☐
EMERGENCY CLOSING OF LID UNOBSTRUCTED	☐	☐
MACHINE PROPERLY GROUNDED	☐	☐
LOCAL PHONE NO. STICKER AFFIXED TO MACHINE	☐	☐
SPENT SOLVENT MEETS ACCEPTANCE CRITERIA	☐	☐

USEPA TRANSPORTER 1 ID NO.	USEPA TRANSPORTER 2 ID NO.	GENERATOR USEPA ID NO.	GENERATOR STATE ID NO.
TXD000747378			

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER	5163055
WASTE COMBUSTIBLE LIQUID, N.O.S. (PETROLEUM NAPHTHA) NA1993 PGIII(D001,D018,D039,D040) (ERG#128) 6.7LBS/GAL					704	
WASTE COMBUSTIBLE LIQUID, N.O.S. (PETROLEUM NAPHTHA) NA1993 PG III RQ (D001) (ERG#128)6.7 LBS/GAL (D018,D039,D040)					801	
CLEANING COMPOUNDS (PETROLEUM NAPHTHA) (NOT USDOT REGULATED)(CONTINUED USE)					60	
DRAINED USED OIL FILTERS (NOT USDOT OR USEPA REGULATED)	2	DM	291	P	1476	2

I CERTIFY THAT MY TOTAL WASTE STREAMS ARE WITHIN ONE OF THE FOLLOWING CATEGORIES.
0 TO 220 LBS./MONTH — INITIALS
220 LBS. TO 2,200 LBS./MONTH — INITIALS
GREATER THAN 2,200 LBS./MONTH — INITIALS

DESIGNATED FACILITY NAME AND ADDRESS SAFETY-KLEEN SYSTEMS, INC.
202 Michael Place Longview, Tx 75602

I CERTIFY THAT NO MATERIAL CHANGE HAS OCCURRED EITHER IN THE CHARACTERISTICS OF THE WASTE MATERIALS OR IN THE PROCESS GENERATING THE WASTE MATERIALS.

USA EPA ID NO. Tx D000747378
STATE ID NO. 67028

PAYMENT RECEIVED SECTION

CASH ☐	TOTAL RECEIVED	APPLY PAYMENT TO:
CHECK NUMBER	230.00	☑ TODAY'S SERVICE/SALE ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO →

CREDIT CARD NO: 5568960000148161 | AMEX VISA MC | EXP DATE 11/06

CUSTOMER REFERENCE INFORMATION: ROBERT K LASHLEY

MANIFEST NO.

LDR MESSAGE

MANIFEST CODE	SEQ #
/	3 D

IN THE EVENT OF AN EMERGENCY CALL 1-800-468-1760 (24 hours)

I AGREE TO PAY THE ABOVE CHARGES AND TO BE BOUND BY THE TERMS AND CONDITIONS SET FORTH ABOVE AND ON THE REVERSE SIDE OF THIS DOCUMENT. PLEASE CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION. THE INDIVIDUAL SIGNING THIS DOCUMENT IS DULY AUTHORIZED TO SIGN AND BIND CUSTOMER TO ITS TERMS.

"This is to certify that the above-named materials are properly classified, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation."

[redacted]

By Customer's Authorized Representative

VISA | MasterCard | AMERICAN EXPRESS

TOTAL CHARGE (FROM ABOVE)	
WASTE MIN. (FROM ABOVE)	
TOTAL DUE	230.00

DO NOT WRITE IN THE AREA BELOW

M003149699
027580

THIS AGREEMENT CONTINUES ON THE REVERSE SIDE

SERVICE AND SALES ACKNOWLEDGMENT

Plano, Texas 75024 www.safety-kleen.com

Safety-Kleen.

CUSTOMER NO. 22 5 0 4 6 8

FOR SERVICE CALL	BRANCH MANAGER	DOC. EXP.	SCHEDULED SERVICE WEEK	SCHEDULED TERRITORY	REFERENCE NUMBER
903-757-9187	MARK LESTER		08		M004743165

CREDIT CODE | PREVIOUS BALANCE | BAL. OVER 60 DAYS

CUSTOMER SEGMENT | CHAIN | OUTER COUNTY | SVC. P/C | PROD. P/C

LOCATION 619401 | TAX EXEMPTION NUMBER

GENERATOR
FCI
4001 Leopard Dr
Texarkana, Texas 75501

BILL TO

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	DATE EQPT/PROD ORDERED	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
3/5/08	435022				OR			

	DEPT	SERVICE/ PRODUCT	SURVEY NUMBER	UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	HALOGEN TESTER PASS	HALOGEN TESTER FAIL	CHLOR-D-TECT RESULTS (PPM)	CHLOR-D-TECT TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS) (INITIAL)	CHANGE SCH DATE (YY WW)	PROMO NO.	RELEASE NO.
1		00661			165				☑	☐			850						
2									☐	☐									
3									☐	☐									
4									☐	☐									
5									☐	☐									
6									☐	☐									
7									☐	☐									
8									☐	☐									
9									☐	☐									

TOTAL SERVICE/PRODUCTS

TANK CAPACITY Drums

TRANSPORTER DATE 3 / 5 / 08
Johnny Price PRINT NAME
X SIGNATURE

FACILITY DATE / /
PRINT NAME
X SIGNATURE

PART NO. 1353 (05/07)

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☐ 1	☐ 3
SQG/LQG	☐ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO. | USEPA TRANSPORTER ID NO. TXD000747378

GENERATOR USEPA ID NO. | GENERATOR STATE ID NO.

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
USED OIL (NOT USDOT HAZARDOUS MATERIAL)	1	TT	165	G	850
USED OIL AND WATER MIXTURE (NOT USDOT HAZARDOUS MATERIAL)					927
USED ANTIFREEZE (NOT USEPA OR USDOT REGULATED)					1176

We Recycle WE CARE

OIL RECOVERY SERVICE/ SALES ACKNOWLEDGMENT

INTERMEDIATE FACILITY NAME AND ADDRESS SAFETY-KLEEN SYSTEMS, INC.
202 Michael Place Longview Texas 75603 D85233

USA EPA ID NO. TXD 000 747378
STATE ID NO. 67026

PAYMENT RECEIVED SECTION

CASH ☐ | TOTAL RECEIVED | APPLY PAYMENT TO:
CHECK NUMBER | ☐ TODAY'S SERVICE/SALE | ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO. →

CREDIT CARD NO. | AMEX VISA MC | EXP. DATE

CUSTOMER REFERENCE INFORMATION

MANIFEST CODE | SEQ # 4

IN THE EVENT OF AN EMERGENCY CALL 1-800-468-1760 (24 hours)

CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION.

Customer certifies that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the U.S. Environmental Protection Agency and the U.S. Department of Transportation.

ADDITIONAL TERMS AND CONDITIONS ON THE REVERSE SIDE OF THIS DOCUMENT ARE INCORPORATED HEREWITH MADE A PART HEREOF.

Print Name [redacted]

X [redacted]

GENERATOR/SHIPPER DESIGNATED REPRESENTATIVE SIGNATURE

VISA MasterCard AMERICAN EXPRESS

TOTAL DUE

DO NOT WRITE IN THE AREA BELOW

M004743165

435022

SEE REVERSE SIDE FOR IMPORTANT ...

5400 Legacy Drive, Cluster II, B3
Plano, Texas 75024
www.safety-kleen.com
CUSTOMER NO.

FOR SERVICE CALL	BRANCH MANAGER	DOC. EXP.	SCHEDULED SERVICE WEEK	SCHEDULED TERRITORY	REFERENCE NUMBER
903-757-9187	MARK LESTER	09/20/08	08-30	11	0037042344

GENERATOR: 0 0 0 2 - 2 5 0 4 - 6 8

FEDERAL CORRECTIONS INSTITUTE TEXARKANA
DEPT: [redacted]
FCI RD AT CITY LIMITS GAR
ATTN R LASHLEY
TEXARKANA TX 75501

BILL TO:
0001-5153-80
SAFETY KLEEN SYSTEMS INC
5400 LEGACY DRIVE CLUSTER II BLDG 3
ATTN KRISTINA GILL CLOSED LOOP
PLANO TX 75024

CREDIT CODE	PREVIOUS BALANCE	BAL. OVER 60 DAYS
E		

CUSTOMER SEGMENT	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C
10	9914	YES	0890	3415

LOCATION	TAX EXEMPTION NUMBER
619401	

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	DATE EQPT/PROD ORDERED	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
7/27/08	6/333/1		[redacted]	44-057-7602	OR			0825

DEPT	SERVICE/ PRODUCT	SURVEY NUMBER	UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	HALOGEN TESTER PASS	HALOGEN TESTER FAIL	CHLOR-D-TECT RESULTS (PPM)	TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS)(INITIAL)	CHANGE SCH. DATE (YY WW)	PROMO NO.	RELEASE NO.
	0166661		—	110	—		—	☑	☐			850		8				

TOTAL-SERVICE/PRODUCTS — TANK CAPACITY

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION*	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☑ 1	☐ 3
SQG/LQG	☐ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO.	USEPA TRANSPORTER ID NO.
XXXXX	TXD000747378

GENERATOR USEPA ID NO.	GENERATOR STATE ID NO.
TX0151909132	73275

TRANSPORTER — DATE 7/27/08
Tyson Lafleur — PRINT NAME
X Tyson Lafleur — SIGNATURE

FACILITY — DATE / /
PRINT NAME
X — SIGNATURE

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
USED OIL (NOT USDOT HAZARDOUS MATERIAL)	1	TT	110	G	850

WE CARE. We Recycle

OIL RECOVERY SERVICE/ SALES ACKNOWLEDGMENT

INTERMEDIATE FACILITY NAME AND ADDRESS: SAFETY-KLEEN SYSTEMS, INC.
202 MICHAEL PLACE, LONGVIEW, TX 75603

USA EPA ID NO. TXD000747378
STATE ID NO. 67028

PAYMENT RECEIVED SECTION

CASH ☐	TOTAL RECEIVED	APPLY PAYMENT TO:
CHECK NUMBER		☐ TODAY'S SERVICE/SALE ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO. → EXPIRED
CREDIT CARD NO. — AMEX VISA MC — EXP. DATE
CUSTOMER REFERENCE INFORMATION

MANIFEST CODE	SEQ #
NR	1 D

IN THE EVENT OF AN EMERGENCY CALL
1-800-468-1760 (24 hours)

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ADDITIONAL TERMS AND CONDITIONS ON THE REVERSE SIDE OF THIS DOCUMENT ARE INCORPORATED HEREWITH MADE A PART HEREOF.
Print Name [redacted]
X
GENERATOR/SHIPPER DESIGNATED REPRESENTATIVE SIGNATURE

VISA MasterCard American Express

TOTAL DUE —
DO NOT WRITE IN THE AREA BELOW
0037042344
0002-2504-68 -1

SEE REVERSE SIDE FOR IMPORTANT INFORMATION

5400 Legacy Drive, Cluster II, B3
Plano, Texas 75024
800-669-5740
www.safety-kleen.com
DUNS NO. 05-397-6551 FED. ID NO. 396090019

CUSTOMER NO. 306300

FOR SERVICE CALL	BRANCH MANAGER	DOC. EXP.	SCHEDULED SERVICE WEEK	SCHEDULED TERRITORY	REFERENCE NUMBER
903-757-9187	MARK LESTER		08		M005074 C

CREDIT CODE	PREVIOUS BALANCE	BAL. OVER 60 DAYS

CUSTOMER SEGMENT	CHAIN	OUTER COUNTY	SVC. P/C	PROD. P/C

LOCATION	TAX EXEMPTION NUMBER
619401	

GENERATOR
FCI
4001 Leopard Dr
Texarkana TX 75501

BILL TO

SERVICE DATE	SALES REP NO.	CUSTOMER P.O. NUMBER	CUSTOMER PHONE #	TAX CODE	DATE EQPT/PROD ORDERED	SERVICE TAX	C.O.M.S. TAX	PRODUCT TAX
3/9/06	435592				OR			

DEPT	SERVICE/ PRODUCT	SURVEY NUMBER	UNIT PRICE	QUANTITY	CHARGE	SALES TAX	TOTAL CHARGE	CHLORINE TEST RESULTS: HALOGEN TESTER PASS	FAIL	CHLOR-D-TECT RESULTS (PPM)	TESTERS INITIALS	SK DOT NUMBER	CC	SERVICE TERM	CHANGE SERVICE TERM (WEEKS)(INITIAL)	CHANGE SCH. DATE (YY WW)	PROMO NO.	RELEASE NO.
	666647			80				☑	☐			850						
								☐	☐									
								☐	☐									
								☐	☐									
								☐	☐									
								☐	☐									
								☐	☐									
								☐	☐									
								☐	☐									

TOTAL SERVICE/PRODUCTS

TANK CAPACITY Drums

TRANSPORTER DATE 8/9/06
Betsy Foreman X
PRINT NAME SIGNATURE

FACILITY DATE / /
X
PRINT NAME SIGNATURE

GENERATOR STATUS: CHECK ONLY ONE BOX BELOW

GENERATOR HAZARDOUS WASTE CLASSIFICATION *	VEHICLE FLUIDS ONLY	OTHER NON-VEHICLE FLUIDS
CESQG	☑ 1	☐ 3
SQG/LQG	☐ 2	☐ 4

1 NO PREQUAL REQUIRED, NO HALOGEN TEST
2 NO PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
3 PREQUAL REQUIRED, NO HALOGEN TEST
4 PREQUAL REQUIRED, HALOGEN TEST AT PICK-UP
* REFER TO REVERSE SIDE FOR DEFINITIONS

MANIFEST NO.	USEPA TRANSPORTER ID NO.
	TXD000747378

GENERATOR USEPA ID NO.	GENERATOR STATE ID NO.

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
USED OIL (NOT USDOT HAZARDOUS MATERIAL)	1	TT	80	G	850
USED OIL AND WATER MIXTURE (NOT USDOT HAZARDOUS MATERIAL)					927
USED ANTIFREEZE (NOT USEPA OR USDOT REGULATED)					1176

INTERMEDIATE FACILITY NAME AND ADDRESS SAFETY-KLEEN SYSTEMS, INC.
202 Michael Pl; Longview TX 75603 A85233

USA EPA ID NO. TXD000747378
STATE ID NO. 67028

OIL RECOVERY SERVICE/ SALES ACKNOWLEDGMENT

PAYMENT RECEIVED SECTION

CASH ☐	TOTAL RECEIVED	APPLY PAYMENT TO:
CHECK NUMBER		☐ TODAY'S SERVICE/SALE ☐ PREVIOUS BALANCE AS FOLLOWS

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO →
CREDIT CARD NO. AMEX VISA MC EXP. DATE

MANIFEST CODE	SEQ #
	5 D

IN THE EVENT OF AN

CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION.
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ADDITIONAL TERMS AND CONDITIONS ON THE REVERSE SIDE OF THIS DOCUMENT ARE INCORPORATED HEREWITH MADE A PART HEREOF.
Print Name [redacted]
X

TOTAL DUE
DO NOT WRITE IN THE AREA BELOW
M005074480
435592

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS

4200 324712

No. 1352
Warehouse Use

FedEx® Ground Universal Waste Package Returns Program (PRP)

...ig Universal Waste PRP Packages:

- **For mercury containing lamp(s)**, place in packaging provided by your recycler. Seal all ends of the packaging with shipping tape.
- **For mercury thermostat(s) or battery(ies)**, place into a minimum 4-mil plastic bag. Twist the bag and seal using shipping tape. Place plastic bag into a packaging or container provided by your recycler and seal.
- Fill out the following on the Universal Waste PRP Label:
  - **From**
  - Check **Lamp(s)**, **Battery(ies)**, **Mercury Thermostat(s)**, or **Other** (fill **Other**, ONLY if the material has been approved Universal Waste.)
  - Fill in the **Accumulation Start Date** (The Accumulation Start Date is when the first Universal Waste was placed in the packaging or container. The shipper has one (1) year from the Accumulation Start Date to store Universal Waste.)
- Affix the PRP Universal Waste Label to each package or container. **DO NOT ALTER THE UNIVERSAL WASTE PRP LABEL.** If you do not have enough labels, you must obtain additional labels from the company that provided them to you.
- Keep the back of this label as your receipt. You may have your FedEx® Ground driver sign below.

