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GROSSE POINTES-CLINTON REFUSE DISPOSAL AUTHORITY
MOUNT CLEMENS, MICHIGAN

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SUMMARY

In July 1990, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request for a Health Hazard Evaluation (HHE) from employees at the Grosse Pointes - Clinton Refuse Disposal Authority in Mount Clemens, Michigan. NIOSH was asked to evaluate possible employee exposures to silica, lead, cadmium, and mercury associated with incinerator ash. A special concern was the possibility of inhalation exposures to ash during the furnace clean-out which is conducted once each week.

Based on an initial visit to the incinerator complex in November 1990, NIOSH investigators determined that the weekly clean-out operation was the primary source of employee exposures to ash. In March 1991, a second site visit was conducted which included an extensive walk-through, collection of bulk samples of ash for elemental analysis, and collection of air samples for measurement of total dust, respirable dust, respirable crystalline silica, and metals.

Personal and general area air sampling data revealed potential short-term exposures to high levels of crystalline silica, lead, and total dust during the incinerator clean-out operation. However, since this cleaning activity lasted for less than 2 hours and occurred only once each week, the measured concentrations for crystalline silica and lead, when calculated over an 8-hour workday, did not exceed the applicable Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) for these substances. One personal air sample collected for total dust measured 20.5 milligrams per cubic meter (mg/m^3), a concentration which exceeds the OSHA PEL of 15 mg/m^3. One personal breathing-zone air sample for crystalline silica did exceed the NIOSH Recommended Exposure Limit (REL) for crystalline silica of 0.05 mg/m^3, a time weighted average (TWA) exposure limit for up to a 10-hour workday. NIOSH further recommends that steps be taken to reduce crystalline silica exposure to the lowest feasible concentration because it is a suspected human carcinogen.

Data collected in this HHE indicates that employees of the Grosse Pointes - Clinton Refuse Disposal Authority experience short-term airborne exposures to crystalline silica, lead, and total dust during the weekly clean-out of the incinerator furnaces. Because the clean-out is completed in less than 2 hours, personal exposures to crystalline silica and lead, measured on the day of this survey, did not exceed the applicable OSHA PELs (based on a calculated 8-hour TWA exposure.) One personal air sample exceeded the NIOSH REL for crystalline silica. Recommendations to improve work practices and provide employees with better personal protective equipment are included in this report.

KEYWORDS: SIC 4953 (Refuse Systems), ash, incinerator, metals, silica, lead, cadmium, mercury

INTRODUCTION

In July 1990, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request for a Health Hazard Evaluation (HHE) from a representative of employees at the Grosse Pointes - Clinton Municipal Refuse Authority in Mount Clemens, Michigan. NIOSH was asked to evaluate possible exposures to silica and various metals that had been identified in an earlier analysis of the incinerator ash. A special concern was the possibility of inhalation exposures to ash during the furnace clean-out which is conducted once each week.

In response to the employee request, NIOSH investigators made two visits to the incinerator site. The initial visit in November 1990 included a walk-through of the facility and a brief review of operating procedures. The weekly clean-out operations appeared to be the primary source of exposures to ash since, during normal operation, the combustion chambers and ash handling system are entirely enclosed and maintained under negative pressure. Although some material would be expected to escape, airborne concentrations were considered low compared to those generated during clean-out. A second site visit in March 1991, which included an air sampling survey, was scheduled on a day when the furnaces would be cleaned.

BACKGROUND AND PROCESS REVIEW

Although incineration of municipal refuse has not generally been cost effective in the past, the increasing expense of land disposal and the limitations on available space are now making incineration a more attractive alternative. As costs continue to rise and as currently available sites for land disposal of municipal waste become filled, it is likely that the volume reduction achieved by incineration of municipal refuse will make this process increasingly popular. Although the environmental and community impact of increased incineration has received considerable study, there is relatively little data available on occupational hazards to incinerator workers.

The Grosse Pointes - Clinton Municipal Refuse Authority is an organization formed in the early 1960s to collect and dispose of household trash from several communities located northeast of Detroit, Michigan. Municipal refuse is trucked to an incinerator in Clinton Township where it is burned in order to reduce the volume of material to be land filled.

The incinerator is a continuous feed/mass burn design similar to that used in many other communities. There are two parallel combustion chambers which feature reciprocating inclined grates. Refuse is first dumped from trucks into a storage pit. An overhead crane is then used to transfer the material to a continuous feed hopper which drops the refuse into the primary combustion chamber at a controlled rate. The "floor" of the primary combustion chamber is an inclined reciprocating grate approximately 12 feet wide by 40 feet long.