...tions To Return PRP Packages:

...ck Up* (for business locations ONLY)

- Log on to FedEx.com and select the "Pickup" tab. Then choose "FedEx Ground Package Returns Program."
- Call (888) 777-6040 to schedule a commercial pickup from your business location.
- If you receive regular pickups, give the package to your FedEx® Ground driver.

The FedEx® Ground driver cannot pickup any Universal Waste packages that are not properly prepared for transportation.

PICKUP RECEIPT [redacted]

RECEIPT 3167014 0004

...kage returning to: [redacted]

Waste shi[redacted](ies) ☒ Mercury Thermostat(s) ☐ Other

...Signature: [redacted] Date: 6-3

...IT PRICE	AMOUNT
95.00	

TOTAL AMOUNT:

COST CENTER: ____ PROJECT: ____ YREGDOC#: ____

Card Holder Signature: [redacted] DATE ____

Cost Center Manager: [redacted] DATE ____

TOOL AUTHORIZATION

Tool Room Officer: ____ Date: ____

Captain: ____ Date: ____

COMPUTER RELATED SUPPLIES/SAFETY

Computer Spec.: ____ Date: ____

Safety Manager: ____ Date: ____

Date: ____

Warehouse: ____

SPECIAL/EMERGENCY INSTRUCTION: ____

"LOCAL REPRODUCTION AUTHORIZED"

UNITED STATES DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF PRISONS
TEXARKANA, TEXAS
CREDIT CARD PURCHASE FORM
(Not for Personal Use Items)
(UNDER $3000.00)

4200 324712

No. 1352
Warehouse Use

VENDOR NAME: Safety Kleen PHONE NUMBER:
DEPARTMENT: Recycle
CARD HOLDER NAME: [redacted] DATE:
(PLEASE PRINT)

STOCK NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	ea	Mercury Kit	495.00	

TOTAL AMOUNT:

COST CENTER: PROJECT: YREGDOC#:

Card Holder Signature: [redacted] DATE

Cost Center Manager: [redacted] DATE

TOOL AUTHORIZATION	COMPUTER RELATED SUPPLIES/SAFETY
Tool Room Officer: Date:	Computer Spec.: Date:
Captain: Date:	Safety Manager: Date:

Warehouse: Date:

SPECIAL/EMERGENCY INSTRUCTION:

"LOCAL REPRODUCTION AUTHORIZED"

FEDERAL PRISON INDUSTRIES - UNICOR

RECEIPT SLIP No. 5000039721 Page 1

---

us receipt date : 04/09/2008
current date : 04/09/2008

Plant : TERC
Description : Texarkana Recycling

Vendor : 0053976551
Name : SAFETY KLEEN SYSTEMS, INC.
PO : 4700324712
Pur. group : 411 Collvins, Dale Telephone : 903-838-4587

Itm	Material / Acct.assgt. / PO Line Item	Description / Recipient	Rate	Qty. Un / Item Value
0001	K C11_TERC 00001	mercury kit	495.00	1 EA 495.00

GRAND TOTAL: 495.00

Issued by: [redacted] SIGNATURE [redacted]
Entry Date: 04/09/2008

... Overview

Account Assignments

Order Type CC PO Date 03/26/2008

.6551 SAFETY KLEEN SYSTEMS, INC.

Item	I	A	Material	Short Text	PO Quantity	O...	C	Deliv. Date	Net Price	Per	O...	Mat. Grp	Plnt	SLoc	D	R	Batch
1		K		mercury kit	1	EA	D	03/26/2008	495.00	1	EA	DD0076	TERC	WHRM			

Item 1

Pac

3-757-9187 MARK LESTER

DUNS NO. 05-397-6551 FED. ID NO. 396090019

NAME
1.
2.

GENERATOR LOCATION

NAME: UNITED

DELIVERY ADDRESS

INFORMATION/ATTENTION LINE

CITY & STATE: TEXARKANA TX

ZIP | TAX CODE

BILL TO (IF DIFFERENT FROM LOCATION)

NAME

DELIVERY ADDRESS

INFORMATION/ATTENTION LINE

CITY & STATE

ZIP | TAX CODE

LOCATION

CUSTOMER SEGMENT	CHAIN	ASSOCIATIO

SALES TAX EXEMPTION N

DATE PLACED	SALES REP NO.	CUSTOMER'S P.O. NUMBER	☐ BLANKET	☐ TEMPORARY	CUSTOMER PHONE NO.	DATE EQPT/PROD ORDERED	SERVICE TAX	C.O.M.S. TAX	PRO.
3/17/08	456664								

DEPT.	SERVICE/ PRODUCT	SERIAL NUMBER	REMARKS/UNIT PRICE	QUAN.	CHARGE	SALES TAX	TOTAL CHARGE	SOLVENT/DRUMS	SK DOT	CC	SERVICE TERM	SCHEDULE DATE	INV. CODE	PROMO NO.	RELEASE NO.
	999781	Ext. Mercury Disp A/B 56.		1	$159.00	—	$159.00								
	999785	Mercury Disp M/B 56.		1	$336.00	—	$336.00								

TOTAL-SERVICE/PRODUCTS 495.00 — 495.00

REFUSED SERVICE EXPLAIN

PLACEMENT CODES: (1) NEW APPLICATION (2) REPLACE DEFECTIVE MACHINE (3) REPLACE COMPETITIVE MACHINE (4) REPLACE HOME MADE VAT (5) ADDITIONAL MACHINE

USEPA TRANSPORTER 1 ID NO.	USEPA TRANSPORTER 2 ID NO.	GENERATOR USEPA ID NO.	GENERATOR STATE ID NO.
TXD000747378			

11. US DOT DESCRIPTION (INCLUDING PROPER SHIPPING NAME, HAZARD CLASS, AND ID.)	12. CONTAINERS NO.	TYPE	13. TOTAL QUANTITY	14. UNIT WT/VOL	SK DOT NUMBER
WASTE COMBUSTIBLE LIQUID, N.O.S. (PETROLEUM NAPHTHA) NA1993 PGIII(D001,D018,D039,D040) (ERG#128) 6.7LBS/GAL					704
WASTE COMBUSTIBLE LIQUID, N.O.S. (PETROLEUM NAPHTHA) NA1993 PG III RQ (D001) (ERG#128)6.7 LBS/GAL (D018,D039,D040)					801
CLEANING COMPOUNDS (PETROLEUM NAPHTHA) (NOT USDOT REGULATED)(CONTINUED USE)					6C

5163055

I CERTIFY THAT MY TOT WASTE STREAMS ARE WIT ONE OF THE FOLLOW CATEGORIES.
() TO 220 LBS./MONTH
INITIALS
220 LBS. TO 2,200 LBS./MON
INITIALS
GREATER THAN 2,200 LBS./MO
INITIALS

DESIGNATED FACILITY NAME AND ADDRESS SAFETY-KLEEN SYSTEMS, INC.

USA EPA ID NO.

STATE ID NO.

CASH ☐ | TOTAL RECEIVED: $495.00 | APPLY PAYMENT TO: ☒ TODAY'S SERVICE/SALE ☐ PREVIOUS BALANCE AS FOLLOWS

CHECK NUMBER: M/C

INVOICE #	AMOUNT $	INVOICE #	AMOUNT $

PREVIOUS CREDIT CARD NO. →

CREDIT CARD NO. | AMEX VISA MC | EXP. DATE

MANIFEST NO.

LDR MESSAGE

MANIFEST CODE	SEQ #
	4 D

IN THE EVENT OF AN EMERGENCY CALL

I AGREE TO PAY THE ABOVE CHARGES AND TO BE BOUND BY THE TERMS AND CONDITIONS SET FORTH ABOVE AND ON THE REVERSE SIDE OF THIS DOCUMENT. PLEASE CHARGE MY ACCOUNT FOR THIS TRANSACTION UNLESS OTHERWISE INDICATED IN THE PAYMENT RECEIVED SECTION. THE INDIVIDUAL SIGNING THIS DOCUMENT IS DULY AUTHORIZED TO SIGN AND BIND CUSTOMER TO ITS TERMS.

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[redacted]

Print Customer Name

By: [redacted]

Customer's Authorized Representative

TOTAL CHARGE (FROM ABOVE)

TOTAL DUE N/A

DO NOT WRITE IN AREA BELOW

P001835293

430664

MSDS #111

MATERIAL SAFETY DATA SHEET

PRODUCT NAME 3-36 (Bulk) #3006, 3009, 3011	# MSDS003006
MANUFACTURED BY: CRC CHEMICALS	Phone (215) 674-4300
885 LOUIS DRIVE, WARMINSTER, PA. 18974	

1. INGREDIENTS	CAS #	ACGIH TLV	OSHA PEL	Other Limits	%
Petroleum Distillate	64742-47-8	NA	NA	200ppm (Est.)	70
*Inhibited Paraffinic Oil	NA		For Mist 5 mg/M3		30

*The oil and additives are not hazardous according to OSHA standards - Additives are primarily fatty acids and fatty acid esters.

2. PHYSICAL DATA

Specific Gravity .8167	Vapor Pressure 0.23 mm	% Volatile 70
Boiling Point 380°F (initial)	Evaporation Rate Slow 0.01 (Toluene = 1)	
Freezing Point NA	Vapor Density Heavier than air	

Appearance and Odor Blue liquid, pleasant odor

Solubility Negligible in water - Dissolves in most organic solvents.

3. FIRE AND EXPLOSION DATA

Flashpoint 175°F Method COC	Flammable Limits
Extinguishing Media CO_2, Dry Chemical or Foam	LEL NA UEL NA

Unusual Hazards Treat as typical oil fire

4. REACTIVITY AND STABILITY

Stability Stable

Hazardous decomposition products CO_2 & Carbon monoxide (Fire)

Materials to avoid Strong oxidizing agents

5. PROTECTION INFORMATION

Ventilation Adequate ventilation to maintain oil mist below PEL if sprayed.

Respiratory Use NIOSH approved respirators for high mist concentration.

Gloves Solvent resistant | Eye & Face Safety glasses

Other Protective Equipment Oil resistant aprons, boots, etc. should be worn if

25-2

MCPB003036

HEALTH HAZARD DATA

Primary Routes of Entry Skin, Inhalation

Signs and Symptoms of Exposure

1. Acute Overexposure May cause burning and irritation of eyes. Skin contact will cause dryness. Inhalation of mist may cause breathing problems. Vapors may also cause headaches and nausea.

2. Chronic Overexposure Prolonged exposure to skin may cause development of dermatitus.

Medical Conditions Generally Aggravated by Exposure NA

Chemical Listed as Carcinogen or Potential Carcinogen	National Toxicology Program	Yes ☐ No ☒	IARC Monographs	Yes ☐ No ☒	OSHA	Yes ☐ No ☒

Emergency and First Aid Procedures (If symptoms persist, call a physician)

1. Inhalation Remove to fresh air - apply artificial respiration if needed.
2. Eyes Flush for 15 minutes with large amounts of water.
3. Skin Remove contaminated clothing. Wash exposed skin with soap & water.

gestion Do not induce vomiting - Call a doctor.

SPILL OR LEAK PROCEDURES

Precautions to be taken in Handling and Storage Store in a cool dry area.

Steps to be taken in case Materials is released or spilled Ventilate area, remove any source of ignition. Dike area and absorb with sand or other absorbant. Scrape up and place in drums.

Waste Disposal Comply with federal, state and local regulations for oil waste material.

8. SPECIAL PRECAUTIONS AND USE DIRECTIONS

Keep containers closed when not in use. Spills should be kept out of streams or water supply.

PREPARED BY: A. B. Reed

DATE OR DATE OF REVISION November 1985

FCC TUCSON

EVALUATION OF ENVIRONMENTAL, SAFETY, AND HEALTH INFORMATION RELATED TO UNICOR E-WASTE RECYCLING OPERATIONS AT FCC TUCSON

PREPARED FOR THE UNITED STATES DEPARTMENT OF JUSTICE
OFFICE OF THE INSPECTOR GENERAL

Submitted to: [redacted]
Investigative Counsel
Oversight and Review Division
Office of the Inspector General
U.S. Department of Justice

Submitted by: Mr. George Bearer, CIH
FOH Safety and Health Investigation Team
Program Support Center
U.S. Public Health Service
Federal Occupational Health Service

April 27, 2010

Table of Contents

Figures

Tables

Images

Attachments

1.0 INTRODUCTION

At the request of the U.S. Department of Justice (DOJ) Office of the Inspector General (OIG), the Federal Occupational Health Service (FOH) coordinated environmental, safety and health (ES&H) assessments of electronics equipment recycling operations at a number of Federal Bureau of Prisons (BOP) facilities around the country. The assessments were conducted as a result of whistleblower allegations that inmate workers and civilian staff members were being exposed to toxic materials, including lead, cadmium, barium, and beryllium at electronics recycling operations overseen by Federal Prison Industries (UNICOR).[1] The allegations stated that these exposures were occurring from the breaking of cathode ray tubes (CRTs) and other activities associated with the handling, disassembly, recovery, and recycling of electronic components found in equipment such as computers and televisions (i.e. e-waste).[2] It was further alleged that appropriate corrective actions had not yet been taken by BOP and UNICOR officials and that significant risks to human health and the environment remained.

This FOH report[3] consolidates and presents the findings of technical assessments performed at UNICOR's e-waste recycling operations at the Federal Correctional Complex[4] in Tucson, Arizona by industrial hygienists and other safety and health specialists representing federal agencies including FOH, the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH), and the Occupational Safety and Health Administration (OSHA). Reports from these agencies are presented in Attachments 1 and 2 (also see references for these reports in Section 7.0). The primary objectives of these assessments were to characterize current UNICOR operations and working conditions at the Tucson Federal Correctional Institution (FCI Tucson) in light of the whistleblower allegations and to identify where worker exposures, environmental contamination/degradation, and violations of governmental regulations and BOP policies may still exist so that prompt corrective actions may be taken where appropriate. In addition, this FOH report also relies upon information from documents assembled by the OIG which were developed by various consultants, regulatory agencies, BOP staff, and others.

The overall purpose of this report is to characterize current operations and working conditions at FCI Tucson especially with respect to the potential for inmate and staff

[1] FPI, (commonly referred to by its trade name UNICOR) is a wholly-owned, government corporation that operates factories and employs inmates at federal correctional institutions.

[2] E-waste is defined as a waste type consisting of any broken or unwanted electrical or electronic device or component.

[3] FOH prepared this report in March 2009 and its findings and conclusions address e-waste recycling conditions known to FOH at that time. FOH provided the report to the OIG, which shared it with the BOP and sought feedback on it. The BOP and UNICOR later provided their comments to FOH about the report's contents, which resulted in FOH making limited changes to some text and figures, as reflected herein.

[4] FCC Tucson is comprised of two main facilities: a Federal Correctional Institution (FCI) and a United States Penitentiary (USP). Since e-waste demanufacturing operations are performed exclusively at the FCI, henceforth in this report the e-waste facilities will be referred to as being at FCI Tucson.

exposures[5] that may result from present day e-waste recycling activities as well as from legacy contamination on building components from electronics recycling operations which took place in the past. Recommendations are provided to address deficiencies identified in the report and to improve workplace health and safety.

FCI Tucson is one of eight BOP institutions that have ongoing e-waste recycling operations for which, to date, an assessment report has been prepared by FOH. On October 10, 2008, FOH issued a separate report entitled "*Evaluation of Environmental, Safety, and Health Information Related to Current UNICOR E-Waste Recycling Operations at FCI Elkton*" detailing current exposure conditions at FCI Elkton. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, pertinent regulatory requirements, and other information that provides additional context to this report on FCI Tucson. FOH will be preparing assessment reports for the remaining BOP institutions that perform recycling upon completion of their respective environmental, safety, and health (ES&H) assessments.

Currently, e-waste recycling operations at FCI Tucson involve the receipt of waste electronics from various locations around the country, disassembly and sorting activities (otherwise referred to as 'breakdown' or 'demanufacturing'), and the associated material handling and facilities maintenance required to support these operations. Facilities and preparations for conducting glass breaking operations were established at FCI Tucson, but glass breaking operations were never implemented. FCI Tucson recycling facilities and operations are described below in Section 2.0 in greater detail.

2.0 UNICOR E-WASTE RECYCLING FACILITIES AND OPERATIONS AT FCI TUCSON

UNICOR e-waste recycling operations commenced at FCI Tucson in February 2005. These operations included receiving and sorting, disassembly, and packaging and shipping. Preparations were made to perform glass breaking, but this operation was never implemented. These operations are conducted at the warehouses, one of which is adjacent to the institution, and the recycling factory located within the institution.

As part of the OIG investigation, NIOSH's Division of Applied Research and Technology (DART), accompanied by FOH, performed an on-site survey of the recycling workplace in June 2007 to evaluate hazards and hazard controls. In its report (Attachment 1), NIOSH/DART described FCI Tucson's e-waste recycling processes.

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[5] In this report, the term "exposure" refers to the airborne concentration of a contaminant (e.g., lead or cadmium) that is measured in the breathing zone of a worker but outside of any respiratory protection devices used. Unless otherwise noted, "exposure" should not be confused with the ingestion, inhalation, absorption, or other bodily uptake of a contaminant. Concentrations reported and discussed in this report are not adjusted based on respirator protection factors. However, when reported, it is indicated whether the exposure was within the protective capacity of the respirator.

This section summarizes information provided about FCI Tucson's recycling facilities and operations.

The recycling of electronic components is performed in a facility located within the FCI. A diagram of the general layout of the recycling factory is provided in Figure 1, below. The inmate population of the UNICOR factory was approximately 86 in 2007.

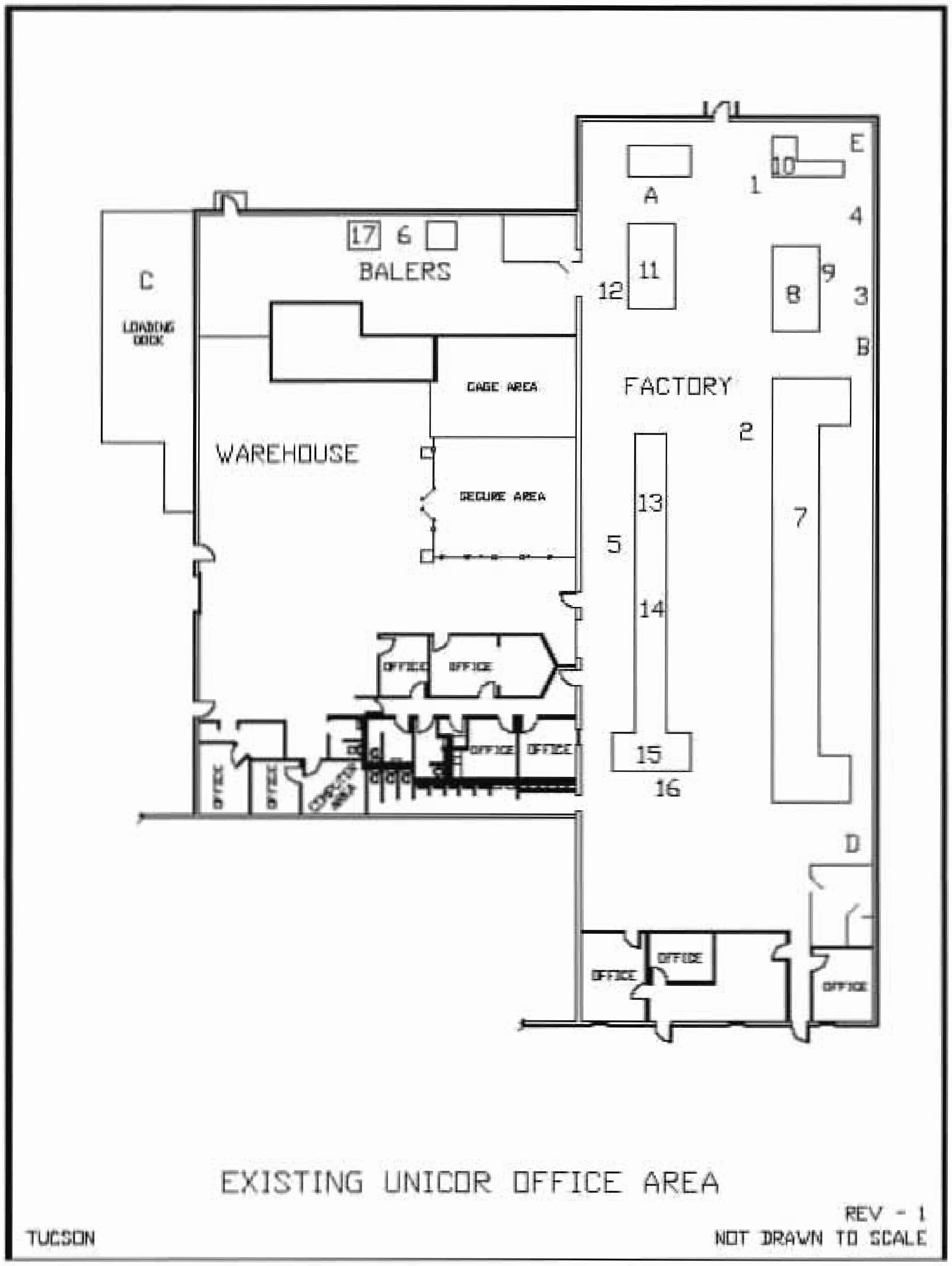

Figure 1. UNICOR E-Waste Recycling Facility, FCI Tucson

The recycling of electronic components at the FCI factory currently consists of three production processes: 1) receiving and sorting, 2) disassembly, and 3) packaging and shipping. Each is discussed below.

Incoming materials are received at a warehouse at a minimum security camp adjacent to the USP where they are examined and sorted. This camp warehouse is located in a separate building several hundred yards from the current e-waste disassembly area. Approximately 25 inmates were assigned to this warehouse in 2007. At the camp warehouse, interstate trucks drop off all e-waste materials for contraband checks, initial sorting, and hard drive destruction. Other activities performed here include computer testing and repairs, toner removal from printers, and some (limited) component removal from computers for use in the repair of others. A second warehouse is also associated with e-waste operations at FCI Tucson. It is referred to as the 'inside warehouse' and is immediately adjacent to the FCI Tucson e-waste disassembly area. This area is no longer used as a warehouse but is so-designated on building drawings (as shown in Figure 1). In this area e-waste materials are received from the camp warehouse, unloaded, and staged for processing in the disassembly area. Also, baling operations of processed materials take place in the 'inside warehouse'.

The bulk of the materials received are computers, either desktop or notebooks, or related devices such as printers. Items such as notebook computers that can be upgraded and resold are sorted for that task.

After electronic memory devices (e.g., hard drives, disks, etc.) are removed and degaussed or destroyed, central processing units (CPUs), servers, and similar devices are sent for disassembly. Monitors and other devices (e.g., televisions) that contain cathode ray tubes (CRTs) are separated and sent for disassembly and removal of the CRT. Printers, copy machines, and any device that could potentially contain toner, ink, or other expendables are segregated and these expendables are removed prior to the device being sent to the disassembly area.

In the disassembly process, external cabinets, usually plastic, are removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing are removed and sorted by grade for further treatment if necessary. Components such as circuit boards or chips that may have value or may contain precious metals such as gold or silver are removed and sorted. With few exceptions each of the workers in the main factory performs all tasks associated with the disassembly of a piece of equipment and uses the provided powered and un-powered hand tools (primarily screwdrivers and wrenches). A few workers collect the various parts and place them into the proper collection bin. Work tasks include removing screws and other fasteners from cabinets, unplugging or clipping electrical cables, removing circuit boards, and using whatever other methods are necessary to break these devices into their component parts. Currently, virtually all components are sold for some type of recycling.

Images of the disassembly area are shown in Images 1 and 2.

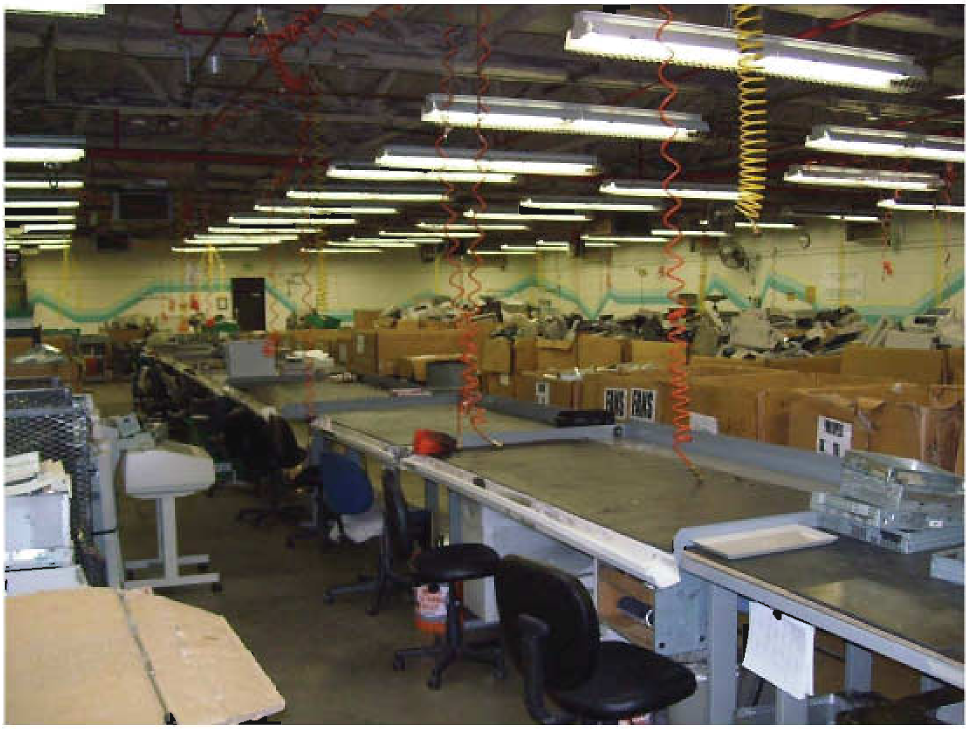

Image 1. UNICOR e-waste disassembly area at FCI Tucson

Image 2. 'Inside' warehouse adjacent to disassembly area at FCI Tucson where baling of e-wastes is performed.

The final process, packaging and shipping, returns the various materials segregated during the disassembly steps to the warehouse where they are sent to contracted purchasers of the various materials. To facilitate shipment, some bulky components such as plastic cabinets or metal frames are placed in a hydraulic baler to be compacted for easier shipping. Other materials are boxed or containerized and removed for subsequent sale.

Glass breaking has not been performed at FCI Tucson, though a glass breaking booth was previously set-up but disassembled prior to any use. CRTs are shipped, unbroken, from FCI Tucson to other locations for breaking and recycling.

The NIOSH/DART report presents information on personal protective measures and work practices used during e-waste recycling activities. These controls are summarized in Sections 3.0 and 4.0 of this report. The NIOSH/DART report, Attachment 1, should be consulted for additional details.

3.0 BOP/UNICOR SAFETY AND HEALTH PROCEDURES AND PRACTICES AT FCI TUCSON

Under 29 CFR 1960 each federal agency is obligated to develop a comprehensive and effective safety and health program. Such programs establish requirements and processes for controlling occupational hazards and meeting federal occupational safety and health regulations. The BOP has established an ES&H program entitled Occupational Safety, Environmental Compliance, and Fire Protection (BOP Program Statement 1600.09). UNICOR's compliance with this policy will be evaluated in the OIG's final report.

Various OSHA standards require written programs or plans to address occupational hazards or implement hazard control measures. Examples that could be applicable to various UNICOR e-waste recycling factories, particularly for glass breaking include:

- 29 CFR 1910.1025, Lead requires a written lead compliance plan;
- 29 CFR 1910.1027, Cadmium requires a written cadmium compliance plan;
- 29 CFR 1910.134, Respiratory Protection requires a written respiratory protection program; and
- 29 CFR 1910.95, Occupational Noise Exposure requires a written hearing conservation program.

At FCI Tucson, glass breaking, which is associated with higher lead and cadmium exposures, has never been performed, and current disassembly processes have not been shown to result in lead and cadmium exposures at levels that would require a written compliance plan. However, even when specific hazards do not meet the exposure threshold for a written standard-specific plan/program, a good practice approach warrants that a general safety and health plan be put in place to identify workplace hazards and specify appropriate hazard controls and safe work practices. Safety and health practices for both routine and non-routine work activities should be addressed. Other hazards such as heat exposure and repetitive stress (e.g., repeated lifting of heavy loads) could also warrant written programs to ensure appropriate evaluation and control of the hazards. UNICOR's safety and health practices and programs conducted at FCI Tucson are discussed below for e-waste recycling activities. Environmental compliance programs to ensure compliance with state and federal regulations are also discussed.