The reciprocating grate slowly pushes refuse from the top of the chamber down toward a water-filled ash collection system. When the trash falls onto the top of the grate, the heat drives off the water and may pyrolyze some of the more volatile materials. As refuse moves down the grate, the solids and the gaseous pyrolysis products ignite. By the time solid materials reach the end of the primary combustion chamber, the volume can be reduced by as much as 90 percent.

At the end of the grating, the unburned materials and bottom ash, which is composed of large particles, fall into a water-filled channel. The hot gases and fly ash are carried into a secondary combustion chamber and then into a conditioning and cooling tower. The cooling tower uses water sprays to cool the exhaust gases and to capture some of the particulate matter. The exhaust gases then move through an electrostatic precipitator which traps most of the remaining fly ash before exiting through the exhaust stack. The bottom ash, unburned refuse, and fly ash are all collected in the water-filled conveyor channel which is located under the incinerator and extends from the primary combustion chamber out to the cooling tower and electrostatic precipitator. Most of the larger ash falls directly into the conveyor channel from the primary combustion chamber. The medium size particles in the fly ash are collected by the water sprays in the conditioning tower which drains directly into the conveyor channel. The smallest particles are collected by the electrostatic precipitator and are carried to the water channel in an enclosed mechanical conveyor. All the materials collected in the water channel are eventually removed by a continuous drag conveyor which carries the wet ash and unburned refuse up a ramp and dumps them into a truck for disposal.

The primary combustion chamber is designed to operate at about 1500^{o} F and the residence time for solids is reported to be about 20 minutes. An induced draft fan, located downstream of the electrostatic precipitators, maintains the system under negative pressure to minimize escape of gases and fly ash. The furnaces do not use oil or gas burners during normal operation and once the fires are lit they burn continuously throughout the week.

On Friday evening the furnaces are shut down and allowed to cool for routine cleaning and repair the following morning. On Saturday the doors of the primary combustion chamber are opened and a crew of two to four workers enters to clean and inspect the grating and to break off slag and the built-up ash from the walls. The ash and unburned refuse are cleaned off the grating with push-brooms. The slag, which if allowed to build up would eventually block the air inlets, is broken off with a pick axe. The entire clean-out procedure takes about 60 to 90 minutes and generates a significant amount of dust. During this evaluation employees wore disposable dust masks while working in the combustion chamber.

After the primary combustion chambers are cleaned, the access doors to the under-fire area, which is below the combustion chamber, are opened to check for buildup of ash and debris under the reciprocal grate. If an unacceptable buildup is found, a section of scaffolding is placed across the under-fire air chamber and one worker climbs in to perform the clean-out.

As previously noted, the weekly clean-out operations were determined to be the primary source of exposures to ash since, during normal operation, the combustion chambers and ash handling system are entirely enclosed and maintained under negative pressure. Intermittent exposures during routine incinerator operation, however, may occur when fly ash becomes caked on electrostatic precipitators or when the dry conveyors become plugged. When these problems occur, the material must be broken and knocked out with a pipe or steel rod. Although this is a frequent problem with some incinerator designs, workers and management both report that it is rare in this facility.

EVALUATION PROCEDURES

Because the most intense exposures were reported to occur during the furnace clean-out, air sampling was conducted only at that time. It was felt that if exposures during the clean-out were within the applicable limits, the overall exposures would also meet these criteria. Whenever possible, samples were collected in a worker's breathing zone using a battery-powered pump that was attached to the employee's belt. However, due to the limited number of employees working on the clean-out, some pumps were set up as general area air samplers. In most cases the area samplers were suspended from pipes on the inside wall of the furnace at a height of about 5 feet.

A total of 25 air samples were collected. These included 10 samples for respirable dust and crystalline silica, 10 samples for measurement of total dust and elements, and 5 samples for measurement of mercury. Sampling for respirable dust and silica was conducted according to NIOSH method 7500.(1) This method calls for collection of dust samples on pre-weighed polyvinyl chloride (PVC) filters at a flow rate of 1.7 liters per minute (LPM). Non-respirable particles (particles larger than approximately 10 microns in diameter) are excluded through the use of a size-selection device called a cyclone. A 10-millimeter cyclone was used in this evaluation for collection of the personal and area air samples. The total mass of collected material was determined gravimetrically by measuring the increase in filter weight. The crystalline silica content was determined by x-ray diffraction methods.