3.1 UNICOR Safety and Health Practices and Procedures to Control Toxic Metals Exposure

At FCI Tucson, UNICOR has various documents in place that address safety and health rules, practices, and procedures to control exposures to toxic metals. One of these documents is UNICOR's Quality Management System, section 6.2.2 "Competence, Awareness, and Training (Procedure)." Elements include the following:

- A basic 32-hour core curriculum course for staff;
- A basic job orientation for inmate workers that includes safety instructions, hazard communication training, and instruction for the work assignment. Toxic metals hazards and controls are addressed in the course outline, including a concise procedure for handling the accidental breakage of CRT glass. [Note: The document does not specify the duration of this orientation];
- Safety rules that include mandatory safety shoes and safety glasses, restrictions on eating, drinking, chewing, and smoking in the disassembly area, brief hand washing requirements, brief lifting precautions, glove requirements, and other non-specific PPE instructions; and
- A training outline for hazardous material recognition and handling, including information on toxic metals potentially encountered during e-waste recycling activities.

Also as part of the Quality Management System, UNICOR has document "7.5.3(a) Identification-Step by Step Work Instructions (Procedure)." This document provides work instructions for the various recycling operations and activities. The instructions do not specifically address toxic metals exposures or procedures to address these hazards but do contain general PPE requirements in the "tools" section, such as for use of safety glasses, gloves, and hearing protection.

NIOSH/DART reported on the type of PPE and respiratory protection that was either worn by or available to inmate workers performing recycling operations at FCI Tucson, such as for the disassembly processes (see NIOSH/DART report, Attachment 1). NIOSH/DART stated that safety glasses were used in most locations, and that hearing protection was available where needed, primarily near the baler. [Note: UNICOR's baler procedure requires hearing protection, as does the crusher procedure.] Disposable respirators were also available to workers on a voluntary use basis.

UNICOR does not have a written respiratory protection program specific to its recycling operations at FCI Tucson, although FCI Tucson has a generic respirator program for its general activities. This document was recently replaced with an updated respiratory protection plan. The original document, Respiratory Protection TCN 1600.8F5, dated October 20, 2004, states that "the only nuisance dust mask approved for use is the single strap which will not require medical approval or fit testing as this is not a tight face to mask fitting unit." This device is currently in use by UNICOR for its recycling operations at FCI Tucson. This mask is not tight fitting to the face. As requested by FOH, the Lead Safety Specialist provided FOH with the current respiratory protection plan that was updated in January 2009. This most recent plan supersedes the program of 2004. The recent plan calls for the use of a more effective disposable respirator. The Assistant Warden expressed willingness to make this upgrade, but also expressed uncertainty regarding requirements for its use; specifically would fit testing be required. The document initially states that fit testing is required, but later Section 5, Fit Testing states that fit testing is to be performed when respirator use is "required." UNICOR at FCI Tucson provides disposable respirators for voluntary use, but does not require their use.

FOH offers the following information for UNICOR's and FCI Tucson's consideration regarding the disposable respirator issue. The employer is not required to do medical qualification or fit testing or have a written respiratory protection program for voluntary use of dust masks (or for respirators whose only use would be for emergency escape). Per an OSHA Instruction /Inspection Procedure dated 9/25/1998: "For voluntary use of filtering facepiece dust masks, the employer needs only ensure that dust masks are not dirty or contaminated, that their use does not interfere with employee's ability to work safely, and that a copy of Appendix D is provided to each voluntary wearer. Merely posting Appendix D is not considered adequate". According to OSHA's enforcement guidelines, Appendix D (or employer's equivalent) is only required to be issued initially.

Because UNICOR at FCI Tucson does not require use of respirators, a written respiratory protection program is not required by OSHA. Regardless of the disposable mask selected, UNICOR should ensure that the limitations of the dust mask selected are addressed with the wearers and that they understand the types of hazards that the respirator is designed to control. For documentation purposes UNICOR should have users read and sign Appendix D of 29 CFR 1910.134, and UNICOR and FCI Tucson should maintain the Appendix D signed records. If UNICOR implements elements of an operations and maintenance (O&M) plan that would require respiratory protection for new or non-routine activities, then UNICOR would need to implement a written respiratory protection program consistent with the types of respirators used (see Section 6.0 for additional information and recommendations).

Although various safety practices and procedures are applied at the FCI Tucson recycling factory, a written safety and health document to define existing workplace hazards and control measures is not in place for UNICOR recycling activities conducted specifically at FCI Tucson. As a "good practice" approach, such a document should be developed and implemented and would serve to concisely define the safety and health practices and requirements specific to FCI Tucson recycling, such as PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Non-routine or periodic work activities should also be addressed in the document, particularly those that potentially disturb dusts such as cleaning and handling/disposing of wastes from HEPA vacuums or containers. The document could specify the safety rules covered in the job orientation training and could also specify requirements for periodic site assessments, hazard analyses, and regulatory compliance reviews.

3.2 Other UNICOR and FCI Tucson Safety and Health Procedures

Other than the documents described in Section 3.1, above, UNICOR does not have safety and health procedures specific to its recycling operations at FCI Tucson. However, FCI Tucson has many written safety procedures that apply to operations for the institution as a whole. FOH reviewed 15 of these procedures that were issued by the Safety Department. These procedures are not specific to the recycling operations, but as an operation conducted at FCI Tucson, recycling would be under their umbrella.

These Safety Department procedures address such topics as hearing conservation, flammable and combustible materials, electrical safety, respiratory protection, safety shoes, hot work, fire prevention and control, hazard communication, confined space entry, disposal of infectious waste, pest control, personal protective equipment, hearing conservation, and housekeeping. These procedures are fairly general in content, and do not specifically address recycling practices. In addition, the FCI Tucson Lead Safety Specialist stated that these procedures are to some extent obsolete. For example, annual noise monitoring is not currently performed as specified in the hearing conservation procedure.

The FCI Tucson hearing conservation program, dated October 7, 2002, states that the Occupational Safety and Health Environmental Department is to perform annual noise evaluations throughout the institution to determine which areas have noise levels above 85 dBA. The Lead Safety Specialist stated that this program has not been supported by BOP or UNICOR management for years and that no noise monitoring evaluations have been conducted by UNICOR or FCI Tucson for the recycling activities. The Assistant Warden confirmed that noise monitoring has not been conducted.

UNICOR is in the process of developing a heat stress program. This program will be evaluated and discussed in the final OIG report. See Section 4.3 for NIOSH/DART and FOH heat measurements and observations at FCI Tucson.

3.3 FCI Tucson Safety Department Concerns

In reviewing correspondence from the FCI Tucson Safety Department, FOH noted several recommendations or deficiencies involving safety and health practices at

UNICOR's FCI Tucson e-waste recycling operations that were raised by Safety Specialists. Examples include the following.

- On April 11, 2006, the Lead Safety Specialist identified a need to conduct air and surface sampling such that proper PPE could be established to protect workers against "harmful dust."

- On April 13, 2006, the Lead Safety Specialist recommended to the Associate Warden of Operations that personal toxic metals monitoring for staff and inmate workers should be conducted at the UNICOR recycling operations at FCI Tucson. Monitoring was later conducted as reported in Section 4.1.

- On May 17, 2006, the Lead Safety Specialist notified the Acting Associate Warden that staff and inmate workers have not been informed of exposure monitoring results as required by OSHA and Bureau policy, and recommended that they be informed.

- On May 17, 2006, the Lead Safety Specialist informed the Acting Associate Warden that the staff who work at the rear gate have not received formal training on the hazards associated with computer recycling products. He mentioned that UNICOR has not determined PPE needs for these personnel. In a recent discussion with FOH, the Lead Safety Specialist stated that these personnel enter trucks and move and search boxes containing e-waste materials. Additional correspondence and a proposed procedure for "rear gate' activities have since been submitted, but not acted upon.

These communications indicate that the FCI Tucson Safety Department is actively engaged to ensure hazard evaluation, communication, and control. Regarding the toxic metals exposure monitoring issue, management responded by arranging for a UNICOR consultant to conduct monitoring in June 2006. See Section 4.1 for monitoring results and information on the effectiveness in responding to the results. Regarding the staff working at the rear gate, the FCI Tucson Lead Safety Specialist recently stated that this issue has still not been addressed to date. The UNICOR Industrial Hygienist was of the opinion that this issue should be a BOP action rather than a UNICOR action.

This open "rear gate" safety item points to the need for BOP and UNICOR to list, track, address, accept or not accept, and close out recommendations from its safety and health staff, consultants, and others, including from the OIG investigation. Such a system will be further discussed in the final OIG report. This item is also an example of the need to clearly delineate responsibilities between BOP and UNICOR for safety and health ownership and actions.

3.4 Environmental Procedures

FCI Tucson has an Environmental Awareness/Pollution Prevention Program, dated March 1, 2006. This procedure primarily addresses the recycling of general use materials associated with general institutional operations and activities, but does not specifically address UNICOR's e-waste recycling operations.

Debris from cleaning operations and equipment such as HEPA vacuums contain dusts and debris contaminated with toxic metals. UNICOR and FCI Tucson should define testing and disposal practices to ensure proper disposal in accordance with U.S. EPA regulations. See Section 4.5 for a discussion of this and other environmental issues.

4.0 FIELD INVESTIGATIONS AND MONITORING RESULTS

Several field investigations of FCI Tucson's e-waste recycling operations have been conducted since 2005. These investigations are listed below:

- OSHA conducted a lighting survey and limited noise monitoring in May 2005.
- OSHA conducted toxic metals exposure monitoring at FCI Tucson in April 2006 as part of a facility inspection (see OSHA Narrative Report as Attachment 2).
- In June 2006, a consulting firm retained by UNICOR and FCI Tucson conducted a field investigation to evaluate exposure to toxic metals in the recycling areas.
- As part of the DOJ OIG investigation, NIOSH/DART and FOH conducted a survey in June 2007 to determine existing toxic metal surface contamination on various building components and to generally evaluate the e-waste recycling operation, associated hazards, and hazard controls (see NIOSH/DART report as Attachment 1).

Results of the OSHA inspections, the consultant's evaluation, and the FOH and NIOSH/DART survey are summarized and discussed in this section[6].

Toxic metals of greatest interest for e-waste recycling include lead, cadmium, and barium. Beryllium can also be associated with e-waste materials and is also of interest because of its high toxicity, adverse health effects, and low exposure limit. These metals were the focus of the field investigations, although 27 other metals were also evaluated. See the FCI Elkton report referenced in Section 1.0 for details regarding e-waste hazards.

Exposure monitoring results are compared to permissible exposure limits (PELs) established by OSHA. In addition, non-mandatory American Conference of Governmental Industrial Hygienist (ACGIH) threshold limit values (TLVs) and NIOSH recommended exposure limits (RELs) are also available for reference. Personal exposure limits are often based on 8-hour time weighted average (TWA) exposures and the TWAs

[6] Given the many variables that may impact air sampling and exposure monitoring, testing data and findings can vary from one period to the next. Also, the findings, interpretations, conclusions and recommendations in this report may in part be based on representations by others which have not been independently verified by FOH.

are applicable to the exposures discussed in this report. Table 1 provides exposure limits for lead, cadmium, barium, and beryllium. PELs and TLVs for other hazards can be found in OSHA standards (29 CFR 1910) and the most recent ACGIH TLV Booklet.

Table 1
Occupational Exposure Limits[1]

	LEAD ($\mu g/m^3$)	CADMIUM ($\mu g/m^3$)	BARIUM ($\mu g/m^3$)	BERYLLIUM ($\mu g/m^3$)
OSHA PEL	50	5.0	500	2[5]
OSHA ACTION LEVEL[2]	30	2.5	N/A	N/A
ACGIH TLV (Total Exposure)	50	10.0	500	0.05[4]
ACGIH TLV (Respirable Fraction)	N/A	2.0	N/A	N/A
NIOSH REL	50	*Ca*[3]	500	0.5

Notes:

1. All limits are based on an 8-hour time weighted average (TWA) exposure. NIOSH RELs are based on TWA concentrations of up to a 10-hour workday during a 40-hour workweek.
2. The action level is an exposure level (often around half of the PEL) that triggers certain actions, such as controls, monitoring, and/or medical surveillance under various OSHA standards.
3. *Ca* (Potential Occupational Carcinogen). NIOSH RELs for carcinogens are based on lowest levels that can be feasibly achieved through the use of engineering controls and measured by analytical techniques. [NIOSH 2005]
4. ACGIH TLV 2009 adoption.
5. OSHA also has 5 $\mu g/m^3$ ceiling and 25 $\mu g/m^3$ peak exposure limits.

Exposure standards for any other hazards evaluated are discussed in the sections below where results of the investigations are presented.

4.1 Investigations for Exposure to Toxic Metals

Given the various materials and components in e-waste, recycling activities have the potential to result in worker exposure to toxic metals including, in particular, lead and cadmium. The magnitude and potential health consequences of exposures are dependant on a number of factors such as workplace engineering controls including ventilation, work practices, protective equipment utilized (e.g., respirators, protective clothing, gloves, etc.), duration of exposures, and others. The FOH report for FCI Elkton should be reviewed for a more comprehensive discussion of the hazardous components found in waste electronics, their relative toxicities, pertinent regulatory requirements, and other information.

Three investigations that included evaluation of toxic metals exposure during FCI Tucson's e-waste recycling operations are discussed below in chronological order of the studies. These investigations were conducted by OSHA, a UNICOR consultant, and NIOSH/DART and FOH.

4.1.1 OSHA Exposure Monitoring for Toxic Metals and Other Findings

OSHA conducted an inspection of e-waste recycling operations at FCI Tucson in April 2006, during which it characterized recycling operations through personal air monitoring, area air monitoring, and hand wipe sampling (see Attachment 2 for the OSHA report). Samples were analyzed for lead, cadmium, barium, and beryllium. Results and recommendations of this inspection were provided in a narrative report and are summarized below.

- OSHA reported that all exposure results were below the OSHA PELs.

- OSHA noted that hand wipe sample results indicated the need for continued vigilance in keeping hands clean in order to prevent transmission of contaminants (i.e., hand-to-mouth ingestion or take home contamination).

- OSHA noted that UNICOR did not have an industrial hygiene baseline study, but stated that UNICOR was in the process of scheduling one. OSHA emphasized that this survey should be performed and requested a copy of the results.

- OSHA also reported that "…some medical tests were completed…" in preparation for glass breaking, but since glass breaking was never implemented these tests are not required.

- OSHA stated that "…overall the facility looked very good and no apparent violations of OSHA standards were observed." The report praised the MSDS program and training documentation. OSHA stated that no citations were to be issued.

Regarding the industrial hygiene (IH) baseline survey, such a survey has not been conducted by UNICOR in response to the OSHA recommendation, even though OSHA was informed that scheduling for an IH baseline survey was in progress. The FCI Tucson Lead Safety Specialist confirmed this information. The Assistant Warden cited a consultant monitoring episode conducted in 2006; however, this monitoring episode, although useful, cannot be considered an IH baseline survey. For instance, it did not evaluate the breadth of hazards associated with the recycling operations and did not appropriately discuss the toxic metals exposure results (see Section 4.1.2, below).

4.1.2 UNICOR Consultant Monitoring Report for Toxic Metals

In written correspondence dated April 13, 2006, from the FCI Tucson Lead Safety Specialist to the Assistant Warden of Operations, the Safety Specialist requested that UNICOR conduct personal air quality sampling of the staff and inmate workers in the UNICOR factory and warehouse at FCI Tucson. The Safety Specialist noted that inspections and walkthroughs of the factory and warehouse found occasions where dust levels were visible to the eye and where dust masks worn by workers had turned black. [Note: In a recent discussion with FOH, the Safety Specialist stated that visible dust emissions have since been remedied.] The Lead Safety Specialist further noted that such dust masks do not protect workers from harmful dusts generated from CRTs and cited BOP's document 1600.08, Chapter 1, Page 25 requiring a hazard assessment of PPE use. Later in April, OSHA conducted exposure monitoring at FCI Tucson (see Section 4.1.1). UNICOR then retained a consulting firm to conduct its own evaluation which included exposure monitoring. The consultant's findings are discussed below.

The consultant's evaluation, conducted in June 2006, included monitoring for both personal exposures and area air levels. Two personal exposure samples were collected for inmate workers performing disassembly. Three area air samples were also collected in the recycling areas. In addition, surface wipe samples were collected from surfaces in various recycling areas. Samples were analyzed for 28 metals including lead, cadmium, barium, and beryllium. Sampling results and overall findings are summarized below.

- The five personal and area exposure samples were collected in the disassembly and crushing/baling areas. The consultant reported that all personal and area monitoring results were below the OSHA PELs. In reviewing the data tables, FOH notes, however, that one area sample showed the cadmium level to be above the OSHA action level. Cadmium was found in the "east area" at 3.5 $\mu g/m^3$ versus the action level of 2.5 $\mu g/m^3$ and PEL of 5.0 $\mu g/m^3$. This level is 70% of the PEL; however, the consultant's report did not clearly show whether the result as reported was an 8-hour TWA. The consultant made no mention of the significance of this result in its report. FOH provides a further discussion of the implications of this result later in this section and also discusses follow-up information concerning this result that was obtained by UNICOR in 2008 from the consultant.

- Seven surface samples were collected from work surfaces, equipment, floors, or other accessible work areas. The consultant reported that all metal concentrations were "low." In reviewing the data tables, FOH notes that all lead results were "none detected" (ND), and based on the detection limit reported, this would equate to less than 2 $\mu g/100cm^2$ or less than about 20 $\mu g/ft^2$. These results are significantly less than the levels found by the NIOSH/DART and FOH survey conducted in June 2007 which ranged from a low of 23 $\mu g/ft^2$ to a high of 1,300 $\mu g/ft^2$. Similarly, the consultant found that cadmium results were ND or very near the detection limit, which were also less than results found by NIOSH/DART. See Section 4.2 for a discussion of the NIOSH/DART and FOH survey results.

- Using total particulates as a surrogate for carbon black analyses, the consultant reported that the carbon black exposures were less than the PEL (<0.03 mg/m^3 total dust versus a carbon black PEL of 3.5 mg/m^3).

- The consultant found that all work practices and procedures were performed in a safe manner and recommended no changes in practices and procedures. The consultant found that the facility appeared cleaner than other e-waste recycling operations that he had observed.

As noted above, one cadmium area air sample was above the OSHA action level, as presented in the consultant's report. The consultant did not mention this finding in its report, even though an exposure above the action level has regulatory implications defined by the OSHA cadmium standard, assuming the sample is representative of the workers' breathing zone. For instance, initial monitoring above the cadmium action level requires additional monitoring to be conducted at least every six months and sometimes more frequently depending on conditions, until levels are consistently found to be below the action level. Also, medical surveillance and biological monitoring is required if exposures above the action level can occur for more than 30 days per year. It is incumbent on the employer to demonstrate that such exposures do not occur for more than 30 days per year, if medical surveillance is not implemented.

A UNICOR Industrial Hygienist made an inquiry of the consultant regarding this sample result and the consultant responded by email in January 2008. The consultant reported that the sample was taken in the middle of a work bench approximately six inches above the surface where disassembly was being performed, and workers were located on both sides of the bench. The consultant also confirmed that the sample was an area sample and not a personal sample. The consultant reported that the sample duration was 383 minutes from which the consultant apparently calculated the 8-hour TWA for this sample as 0.00199 mg/ m^3 (1.99 $\mu g/m^3$) and reported that this level does not exceed the cadmium action level. However, based on a 383 minute sample with an exposure of 3.4 $\mu g/m^3$ for that duration and assuming zero exposure for the rest of the 8-hour period, the 8-hour TWA actually calculates to 2.7 $\mu g/m^3$ which is above the cadmium action level of 2.5 $\mu g/m^3$.

According to the OSHA cadmium standard, monitoring to determine exposures relative to the action level are to be "breathing zone" samples. It is not known whether this area sample is representative of the workers' breathing zone; however, the sample was taken above the work bench where workers are stationed. UNICOR should have considered that the result was representative of the breathing zone, unless it demonstrated otherwise by conducting sufficient additional monitoring over time or other means. FOH acknowledges however that recent studies conducted by UNICOR consultants at UNICOR factories have not found personal exposures during disassembly to be above the cadmium action level.

Based on this cadmium result, UNICOR should have conducted follow-up breathing zone monitoring to determine whether this area exposure is a rare or frequent occurrence, to determine if this area result is representative of the worker's breathing zone, to determine if it represents a worst case exposure, and to determine and correct contributing factors for the exposure. FOH also notes, however, that based on the consultant's narrative report, the consultant did not provide UNICOR with any indication that a cadmium area exposure result was above the action level, warranting follow-up analysis. The consultant also did not provide this information in its follow up email correspondence.

4.1.3 NIOSH/DART Surface Wipe and Bulk Dust Sample Results

As part of the OIG investigation, in June 2007 FOH and NIOSH/DART conducted bulk dust and surface wipe sampling in current areas where e-waste recycling is performed at FCI Tucson. Samples were analyzed for total lead, cadmium, barium, nickel, and other toxic metals.

Federal standards or other definitive criteria have not been developed for acceptable levels of lead or cadmium surface contamination or dust concentrations in industrial areas where activities are performed involving lead and/or cadmium bearing materials. However, several recommendations or guidelines, primarily for lead, provide points of reference to subjectively evaluate the significance of surface contamination. Some guidelines that are available are noted below (see the NIOSH/DART FCI Elkton report for a more detailed discussion of guidelines):

- OSHA's Directorate of Compliance Programs indicated that the requirements of OSHA's standard for lead in the construction workplace (i.e., 29 CFR 1926.62) can be summarized and/or interpreted as follows: all surfaces shall be maintained as 'free as practicable' of accumulations of lead; the employer shall provide clean change areas for employees whose airborne exposure to lead is above the PEL; and the employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination. The OSHA Compliance Directive for the Interim Standard for Lead in Construction, CPL 2-2.58 recommends the use of the Department of Housing and Urban Development's (HUD) initially proposed decontamination criteria of 200 $\mu g/ft^2$ for floors in evaluating the cleanliness of change areas, storage facilities, and lunchrooms/eating areas. In situations where employees are in direct contact with lead-contaminated surfaces, such as, working surfaces or floors in change rooms, storage facilities, lunchroom and eating facilities, OSHA has stated that the Agency would not expect surfaces to be any cleaner than the 200 $\mu g/ft^2$ level.

- For other surfaces (e.g., work surfaces in areas where lead-containing materials are actively processed), OSHA has indicated that no specific level can be set to define how "clean is clean" nor what level of lead contamination meets the definition of "practicable." Specifically addressing contaminated surfaces on rafters, OSHA has indicated that they must be cleaned (or alternative methods used such as sealing the lead in place), as necessary to mitigate lead exposures. OSHA has indicated that the intent of this provision is to ensure that employers regularly clean and conduct housekeeping activities to prevent avoidable lead exposure, such as would potentially be caused by re-entrained lead dust. Overall, the intent of the "as-free-as-practicable" requirement is to ensure that accumulation of lead dust does not become a source of employee lead exposures. OSHA has stated that any method that achieves this end is acceptable.

- Lange [Lange, JH 2001] proposed a clearance level of 1,000 $\mu g/ft^2$ for floors of non-lead free commercial buildings and 1,100 $\mu g/ft^2$ for lead-free buildings.

These proposed clearance levels are based on calculations that make a number of intentionally conservative assumptions.

- HUD has established clearance levels for lead on surfaces after lead abatement. These levels range from 40 to 800 $\mu g/ft^2$, depending on the type of surface. The level of 200 $\mu g/ft^2$ is most commonly used. These levels, however, apply to occupied living areas where children reside, and are not intended for industrial operations.

- Regarding lead in bulk dust or soil samples, the U.S. EPA has proposed standards for residential soil-lead levels. The level of concern requiring some degree of risk reduction is 400 ppm (mg/kg), and the level requiring permanent abatement is 2,000 ppm (mg/kg). Again these levels are for residential settings, rather than for industrial settings.

- There is no quantitative guidance for surface cadmium concentrations. OSHA states that surfaces shall be as free as practicable of accumulations of cadmium, all spills and sudden releases of cadmium material shall be cleaned as soon as possible, and that surfaces contaminated with cadmium shall be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne.

During its June 2007 survey, NIOSH/DART collected surface wipe and bulk dust samples from various locations in the FCI Tucson recycling facilities both inside the glass breaking room and in the general factory and associated areas. Samples were analyzed for lead and cadmium and other toxic metals. Summary results for lead and cadmium levels in these samples are presented below (see Attachment 1 for complete results for all metals evaluated).

- Five bulk dust samples were collected in the recycling factory. Lead ranged from 34 mg/kg to 1,000 mg/kg. All levels were below the U.S. EPA soil-lead proposed level for permanent abatement, although this proposed level is not directly applicable to surface dust in an industrial workplace. Three of the five were above the U.S. EPA proposed level that suggests some degree of risk reduction. Risk reduction involves a program of cleaning and housekeeping, as well as an operations and maintenance (O&M) plan to prevent build-up of contamination. Wastes collected from cleaning and O&M activities should be tested via the TCLP methodology to ensure disposal in accordance with U.S. EPA regulations.

- Surface wipe samples were collected in the FCI Tucson recycling factory and analyzed for lead and cadmium along with other metals. Six of 17 surfaces had lead concentrations above the OSHA-referenced guideline of 200 $\mu g/ft^2$, with the highest measurements at 900 $\mu g/ft^2$ and 1,300 $\mu g/ft^2$. The two highest results were from elevated surfaces (light fixtures) only accessible by ladder. Three other samples above 200 $\mu g/ft^2$ were also from light fixtures. Only one sample above 200 $\mu g/ft^2$ was from a work surface to which workers could be routinely exposed during daily activities. As stated above, the OSHA guideline does not apply to work areas involving lead materials and is not directly applicable to recycling work areas. It would apply to clean rooms, lunch areas and similar non-work areas that are associated with lead work activities. The level proposed by Lange, also for occupied work environments is 1,000 or 1,100 $\mu g/ft^2$, which approximates the level of the two highest surface wipe samples.

- The highest cadmium surface concentration in the FCI Tucson recycling factory was 100 $\mu g/ft^2$ with all others below 80 $\mu g/ft^2$.

In evaluating these results, FOH notes that the levels of lead surface contamination, although generally within the range of available guidelines, are significantly higher than those found by the UNICOR consultant that conducted sampling only 12 months prior to NIOSH/DART. All consultant samples were less than the lead detection limit which was about 20 $\mu g/ft^2$, while NIOSH/DART samples were up to 65 times this level and averaged more than 10 times this level. NIOSH/DART collected samples from both elevated surfaces and work surfaces. When eliminating elevated surfaces from this equation, NIOSH/DART results are still up to 10 times higher for work surfaces and about five times higher on average. Similar differences were noted for cadmium surface results. [Note: Although direct comparison of results is problematic because of variability in sample locations and other factors, the levels are different enough to warrant follow-up evaluation.]

The reason for the differences in surface contamination between 2006 and 2007 is not known with certainty, but possibilities could include differences in sampling methods, differences in sampling times relative to surface cleaning, and differences in sampling locations that do not allow for a direct comparison of results. Consultant monitoring was conducted approximately 16 months after the start of recycling operations, therefore, sufficient time should have passed to allow for surfaces to exhibit contamination representative of the recycling operations. Regardless of the reason(s) for the differences in results, UNICOR should conduct periodic surface testing to determine if surface contamination is building up over time and to take action to prevent and correct this condition if it is occurring.

The levels of lead and cadmium contamination found in June 2007 at the FCI Tucson recycling factory are not widespread throughout the facility. However, based on some levels near the suggested Lange guidance, UNICOR and FCI Tucson should implement procedures to reduce the risk of exposure to surface dusts and dust accumulations. UNICOR and FCI Tucson should implement an operations and maintenance (O&M) plan to limit contact with existing lead and cadmium contamination, limit its accumulation, prevent and/or control any releases of the contamination to the air, and generally prevent potential for inhalation and ingestion (i.e., hand-to-mouth contact) exposure. With proper controls established, this plan could include periodic clean-up of surfaces by inmate or other workers using appropriate wet methods and HEPA vacuuming, such as the light fixtures and other surfaces above the work area where regular cleaning is not conducted and where dusts can accumulate over time. UNICOR should also conduct periodic surface sampling (perhaps annually) to ensure that surface contamination levels are kept in check and are not significantly building up over time, as contrasting data from 2006 and 2007 could suggest. Elements of an O&M plan and suggestions for surface sampling are discussed in Section 6.0, Recommendations.

In addition, NIOSH/DART observed that cleaning is conducted primarily using brooms and brushes. This can generate airborne dusts that increase personal exposures and become re-deposited on other surfaces at various elevations. Brush and similar cleaning methods are also explicitly prohibited in the OSHA cadmium standard. NIOSH/DART recommends use of HEPA vacuums and wet methods to clean surfaces of dusts containing lead, cadmium, and other toxic metals. When using wet methods, care should be taken to ensure that other safety hazards (such as slips or electrical hazards) are not introduced into the work area.

4.2 Investigations for Noise Exposure

Noise measurements were taken at various UNICOR recycling locations at FCI Tucson by OSHA and NIOSH/DART. These results are discussed below.

OSHA conducted noise monitoring on May 4, 2005. Operations at a metal baler, cardboard baler, and station 14 during air gun use were monitored. The report states that a sound level meter and noise dosimeter were used. Some sound levels above 85 dB were reported for short periods, but as TWAs, the results were less than 85 dB, which is the level that triggers the requirement for a hearing conservation program. This monitoring, although useful for these activities, is limited in its scope and does not represent a complete noise survey for all recycling operations that could contribute to noise exposures.

NIOSH/DART also conducted a limited amount of noise testing using a hand-held sound level meter (SLM). No noise dosimetry was performed. NIOSH/DART found peak levels up to 103 dBA near the plastic baler and 86 dBA near the metal baler. Where hard disks were being destroyed, peak levels over 100 dBA were common and levels were up to 112 dBA. The background noise in this area was in the range of 80 to 85 dBA. NIOSH/DART concluded that the SLM measurements indicated the need for a more comprehensive noise study.

UNICOR has not conducted a noise evaluation at FCI Tucson. This is a deficiency in hazard analysis and control.

4.3 Heat Exposure and Repetitive Stress

In June 2007, NIOSH/DART found that indoor temperatures ranged from 71 to 81 degrees F in the factory and up to 91 degrees F in the camp warehouse located across the street from the FCI recycling factory. Relative humidity ranged from 30% to 60%. Outdoor temperatures were measured in excess of 100 degrees F. NIOSH/DART concluded that heat stress (i.e., heat exposure) should be periodically evaluated to ensure proper precautions are in place to prevent excessive heat exposure. Heat exposure evaluations should be focused on the camp warehouse and outside or other areas without air conditioning. Heat exposure in the general factory area and its associated warehouse during the NIOSH/DART and FOH site visits was not a factor.