Sampling for total dust and elements was performed according to NIOSH methods 0500 and 7300, except that the normal PVC filters were replaced with pre-weighed mixed cellulose ester (MCE) filters.(1) Because of the relatively short sampling time, 1 to 2 hours, samples were collected at a flow rate of 2.5 LPM. As with the respirable dust samples, the total amount of material collected was determined by measuring the increase in filter weight. The collected dust was subsequently analyzed for elemental content using inductively coupled plasma (ICP) spectroscopy as described in NIOSH method

7300.(1) This sensitive method of analysis was used to measure the amount of lead, cadmium, zinc, arsenic, beryllium, chromium, and nickel collected on each filter. In addition to the analysis of air samples, 4 bulk samples of ash collected from various areas of the incinerator were analyzed for metal content using the same method.

Mercury was sampled using Hydrar tubes with MCE pre-filters as described in NIOSH method 6009.(1) The Hydrar tubes and the pre-filters were analyzed separately to allow the concentrations of mercury vapor and of particulate material to be independently determined. Because mercury was thought to represent a less significant health hazard than the other contaminants being measured in this workplace, the mercury sampling systems were set up only as area monitors.

EVALUATION CRITERIA

When conducting a health hazard evaluation at an industrial work site NIOSH investigators frequently perform sampling to measure the concentrations of various airborne contaminants. The air sampling results are then compared to various criteria or exposure limits that are intended to represent the maximum exposure concentration that is believed to be safe for most workers. Exposure criteria have been developed by NIOSH, the Occupational Safety and Health Administration (OSHA), and by other government or professional organizations. Employers are required to meet the exposure limits developed by OSHA, which are called Permissible Exposure Limits (PELs).(2) The exposure limits developed by NIOSH are called Recommended Exposure Limits (RELs) and are not legally enforceable. If the REL for a given substance is lower than the PEL, employers are strongly encouraged to meet the REL.

Most exposure criteria used in occupational health are expressed as 8-hour time-weighted average (TWA) concentrations. That is, they represent the maximum average concentration which is acceptable for an 8- or 10-hour workday. For example, the current PEL for quartz, which is a form of crystalline silica, is 0.1 milligrams per cubic meter (mg/m^3) expressed as an 8-hour TWA concentration.(2) It is considered acceptable for workers to be temporarily exposed to concentrations that are higher than 0.1 mg/m^3, as long as the average concentrations does not exceed this limit. If the duration of the exposure is reduced, then it is acceptable for the concentration to be higher than the stated limit.

In addition to the 8-hour TWA limit, some exposure criteria also include a short-term exposure limit (STEL) or ceiling limit which is a maximum concentration which would be considered acceptable. Ceiling limits and STELs are not based on 8-hour average exposures. Instead, they are maximum concentrations which should not be exceeded for even a short time. In general, it is permissible for the concentration of a contaminant to temporarily rise above the 8-hour TWA exposure limit, but it is not acceptable for the concentrations to exceed the STEL or ceiling limits.

When reviewing the results obtained in this survey, it is important to remember that air samples were collected during a furnace clean-out operation that requires less than 2 hours of work and which occurs only once each week. It would not be surprising if contaminant concentrations during the clean-out procedure exceeded either NIOSH or OSHA exposure limits that are expressed as 8-hour TWA values. Because the exposure duration is approximately two hours, however, the average contaminant concentration during that time would have to be about four times the applicable PEL or REL in order to constitute an over-exposure when calculated over an entire workday. In the following section, the results obtained from each analysis are presented and are compared to the appropriate NIOSH or OSHA criteria.

RESULTS AND DISCUSSION

BULK ASH SAMPLES

The 4 bulk samples of ash were analyzed for arsenic, beryllium, cadmium, chromium, lead, nickel, and zinc. Although no beryllium or arsenic was detected, all of the other metals were present at the concentrations shown in Table I. The primary reasons for analyzing bulk samples were to provide a qualitative description of the material and to obtain information that could be used in the analysis and interpretation of air samples. Because the bulk samples may not be representative of the airborne materials that workers are exposed to, the data obtained from the analysis of bulk samples cannot be compared to any criteria for occupational exposure. While the number of samples was too limited to allow any generalizations to be made, the data seem to suggest that fly ash collected at the electrostatic precipitator may have a higher metal content than the bottom ash collected from the furnaces or the under-fire area. This may be important because it is the small fly-ash particles that are most likely to become airborne and can be inhaled.

TOTAL AND RESPIRABLE PARTICULATE

When evaluating the air quality in a work environment it is often useful to measure the total concentration of dust or particulate in the air in addition to measuring the individual components such as lead or crystalline silica. For this evaluation, the total dust concentration was determined by collecting material from the air on a filter and measuring the increase in weight.