As with other UNICOR recycling facilities, NIOSH/DART also observed tasks such as lifting that could produce repetitive stress. NIOSH/DART recommended that UNICOR evaluate tasks to determine if they are biomechanically taxing and implement modifications, procedures, training, or equipment to mitigate any identified hazard.

4.4 Environmental Issues

FOH conducted a limited review of available information pertaining to environmental issues associated with e-waste recycling operations at FCI Tucson. E-mail correspondence in March 2005 between the Arizona Department of Environmental Quality (ADEQ) Hazardous Waste Inspections and Compliance Unit and UNICOR at FCI Tucson reflected that UNICOR had made appropriate up-front inquiries prior to the initiation of CRT recycling operations and that ADEQ conveyed the position that intact electronic scrap was not considered a hazardous waste (consistent with the U.S. EPA proposed rule on CRT management published June 12, 2002 that allowed for an exclusion from the EPA definition of solid waste for used CRTs and glass, including broken and crushed, provided it was recycled and not disposed). ADEQ and UNICOR therefore concluded that the e-waste recycling activities at FCI Tucson did not fall under ADEQ's regulatory oversight so long as e-waste materials (particularly CRTs) were managed in accordance with the practices outlined in the EPA's proposed rule. The correspondence outlined a number of requirements should CRT glass breaking commence, but since this operation never occurred these requirements did not need to be followed.

According to UNICOR officials at FCI Tucson, e-waste activities at this facility are not currently subject to any environmental permits associated with hazardous waste, air, or water/wastewater and none are in place. Cleaning activities such as HEPA vacuuming or wet mopping/wiping accumulate dusts that potentially contain toxic metals. These dusts and associated wastes should be tested via the TCLP methodology to determine proper disposal methods in accordance with U.S. EPA regulations. The Lead Safety Specialist said that evaluations of HEPA vacuum wastes and mop rinse water were underway or being planned to determine acceptable disposal methods per U.S. EPA regulations.

5.0 CONCLUSIONS

Conclusions concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at FCI Tucson are provided below under the following subsections:

- Heavy Metals Exposures;
- Noise, Heat, and Repetitive Stress Exposure;

- Safety and Health Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

These conclusions are supported by the results, findings, and analyses presented and discussed in Sections 3.0 and 4.0 of this report, as well as the documents assembled by the OIG and reviewed by FOH. These conclusions, in part, are consolidated from the various federal agency reports, and are also supplemented by FOH based on the entire body of information assembled and reviewed. See Attachments 1 and 2 for additional conclusions from the individual contributing federal agencies, including NIOSH/DART and OSHA.

5.1 Heavy Metals Exposures

1. OSHA's and the UNICOR consultant's monitoring results from April and June 2006 showed that inhalation exposure to lead, cadmium, and other toxic metals during FCI Tucson recycling operations are maintained below the OSHA PELs. However, one cadmium area result determined by the UNICOR consultant showed the cadmium concentration to be above the action level, but below the PEL. [Note: FCI Tucson's recycling operations include disassembly and associated activities, but do not include CRT glass breaking.]

2. UNICOR and FCI Tucson did not follow-up with additional monitoring or further evaluation to determine the source, cause, or frequency of the cadmium result that was above the action level. Workers were stationed near this area sample and UNICOR should presume that this sample is representative of the workers' breathing zone, unless it demonstrates otherwise. Follow-up monitoring is required by OSHA when cadmium breathing zone exposure is above the action level. Medical surveillance is required by OSHA when the cadmium action level is exceeded for 30 days or more per year. In the narrative of its report and later follow up email correspondence, the UNICOR consultant did not bring the cadmium exposure that was above the action level to the attention of UNICOR. Even though UNICOR should have conducted a follow-up evaluation, FOH acknowledges that monitoring of disassembly operations at other UNICOR factories has not found cadmium and lead exposures to be above the action level.

3. Based on surface wipe samples collected by NIOSH/DART in June 2007, lead and cadmium surface contamination in the factory can be controlled by implementing improved housekeeping and cleaning practices and by implementing an operations and maintenance (O&M) plan. An element of the O&M plan could include periodic clean-up of surfaces by inmate or other workers; however, this would have to be performed using proper hazard controls. This conclusion, however, is based on the 2007 levels remaining constant and not being allowed to increase (see Conclusion 4 for additional information on this issue).

4. In June 2007, NIOSH/DART found that lead surface contamination was significantly higher than levels found by a UNICOR consultant in June 2006. Similar surface contamination differences were found for cadmium. UNICOR should conduct further sampling and analysis to determine if surface levels are significantly increasing over time and should take any necessary preventive or corrective action based on the results (see Recommendations, Section 6.0 for more detailed information on further analyses recommended).

5. Given that glass breaking has never been performed at FCI Tucson, the source of surface dust contamination is not from glass breaking, but is from contamination which has been released to the air and re-deposited on surfaces during routine e-waste disassembly and handling. Effective cleaning and housekeeping practices, proper handling of dusts and debris resulting from cleaning and housekeeping, and possibly ongoing cleaning during disassembly are important to keep surface contamination in check and limit potential worker exposure during recycling operations.

6. NIOSH/DART observed that cleaning was primarily performed using brooms and brushes which can generate airborne dusts that contribute to inhalation exposures to toxic dust. Also, dry sweeping can cause dusts to become re-deposited on building surfaces, including elevated surfaces (see Attachment 1).

5.2 Noise, Heat, and Repetitive Stress Exposure

7. Spot noise measurements conducted by NIOSH/DART found noise exposure at levels that suggest the need for a more comprehensive noise study (see Attachment 1), beyond the limited monitoring conducted by NIOSH/DART. A previous noise evaluation conducted by OSHA did not reveal exposures above the level that requires implementation of a hearing conservation program, but the OSHA study was also of limited scope. UNICOR has not conducted a noise evaluation at FCI Tucson.

8. NIOSH/DART found that ambient outside temperature measurements and camp warehouse temperature measurements indicated the need to periodically evaluate heat stress potential in these areas and ensure implementation of proper precautions, as indicated from the evaluation (see Attachment 1). Heat exposure was not a factor in the general recycling factory and associated FCI warehouse on the days of the FOH and NIOSH/DART study.

9. NIOSH/DART observed tasks (such as lifting and using screwdrivers) being conducted in an awkward manner which could produce repetitive stress injuries (see Attachment 1).

5.3 Safety and Health Programs, Plans, and Practices

10. UNICOR's Quality Management System, "6.2.2 Competence, Awareness, and Training (Procedure)" calls for a basic 32-hour core curriculum course for staff. The same document outlines a basic job orientation for inmate workers. It includes safety instructions, hazard communications training, and instruction for the work assignment. Toxic metals hazards and controls are addressed in the course outline, including a concise procedure for handling of accidental breaking of CRT glass. The document contains safety rules that include mandatory safety shoes and safety glasses, restrictions on eating, drinking, chewing, and smoking in the demanufacturing area, brief hand washing requirements, brief lifting precautions, glove requirements, and other non-specific PPE instructions.

11. UNICOR is in the process of providing a different disposable respirator for voluntary use to replace the existing single strap unit which is not tight fitting to the face. UNICOR and FCI Tucson personnel expressed some concern and/or uncertainty regarding requirements for its implementation, such as any requirement for fit testing. OSHA's position is that fit testing is not required for voluntary use, but information from Appendix D of 29 CFR 1910.134 must be provided to workers. See Section 3.1 of this report for information on this topic that will serve to assist UNICOR in implementation of this disposable respirator.

12. UNICOR does not have a site-specific safety and health program for FCI Tucson recycling operations. Such a program that addresses both routine and non-routine activities would be a good practice for all UNICOR recycling facilities that do not have this type of program.

5.4 Health and Safety Regulatory Compliance

13. Based on OSHA's and UNICOR's consultant monitoring performed in 2006, current routine FCI Tucson operations conducted in the factory and other associated areas (e.g., disassembly) are in compliance with the OSHA lead and cadmium standards regarding control of employee exposure at levels below the OSHA PEL. However, the one cadmium area sample that was above the action level raises concerns over compliance with the OSHA monitoring requirements for cadmium and possibly medical surveillance requirements if exposures above the action level occur for 30 days or more per year.

14. The OSHA cadmium standard states that surfaces contaminated with cadmium shall be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne. NIOSH/DART observed that cleaning is primarily performed using brooms and brushes which can increase airborne exposures. OSHA explicitly restricts use of brushing as employed by UNICOR at FCI Tucson (see Attachment 1).

15. At the time of the June 2007 NIOSH/DART and FOH investigation, UNICOR did not provide for heat exposure controls at FCI Tucson. Although OSHA does not have a heat exposure standard, it can enforce heat exposure controls under the General Duty Clause.

16. UNICOR has not conducted a complete noise monitoring survey to ensure compliance with 29 CFR 1910.95, Noise.

5.5 Environmental Compliance

17. No information was obtained that indicated that e-waste activities at FCI Tucson are currently subject to any environmental permits dealing with hazardous waste, air, or water/wastewater. Based on recent discussions with UNICOR representatives at FCI Tucson no such permits are currently in place.

6.0 RECOMMENDATIONS

Recommendations concerning safety, health, and environmental aspects of UNICOR's e-waste recycling operations at FCI Tucson are provided below under the following subdivisions:

- Heavy Metals Exposures;
- Noise, Heat, and Repetitive Stress Exposure;
- Safety and Health Programs, Practices, and Plans;
- Health and Safety Regulatory Compliance; and
- Environmental Compliance.

These recommendations relate to the conclusions presented in Section 5.0, above. Some recommendations are taken from supporting documents such as the NIOSH/DART report (Attachment 1) and OSHA inspection report (Attachment 2). See these reports for additional recommendations, as well. Other recommendations are developed by FOH from the body of data and documents reviewed to prepare this report. Recommendations are provided for current factory operations (e.g., disassembly and associated activities).

6.1 Heavy Metals Exposures

1. UNICOR should conduct follow-up evaluation of lead and cadmium exposures including additional personal exposure (breathing zone) monitoring during disassembly and associated activities to determine the significance of the one cadmium area exposure result that was above the action level, but below the PEL. Guidance for further analysis and monitoring is recommended below.

    - The minimum requirement specified in the OSHA cadmium standard is that breathing zone samples be taken at least every six months (and possibly more often) when any initial or periodic monitoring sample exceeds the action level.

To justify discontinuation of monitoring for the personnel represented, two additional monitoring episodes at least seven days apart must indicate exposures to be below the action level. It is recommended that UNICOR conduct monitoring beyond the minimum requirement to ensure that variability in exposures be evaluated and to ensure that all activities that could result in exposure be captured.

- Additional monitoring should concentrate on the use of breathing zone samples, and represent the breadth of activities related to disassembly, including both routine and non-routine activities. UNICOR should ensure that additional exposure monitoring characterizes the activities and location represented by the area sample collected by its consultant in 2006 that exceeded the action level. Cleaning and any other activities that could disturb existing dust should also be monitored.

- The follow-up monitoring and analysis should involve more than just collecting samples. It should involve an analysis and documentation of the operations and activities conducted, their duration, pertinent observations, locations, types and quantities of materials processed, and any other information that is important to evaluate exposure levels and take preventive or corrective action in the future should exposures be elevated.

2. Even if additional monitoring as recommended above shows that monitoring can be discontinued, it is recommended that UNICOR periodically conduct at least a limited amount of personal exposure monitoring that characterizes exposures resulting from current recycling and associated activities. This monitoring will serve to document continued control of the lead and cadmium hazards. An annual monitoring program would be appropriate. This recommendation goes beyond the requirements of the OSHA lead and cadmium standards, but would provide important documentation of consistently low exposures.

3. If consistently low exposures are found over time, then monitoring could be limited to any new activities (e.g., non-routine or certain O&M activities) and future changes in work operations, work processes/practices, personal protection, and other practices. Exposure monitoring is an OSHA requirement when any change is made that could result in a new or additional lead or cadmium exposure.

4. Given the higher surface contamination levels of lead and cadmium in 2007 over 2006, UNICOR should implement an annual surface monitoring program to ensure that surface concentrations of lead and cadmium are not building up over time. As NIOSH/DART did, UNICOR should conduct sampling for both work surfaces and elevated surfaces in the factory and associated areas. The method of monitoring should be identical to the NIOSH/DART method to allow proper comparisons of data. UNICOR should implement this annual surface monitoring program for all recycling facilities to ensure that contamination levels are kept in check. This monitoring in combination with an effective O&M plan could avoid

future costly remediation requirements (also see the O&M recommendation below).

5. In conducting hazard evaluations that include exposure monitoring and surface sampling, UNICOR should select well qualified contractors, consultants, or internal industrial hygiene personnel with appropriate background, training, education, and experience for the assigned tasks. Industrial hygienist(s) certified by the American Board of Industrial Hygiene (ABIH) should provide leadership in hazard identification, evaluation, and control. Approved, standardized, and consistent methods should be applied. The industrial hygienists should provide a thorough evaluation of workplace conditions during monitoring episodes and provide a complete narrative discussion of the findings, along with conclusions and recommendations.

6. UNICOR should develop and implement an operations and maintenance (O&M) plan at FCI Tucson to ensure that surface contamination is minimized and that existing contamination is not released that could result in inhalation or ingestion exposures. Elements of this plan could include:

   - Identification of activities that could disturb contamination (e.g., HVAC maintenance, periodic or non-routine cleaning of elevated surfaces, and various building maintenance functions);

   - Processes to identify and control hazards for routine and non-routine activities (e.g., job hazard analysis process prior to conducting certain work with identification of mitigating actions);

   - Mitigating techniques and procedures during activities of concern (e.g., dust suppression and/or clean-up and capture, filter removal and bagging processes, hygiene and housekeeping practices, and use of PPE and respiratory protection);

   - Training and hazard communication;

   - Disposal of contaminated materials; and

   - Periodic inspection, monitoring and evaluation of existing conditions, as appropriate.

   At UNICOR's discretion, the O&M plan could also include periodic clean-up of surfaces by inmate or other workers, such as the elevated surfaces that NIOSH/DART found to contain the higher contamination levels. If this element were adopted, however, UNICOR should ensure that practices to control exposures are included in the plan and implemented, such as appropriate PPE, respiratory protection, exposure monitoring, clean-up methods (e.g., HEPA vacuuming and wet methods), waste disposal, hygiene and housekeeping practices, and others deemed appropriate by UNICOR. Initial exposure and/or additional monitoring for clean-up under the O&M plan should be conducted to determine whether exposure during clean-up is above the action levels and PELs for lead and cadmium. Controls for future clean-up activities should then be based on exposure results.

6.2 Noise, Heat, and Repetitive Stress Exposure

7. NIOSH/DART recommends that UNICOR evaluate FCI Tucson work activities for hazards related to lifting and other repetitive stress, and implement any appropriate procedures, training, or equipment to address the hazards (see Attachment 1, Recommendation 2). UNICOR should conduct a noise survey as recommended by NIOSH/DART (see Attachment 1, Measurements and Observations section) to ensure compliance with 29 CFR 1910.95, Noise.

8. NIOSH/DART recommends that UNICOR evaluate the heat exposure hazard to determine any precautions necessary to prevent heat strain and heat stress (see Attachment 1, Recommendation 3.)

6.3 Safety and Health Programs, Practices, and Plans

9. As a "good practice" approach, UNICOR should prepare a concise written safety and health document specifically for its recycling operations at FCI Tucson, as well as for each of its other recycling factories that lack such a document. Such a document should be developed and implemented and would serve to concisely define the safety and health practices and requirements specific to FCI Tucson recycling, such as PPE requirements or voluntary use, hygiene (e.g., hand washing) practices, daily and periodic housekeeping practices, special training requirements for any hazardous equipment use or other hazard controls, and other practices essential to conduct work safely. Elements of the inmate worker job orientation content that addresses safe work rules should be part of this document.

10. Per OSHA requirements regarding voluntary respirator use, UNICOR should provide Appendix D of 29 CFR 1910.134 to workers and ensure that the workers read and understand the information. In addition, UNICOR should ensure that workers understand the proper use and limitations of the respirators that UNICOR provides. For good practice documentation purposes, UNICOR should have inmate workers read and sign Appendix D of 29 CFR 1910.134, and UNICOR and FCI Tucson should maintain the Appendix D signed records.

11. BOP and UNICOR should implement a system to list, track, address, accept or not accept, and close out recommendations or deficiencies identified by its health and safety staff, consultants, and others, including from the OIG investigation. This system will also assist in clearly defining responsibility for actions between UNICOR and BOP. This recommendation applies to all UNICOR recycling factories and will be further discussed in the OIG final report.

6.4 Health and Safety Regulatory Compliance

12. FCI Tucson should conduct an activity-based job hazard analysis (JHA) for any new, modified, or non-routine work activity prior to the work being conducted. The JHA process is intended to identify potential hazards and implement controls for the specific work activity prior to starting the work. For instance, the JHA process should be integral to an effective O&M plan, as described in Section 6.1.

13. Per OSHA's 2006 recommendation and FCI Tucson's statement that one is to be scheduled, UNICOR and FCI Tucson should conduct a baseline industrial hygiene survey (see Attachment 2).

14. As recommended by NIOSH/DART (see Attachment 1, Recommendations 5 and 6), UNICOR should discontinue broom and brush cleaning of dusts containing lead, cadmium, and other toxic metals. Instead, HEPA vacuuming and wet methods should be used. Hand washing should be strictly enforced before eating, drinking, smoking, and after work shifts are completed. OSHA also recommended vigilance in keeping hands clean to avoid transmission of contaminants (see Attachment 2).

15. Based on additional monitoring results recommended in Section 6.1, UNICOR should implement any actions that are required under the OSHA lead and cadmium standards or that are appropriate to reduce employee exposures, such as equipment cleaning prior to or during disassembly, PPE modifications, housekeeping practices, and others.

6.5 Environmental Compliance

16. In implementing clean-up methods, UNICOR should evaluate the wastes from HEPA vacuums, mop rinse water, and other potentially contaminated debris to determine acceptable disposal methods per U.S. EPA regulations. The FCI Tucson Lead Safety Specialist identified this need and indicated that these evaluations are planned or currently underway.

7.0 REFERENCES

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ATTACHMENT 1

WALK-THROUGH SURVEY REPORT:
ELECTRONIC RECYCLING OPERATION

At

FEDERAL CORRECTIONAL INSTITUTION
TUCSON, ARIZONA

PRINCIPAL AUTHOR:
G. Edward Burroughs, Ph.D., CIH, CSP

REPORT DATE:
February 2009

FILE NO.:
EPHB 326-18a

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Division of Applied Research and Technology
4676 Columbia Parkway
Cincinnati, Ohio 45226

SITES SURVEYED: UNICOR Recycling Operations
Federal Correctional Institution
Tucson, AZ

NAICS: 562920

SURVEY DATE: June 27 - 28, 2007

SURVEY CONDUCTED BY: Edward Burroughs, PhD, CIH, CSP (NIOSH)
Paul Pryor, MS, CIH (FOH)

"The findings and conclusions in this report have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy."

DISCLAIMER

Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention.

The findings and conclusions in this report do not necessarily reflect the views of the National Institute for Occupational Safety and Health.

INTRODUCTION

On June 27 - 28, 2007 a researcher from the National Institute for Occupational Safety and Health (NIOSH), accompanied by a representative from Federal Occupational Health (FOH), conducted a walk-through evaluation of exposures to metals and other occupational hazards associated with the recycling of electronic components at the Federal Prison Industries (aka, UNICOR) facility in the Federal Correctional Institution (FCI), Tucson, AZ. The principal objectives of this visit were:

a. To observe potential exposures to metals including barium (Ba), beryllium (Be), cadmium (Cd), lead (Pb) and nickel (Ni).

b. To evaluate contamination of surfaces in the work areas that could create dermal exposures or allow re-entrainment of metals into the air.

c. To identify and describe the control technology and work practices used in operations associated with occupational exposures to toxic substances, and to determine additional controls, work practices, substitute materials, or technology that can further reduce these exposures.

d. To evaluate the use of personal protective equipment in operations involved in the recycling of electronic components.

PROCESS DESCRIPTION

The recycling of electronic components at this prison is done in a facility located within the Federal Correctional Institution (FCI). A diagram of that facility is shown in Figure I. This figure provides a general layout of the work process, although workers often moved throughout their respective areas in the performance of their tasks. The population of the UNICOR facility was approximately 86 in the FCI factory with an additional 25 in the camp warehouse.

The recycling of electronic components at this facility can be organized into three production processes: a) receiving and sorting, b) disassembly, and c) packaging and shipping. Incoming materials to be recycled are received at a warehouse where they are examined and sorted. During this evaluation it appeared that the bulk of the materials received were computers, either desktop or notebooks, or related devices such as printers. Some items, notably notebook computers, could be upgraded and resold, and these items were sorted out for that task.

After electronic memory devices (e.g., hard drives, discs, etc.) were removed and degaussed or destroyed, computers' central processing units (CPUs), servers and similar devices were sent for disassembly; monitors and other devices (e.g., televisions) that contain cathode ray tubes (CRTs) were separated and sent for disassembly and removal of the CRT. Printers, copy machines and any device that could potentially contain toner, ink, or other expendables were segregated and those expendables were removed prior to the device being sent to the disassembly area.

In the disassembly process external cabinets, usually plastic, were removed from all devices and segregated. Valuable materials such as copper wiring and aluminum framing were removed and sorted by grade for further treatment if necessary. Components such as circuit boards or chips that may have value or may contain precious metals such as gold or silver were removed and sorted. With few exceptions each of the workers in the main factory will perform all tasks associated with the disassembly of a piece of equipment into the mentioned components with the use of powered and un-powered hand tools (primarily screwdrivers and wrenches), with a few workers collecting the various parts and placing them into the proper collection bin. Work tasks included removing screws and other fasteners from cabinets, unplugging or clipping electrical cables, removing circuit boards, and using whatever other methods necessary to break these devices into their component parts. Essentially all components currently are sold for some type of recycling.

The final process, packing and shipping, returned the various materials segregated during the disassembly steps to the warehouse to be sent to contracted purchasers of those individual materials. To facilitate shipment some bulky components such as plastic cabinets or metal frames were placed in a hydraulic bailer to be compacted for easier shipping. Other materials were boxed or containerized and removed for subsequent sale.

A fourth production process, the glass breaking operation where CRTs from computer monitors and TVs were sent for processing, was not currently being done at Tucson. CRTs are shipped, unbroken, from Tucson to other locations for breaking and recycling. This process was observed and evaluated at other UNICOR facilities as part of this research and those reports are available.

POTENTIAL HAZARDS

Computers and their components contain a number of hazardous substances. Among these are "platinum in circuit boards, copper in transformers, nickel and cobalt in disk drives, Ba and Cd coatings on computer glass, and Pb solder on circuit boards and video screens" [Chepesiuk 1999]. The Environmental Protection Agency (EPA) notes that "In addition to lead, electronics can contain chromium, cadmium, mercury, beryllium, nickel, zinc, and brominated flame retardants" [EPA 2008]. Schmidt [2002] linked these and other substances to their use and location in the "typical" computer: Pb used to join metals (solder) and for radiation protection, is present in the CRT and printed wiring board (PWB). Aluminum, used in structural components and for its conductivity, is present in the housing, CRT, PWB, and connectors. Gallium is used in semiconductors; it is present in the PWB. Ni is used in structural components and for its magnetivity; it is found in steel housing, CRT and PWB. Vanadium functions as a red-phosphor emitter; it is used in the CRT. Beryllium, used for its thermal conductivity, is found in the PWB and in connectors. Chromium, which has decorative and hardening properties, may be a component of steel used in the housing. Cadmium, used in Ni-Cad batteries and as a blue-green phosphor emitter, may be found in the housing, PWB and CRT. Cui and Forssberg [2003] note that Cd is present in components like SMD chip resistors, semiconductors, and infrared detectors. Mercury may be present in batteries and switches, thermostats, sensors and relays [Schmidt 2002, Cui and Forssberg 2003], found in the housing and PWB. Arsenic, which is used in doping agents in transistors, may be found in the PWB [Schmidt 2002].

EVALUATION TECHNIQUES

Observations regarding work practices and use of personal protective equipment were recorded. Information was obtained from conversations with the workers and management to confirm this was a typical workday to help place conclusions in proper perspective.

Bulk material samples were collected by gathering a few grams of settled dust or material of interest and transferring this to a glass bottle for storage and shipment. These samples were analyzed for metals using NIOSH Method 7300 [NIOSH 1994] modified for bulk digestion.

Surface wipe samples were collected using Ghost™ Wipes for metals (Environmental Express, Mt. Pleasant, SC) to evaluate surface contamination. These wipe samples were collected in accordance with ASTM Method D 6966-03 [ASTM 2002], using a disposable paper template with a 12 inch by 12 inch square opening. The templates were held in place by hand or taped in place to prevent movement during sampling. Wipes were placed in sealable test tube containers for storage and then sent to the laboratory to be analyzed for metals according to NIOSH Method 7303 [NIOSH 1994].

An assessment of noise levels in various locations was made using a hand held sound level meter (Model 2400, Quest Technologies, Oconomowoc, WI) calibrated on-site prior to use with a 110 dB source. All noise measurements were weighted on an "A" scale, slow response.

Ambient dry bulb temperature and humidity measurements were made periodically with a Velocicalc Plus (TSI Inc., Shoreview, MN) air meter.

MEASUREMENTS AND OBSERVATIONS

The measurements and observations described here were made in June, 2007 at the UNICOR recycling operation at FCI Tucson . During this visit, surface wipe and bulk dust samples were collected in locations where the electronics recycling operations were taking place or had taken place in the past. Results of surface wipe samples are presented in Table 1 and bulk material sample results are presented in Table 2 for the metals of primary interest. Observations are presented below.

The highest measurements for lead by wipe samples were those taken from the top of light fixtures in locations accessible only from a ladder. Six of the 17 wipe samples were taken from these locations, and 5 of these 6 samples were >300 µg Pb/sq ft. One of these samples (TFMWW-1) was in excess of the 1,000 µg Pb/sq ft concentration recommended by Lange for final clearance of floors in commercial and industrial buildings (the most applicable recommendation found). Of the 11 other surfaces tested, all but one were below 200 µg Pb/sq ft, the most stringent recommendation found and a level which OSHA "would not expect surfaces to be any cleaner than." [Fairfax 2003],. Additionally, the 200 µg/sq ft recommendation applies to clean areas such as lunch areas, change areas, and storage areas, rather than work areas where lead containing materials are actively processed.

The highest Cd surface measurement (TFMWW-4) was 100 µg/sq ft., with all others below 80 µg/sq ft. Although there are no published criteria for use in evaluating wipe samples, the OSHA Cadmium standard [29 CFR 1910.1027] mandates that "All surfaces shall be maintained as free as practicable of accumulations of cadmium," that, "all spills and sudden releases of material containing cadmium shall be cleaned up as soon as possible," and that, "surfaces contaminated with cadmium shall, wherever possible, be cleaned by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne."

Ni surface contamination was highest in samples TFMWW-1 and TFMWW-4 at 780 and 670 µg/sq ft, respectively. All other measurements were at or below 460 µg/sq ft, and the maximum work surface measurement was 210 µg/sq ft. Like Cd, there are no published criteria for use in evaluating wipe samples for Ni and while the toxicity of this metal is somewhat dependent on species no compound identification was conducted.

Wipe samples did not indicate levels of Ba in any wipe samples at levels of concern, with the highest Ba concentrations (TFMWW-1 & 4) at 410 and 460 µg/sq ft. All other Ba measurements were 200 µg/sq ft or below. There are no published criteria for use in evaluating wipe samples.

No Be was detected in any sample from the Tucson FCI above the limit of detection of 0.06 µg/sq ft.

The five bulk samples showed no discernable pattern of contamination in this facility. No Be was detected in any bulk sample above the limit of detection of 0.3 mg/kg. The highest metal concentrations were Pb at 1,000 mg/kg and Ni at 880 mg/kg in samples TFMWB-1 and 4, respectively. These two samples were collected from opposite corners of the factory area, as shown on Figure 1.

Operations at the Tucson FCI were similar to procedures observed at other UNICOR recycling facilities where personal exposures have been evaluated and at which there were few significant exposures in the receiving and sorting, disassembly, and packaging and shipping processes.

No local exhaust ventilation systems were in use at the time of this visit nor were any needed. Work areas were kept reasonably clean, primarily by the use of brooms and brushes which can be a source of airborne dust, so the use of HEPA vacuums and wet mopping is recommended in the next section. Care must be taken when using wet methods to assure no electrical or other safety hazard is introduced.

Safety glasses were used in most operations. Hearing protection was available where needed (primarily near the bailer) and disposable respirators were available to workers who chose to use them although respirators were not required at this facility.

Spot measurements of noise made with a hand-held sound pressure meter suggested the need for a more comprehensive noise study. Peak levels up to 103 dBA near the plastic bailer and 86 dBA near the metal bailer were measured with durations of 20 to 40 seconds. In the area where hard discs were being destroyed by puncturing, shorter duration (<2 seconds) peaks over 100 dBA (up to 112) were common and the background noise level was in the range of 80 to 85 dBA.

Ambient indoor temperatures ranged from 71 to 81°F in the factory and to 91°F in the warehouse, with relative humidity's from 30 to 60%. Outdoor temperatures in excess of 100°F were measured.

CONCLUSIONS AND RECOMMENDATIONS

Based on measurements and observations presented, the following recommendations are made.