Although NIOSH has not issued any criteria for total dust concentrations, OSHA and the American Conference of Governmental

Industrial Hygienists (ACGIH) have both issued exposure criteria that can be applied in some situations. The OSHA PEL for total dust is 15 milligrams per cubic meter (mg/m^3) and the ACGIH Threshold Limit Value (TLV) is set at 10 mg/m^3.(2,3) In both cases the exposure criteria are expressed as 8-hour TWA concentrations.

These nuisance dust, or total particulate, criteria are intended for use with low toxicity dusts that are not expected to produce any specific disease. In general they should not be relied on to assess the hazard associated with exposure to materials like fly ash. However, because the specific components of the fly ash were also measured, it may be helpful to compare the total dust levels to the OSHA PEL and ACGIH TLV. As shown in Tables II and IIA, the total dust concentrations ranged from 0.5 mg/m^3 on the stairway between the two furnaces to 78 mg/m^3 in the under-fire area of one furnace. Two of the 4 area samplers and 1 of the 6 personal samplers indicated average dust concentrations that were well above the limits specified by OSHA and ACGIH. Although some extremely high dust levels were recorded, it should be noted that the exposure criteria are based on the assumption that workplace exposures last for 8 hours each day. Since the furnace clean-out lasts less than 2 hours, these data probably do not indicate a violation of the OSHA standard for total dust.

In addition to the total dust levels, the concentration of respirable dust was also measured. Respirable dust is generally defined to include only those particles that are smaller than 10 micrometers in diameter. It is these extremely small particles that can reach the lungs when inhaled, and which are responsible for many occupational respiratory diseases. OSHA has established a PEL of 5 mg/m^3 for respirable dust.(2) As with the total dust standard discussed earlier, the respirable dust standard is intended for use only when the material is classified as inert and is not expected to produce any specific disease. The results of the respirable dust measurements are presented in Tables III and IIIA. The data show that respirable dust levels were close to, but did not exceed, the OSHA standard.

METALS

When assessing worker exposures to complex materials such as fly ash, it is necessary to measure the individual components of the dust as well as the total dust levels. Previous experience with analysis of fly ash indicates that it is likely to contain a number of common metals including zinc, lead, and chromium. Analysis of air samples collected for this evaluation found that the concentrations of metal dust are highly variable. Lead, zinc, chromium, nickel, and cadmium were all detected in at least one air sample.

Inhalation (breathing) of lead dust and fume, and ingestion (swallowing) resulting from hand-to-mouth contact with lead-contaminated food, cigarettes, clothing, or other objects are the major routes of worker exposure. Once absorbed, lead is excreted from the body very slowly. Overexposure to lead can result in damage to the kidneys, gastrointestinal tract, peripheral and central nervous systems, and the blood-forming organs (bone marrow).(4) Among the effects of lead intoxication in adults are weakness, tiredness, irritability, constipation, anorexia (loss of appetite), abdominal discomfort, colic (cramping abdominal pain), anemia, high blood pressure, kidney damage, motor weakness which may progress to paralysis of the wrist extensor muscles ("wrist drop"), anxiety, depression, forgetfulness, and/or slowed reaction times.(4,5,6)

While short-term lead concentrations approached, or in some cases exceeded, the OSHA PEL for lead of 0.05 mg/m^3, these concentrations were below this OSHA criteria when averaged over an 8-hour workday.(7) The NIOSH REL for lead is less than 0.1 mg/m^3 as a TWA for up to 10 hours.(8) This REL is an air concentration to be maintained so that worker blood lead remains below 60 micrograms of lead per 100 grams of whole blood.(8) NIOSH is presently reviewing literature on the health effects of lead and may re-evaluate its REL. The OSHA PEL for general industry is currently the most protective criteria and is recommended by the NIOSH investigators. Since personal exposures to lead (as well as other metals) could vary from week to week depending on the composition of the ash, recommendations have been included in this report for providing additional personal protective equipment during clean-out activities.

CRYSTALLINE SILICA

Silicosis, which is caused by inhalation of respirable-size crystalline silica particles, has historically been one of the most common occupational diseases. Inhalation of crystalline silica can cause serious lung damage and may eventually lead to an incapacitating or even fatal condition. Silicosis usually occurs as the result of many years of exposure to dust from operations such as mining and stone cutting. Previous studies of fly ash have shown that it can contain significant amounts of crystalline silica.(9,10) However, the potential hazard to incinerator workers is not well defined.