1. Training of workers should be scheduled and documented in the use of techniques for dust suppression, personal protection equipment (e.g., respirators, gloves, etc.) and hazard communication. Additional training, recordkeeping and other restrictions apply if a formal respiratory protection program is implemented.
2. Frequently while conducting the on-site work, NIOSH researchers observed tasks (such as lifting and using screwdrivers) being conducted in an awkward manner which could produce repetitive stress injuries. Tasks should be evaluated to determine if they are biomechanically taxing and if modifications in procedures or equipment would provide benefit to this workplace.
3. Ambient temperature measurements indicate that heat stress should be periodically evaluated to ensure proper precautions are in place to prevent problems associated with a hot environment.
4. A program should be established within the Bureau of Prisons to assure that all UNICOR operations, including but not limited to recycling, should be evaluated from the perspective of health, safety and the environment in the near future. This program should be overseen by competent, trained and certified individuals.
5. Due to the levels of surface contamination of Pb measured in the recycling facility, workers should wash their hands before eating, drinking, or smoking.
6. Daily and weekly cleaning of work areas by HEPA-vacuuming and wet mopping should be conducted, taking care to assure no electrical or other safety hazard is introduced.
7. A comprehensive noise survey should be conducted focusing on the bailing and disk-destroying areas since spot measurements showed these are the most likely areas for potential noise problems.

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Table 1.

TUCSON WIPE SAMPLES

Sample Location*	Sample I D	Sample Description**	Ba ug/sq ft	Be ug/sq ft	Cd ug/sq ft	Pb ug/sq ft	Ni ug/sq ft
1 TFM	WW-1	Top of Light Fixture Near Work Stations 16 & 18	410	<0.06	76	1,300	780
2 TFM	WW-2	Top of Light Fixture Center of Shop near WS 8 + 25	69	<0.06	20	83	53
3 TFM	WW-3	Top of Light Fixture Behind W S 7	290	<0.06	74	290	300
4 TFM	WW-4	Top of Light Fixture Beside W S 19	460	<0.06	100	900	670
5 TFM	WW-5	Top of Light Fixture Behind W S 28	190	<0.06	47	460	170
6 TFM	WW-6	Top of Light Fixture in Bailing Room Between Bailers	100	<0.06	74	310	460
7	TFMWW-7	Work Surface W S 4	48	<0.06	8	73	170
8	TFMWW-8	Work Surface W S 10	37	<0.06	14	58	91
9	TFMWW-9	Inside trough in front of W S 10	75	<0.06	37	99	210
10	TFMWW-10	Work Surface W S 15	49	<0.06	13	210	100
11	TFMWW-11	Work Surface W S 20	40	<0.06	6	51	120
12	TFMWW-12	Trough in Front of W S 20	15	<0.06	4	23	43
13	TFMWW-13	Top of Work Surface W S 26	10	<0.06	3	150	42
14	TFMWW-14	Work Surface W S 30	12	<0.06	4	24	32
15	TFMWW-15	Work Surface W S 33	29	<0.06	3	32	43
16	TFMWW-16	Trough in Front of W S 33	54	<0.06	6	110	110
17	TFMWW-17	Inside Metal (Blue) Bailer	81	<0.06	14	32	130

* Location identifiers correspond with Figure I

** "W S" indicates work station

Table 2.

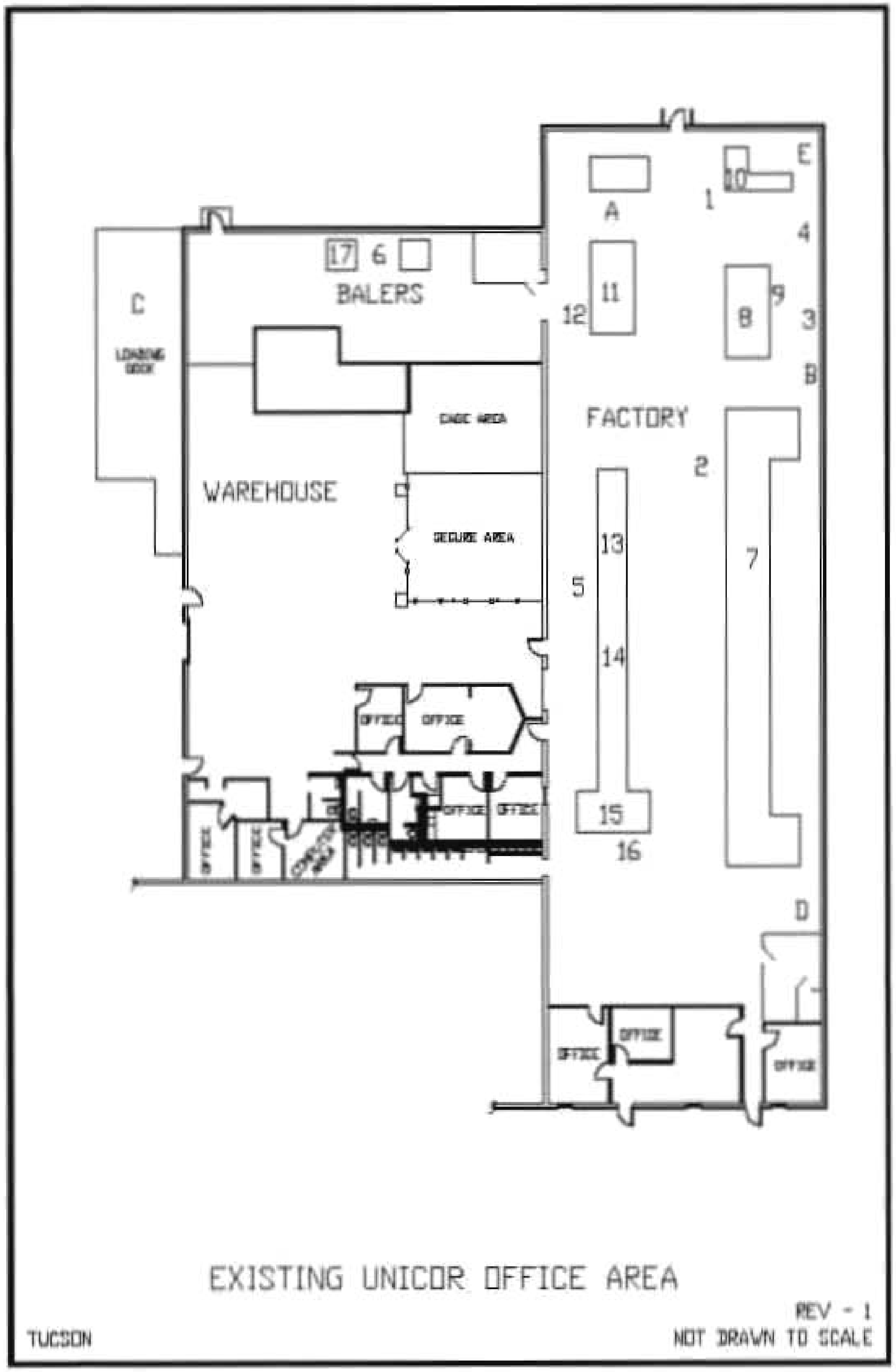
TUCSON BULK SAMPLES

Diagram location*	Sample I D	Description**	Ba mg/kg	Be mg/kg	Cd mg/kg	Pb mg/kg	Ni mg/kg
A	TFMWB-1	Bottom of Trash Can at W S 20	290	<0.3	52	1000	140
B	TFMWB-2	Top of Conduit Along Wall, near W S 14	440	<0.3	130	590	310
C	TFMWB-3	Dirt from Floor of Semi-Trailer used to haul product between warehouse & shop	240	<0.3	5	110	31
D	TFMWB-4	Dust from HEPA Vac Near W S 1	380	<0.3	42	790	880
E	TFMWB-5	Dust from HEPA Vac Near W S 14	20	<0.3	14	34	60

* Location identifiers correspond with Figure I

** "W S" indicates work station

Figure I Tucson UNICOR Floor Plan



ATTACHMENT 2

U.S. Department of Labor
Occupational Safety and Health Administration

Inspection Report

Mon May 1, 2006 11:53am

Rpt ID	Assignment Nr.	CSHO ID	Supervisor ID	Inspection Nr.	Opt. Insp. Nr.
0935000	0	R4531	F0799	309845071	

Establishment Name	Federal Correctional institution Tucson				
Site Address	8901 South Wilmot Road Tucson, AZ 85706	Site Phone	(520) 574-7100	Site FAX	(520) 574-4206
Mailing Address	8901 South Wilmot Road Tucson, AZ 85706	Mail Phone	(520) 574-7100	Mail FAX	(520) 574-4206
Controlling Corp		Employer ID			
Ownership	D. Federal Agency: 1503 - BUREAU OF PRISONS	City	0530	County	019
Legal Entity		Previous Activity (State Only)			

Related Activity					
Type	Number	Satisfied	Type	Number	Satisfied

Employed in Establishment	1000	Advance Notice?	No	Category	H. Health
Covered By Inspection	82	Union?	Yes	Interviewed?	Yes
Controlled By Employer	1000	Walkaround?	Yes		
Primary SIC	9223	Secondary SIC		Inspected	
Primary NAICS	922140	Secondary NAICS		NAICS Inspected	

Inspection Type	H. Programmed Planned	Reason No Inspection	
Scope of Inspection	B. Partial Inspection		
Classification			
Strategic Initiatives			
National Emphasis			
Local Emphasis			

Anticipatory Warrant Served?	No	Denial Date	Date ReEntered	Date ReDenied	ReEntered
Anticipatory Subpoena Served?	No				

Entry	04/26/06	11:30	First Closing Conference	04/27/06	15:00
Opening Conference	04/26/06	12:00	Second Closing Conference	5/17/06	
Walkaround	04/26/06	12:30	Exit	04/27/06	15:45
Days On Site	2		Case Closed	04/27/06	5/17/06
			No Citations Issued		

Type	ID	Optional Information

CSHO Signature	[signature]	Date	5/01/06

OSHA 001746

OSHA-1 (Rev. 7/02)

U.S. Department of Labor
Occupational Safety and Health Administration

Inspection Narrative

Mon May 1, 2006 11:53am

Inspection Nr.	309845071
Opt. Case Number	

Establishment Name	Federal Correctional institution Tucson		
Legal Entity		Type of Business	Unicor Recycling Factory

Additional Citation Mailing Addresses

Organized Employee Groups

Authorized Employee Representatives

[redacted] [redacted]

Employer Representatives Contacted

Name	Title	Function	Walk Around?
[redacted]	[redacted]	I O	Y
		I O C	Y
		I O C	Y
		I O C	Y
		I O C	Y

Other Persons Contacted

Entry	04/26/06	11:30	First Closing Conference	04/27/06	15:00
Opening Conference	04/26/06	12:00	Second Closing Conference	5/17/06	
Walkaround	04/26/06	12:30	Exit	04/27/06	15:45
			Case Closed	04/27/06	

Penalty Reduction Factors

Size	0	Good Faith	0	History	0

Followup Inspection?	N	Reason	in compliance

Coverage Information/Additional Comments

CSHO Signature		Date	5/01/06
Accompanied By			

OSHA 001747

OSHA-1A(Rev. 6/93)

NARRATIVE #309845071

Federal Correction Institution Tucson (FCI Tucson)
8901 South Wilmot Rd.
Tucson, AZ 85706

CSHO conducted an Opening conference on 4-26-06 (wed) and presented OSHA credentials. CSHO also provided business cards. Present were production controller, Associate Warden, Warden, Warden, Safety manager and Union rep. CSHO indicated the nature and scope of the inspection was a programmed planned inspection of the Unicor Recycling operations at the facility. CSHO indicated that personal and general area air sampling would be conducted based on what was observed during the walk around.

FCI Tucson is a medium security facility which has approximately 789 inmates and 230 staff members. The Unicor operation consists of four employees and 82 inmates. The Unicor operation consists of a warehouse located at the new Federal Penitentiary located a short three minute drive up the road. The warehouse is where materials such as computers printers and others are bought in and evaluated and sorted. Video monitors are tested for usability and some material is salvaged and others are prepared for recycling. The sorted material is sent to the factory by truck for recycling operations. At the factory there is a main production area. In this area there are two long bays and several tables in the rear of the room workstations for the inmates. Inmates are given a set of tools at the start of the shift and are required to wear eye protection, foot protections and have the option of dust masks, and aprons. Hand and face washing is required before leaving the facility for lunch and at the end of the shift. There is a Bailing area, where metal, plastic, and cardboard are baled employees who operate this equipment have been trained and are familiar with the hazards associated with this work. There is a location where the glass breaking area was scheduled to be located but is now used for storage There has never been glass breaking of CRT's at this facility this material is shipped to another facility (Texarkana) for breaking the CRT's. A video tape/tape destruction area, a sewing cage (for making aprons) as wells as a hazardous materials storage area. All materials were labeled and MSDS were located in a book at the site.

CSHO conducted personal air samples on the staff members and placed general area pumps in the inmate work areas. During the sampling one employee indicated that she was not feeling well and seemed to attribute it to wearing the pump. When this was disclosed to CSHO the pump was removed from the employee. CSHO requested a full metal scan which will analyze for several metals and includes lead, cadmium, and berrylium. All samples results were below the OSHA PEL. Hand wipe samples indicate the need for continue vigilance on keeping hands clean in order to prevent transmission of contaminates.

All requested documents were received and reviewed. The Prison did not have its own baseline IH survey but was in process of scheduling it. Some medical tests were completed in preparation for the glass breaking operation that never materialized and therefore are not required.

The Exit conference consisted of [redacted] (warden) [redacted] (associate warden) [redacted] (production controller) [redacted] (safety Manager) and [redacted] (union). CSHO provided a copy of the OSHA 3000 and indicated the employer's rights and responsibilities following an OSHA inspection. (The union requested a copy of the pamphlet and it was given to them as well)
CSHO indicated that overall the facility looked very good and no apparent violations of the OSHA standards were observed. CSHO noted several positive highlights such as the MSDS program and the monthly safety inspections of the site and the fact that all training material and other documentation were made readily available. During the visit the facility received a copy of their ISO certification which is a prestigious honor in the recycling field. CSHO did indicate that pending the results of the samples coming back below the OSHA PEL then no citations would be issued. CSHO also encouraged the facility to continue with its scheduled industrial hygiene baseline survey plan and to provide me with a copy of the results. CSHO indicated that a final closing conference would be held d by Phone with the Warden and the Union when the results came in. CSHO answered questions and comments and exited the site.

CSHO spoke with BOP National Safety Manager on 5/15/06 Re sample results and inspection findings.

CSHO spoke with Warden by phone on 5/15/06 and held final closing conference. I indicated that samples were below PEL and no citations were scheduled. I did indicate that hand washing should be emphasized to the inmates and staff. She indicated that Union President would be available for a closing call the next day.

CSHO spoke with Union President by phone on 5/17/06 and held a final closing conference. I indicated that samples were below the PEL and no citations would be issued. I reemphasized the hand washing as well. I informed President that if he had any additional concerns or questions he could contact me.

Note: During the Inspection there was an issue with the union representation. On the first day of the inspection Mr. B. was the designated representative. On the next day CSHO repeatedly requested Mr. B's participation and it was discovered that he didn't come because Mr. S. was appointed the union representative by the President of the union in an email to the Warden dated the previous night. Mr. S. did approach CSHO while she was conducting sampling and requested to be at closing conference. There was a question of if Mr. S. was a bargaining union employee and was entitled to be the union rep. CSHO indicated her desire to stay out of labor management issues and indicated that there was no problem with Mr.S. and she ensured that Mr. S. attended the closing as requested. CSHO also met privately with Mr. S. on the first day of the inspection in his capacity as "safety officer". The following day in his capacity as "union representative". .CSHO was very clear with Mr. S. had my card and phone number so he could contact OSHA if there were any additional issues.