Three forms of silicosis have been described: simple, complicated, and acute silicosis.(11) Simple silicosis, the most common form, usually develops after 20 or more years of exposure to dust containing a relatively small proportion of silica (less than 30% quartz silica). Usually there is little or no respiratory impairment associated with the early stages of simple silicosis. Complicated silicosis develops after

5-15 years of exposure to dust containing higher concentrations of silica (approximately 47-84% quartz silica).(11) Lung function may be severely compromised in these individuals. Acute silicosis develops after 1-3 years of exposure to very high levels of silica (90-100% quartz silica) over a short period of time.(11) There is a rapid loss of lung function generally followed by death within 1 year. Symptoms of silicosis include cough, shortness of breath, wheezing, and repeated non-specific chest illnesses.(6,11) Silicosis is associated with an increased risk for tuberculosis and progression of the disease can occur in the absence of further silica exposure. Factors that determine the progression of disease include silica dust concentrations and duration of exposure. Neither the risk of developing silicosis nor the progression of the radiographic lesions of silicosis is associated with smoking behavior.(11)

Because silicosis is a potentially severe disease and was one of the most common occupational health problems, OSHA, NIOSH, and ACGIH have all issued criteria for limiting exposures. The OSHA PEL is currently set at 0.1 mg/m^3 for most forms of crystalline silica.(2) The ACGIH TLV for quartz silica is also 0.1 mg/m^3.(3)

In 1987, the International Agency for Research on Cancer (IARC) reviewed the published data on silica and concluded that there was sufficient evidence indicating that silica is an animal carcinogen and limited evidence indicating that silica is a human carcinogen (primarily to the respiratory system).(11) Because there is some evidence that crystalline silica may cause cancer as well as silicosis, NIOSH recommends that occupational exposures to crystalline silica (as quartz) be controlled so that employees are not exposed to respirable concentrations greater than 0.05 mg/m^3, determined as a TWA concentration for up to a 10-hour work shift in a 40-hour workweek.(12) Although NIOSH has established this limit which should not be exceeded, the Institute still urges that exposures to crystalline silica be reduced to the lowest feasible limit because it is not at present possible to establish thresholds for potential occupational carcinogens which will protect 100% of the population.(13)

The results of silica monitoring conducted for this HHE, which are presented in Tables III and IIIA, indicate that there is a potential for respirable silica concentrations to exceed both the NIOSH and OSHA criteria. Because of the short exposure times, however, none of the results obtained in this evaluation would constitute an actual OSHA violation.

One personal breathing-zone air sample did exceed the NIOSH REL for crystalline silica of 0.05 mg/m^3, TWA for up to a 10-hour workday.

Although NIOSH has established this REL, exposures should still be reduced to their lowest feasible limits since NIOSH considers crystalline silica to be a potential occupational carcinogen.

MERCURY

Mercury is a silvery-white metal which exists as a liquid at room temperature. It is used in thermometers, barometers, batteries, and other consumer products, and therefore could reasonably be expected in municipal refuse. Because elemental mercury is highly volatile, most of it is probably driven off as a vapor and it seems unlikely that high concentrations would be found in the ash.

Excessive exposure to mercury has been associated with a variety of health problems. The most common adverse effects are associated with neurological problems and include muscular tremors and personality changes such as increased irritability.(6) Because occupational exposures to mercury were relatively common in the past, OSHA and NIOSH have both issued criteria for limiting occupational exposures. In this case the OSHA PEL and NIOSH REL are both set at 0.1 mg/m^3 as an 8-hour TWA concentration.(2,14)

As shown in Table IV, most of the air samples collected for analysis of mercury did not find any measurable vapor or particulate. One sample did contain mercury particulate at 0.2 mg/m^3, a level twice the NIOSH and OSHA limits. As with the silica results discussed earlier, the short-term exposures associated with the clean-out, when averaged over an 8-hour workday, would keep employees' exposures within acceptable limits. Although these data do not document any overexposure to mercury, they do show that mercury exposures are a possibility.

CONCLUSIONS

During the incinerator clean-out, a significant amount of ash and other particles become airborne and create a dense cloud inside the furnace. Air sampling data presented in the preceding paragraphs shows that potentially high concentrations of lead, crystalline silica, mercury, and possibly other metals can be generated. Another factor to be considered in examining the exposures to workers performing the incinerator clean-out is that the changing composition of municipal refuse from week to week will alter the elemental content of the ash.

Despite the high short-term concentrations, the measured exposures generally did not exceed OSHA or NIOSH criteria when calculated over an 8-hour TWA exposure period. In several short-term air samples, however, personal exposures did exceed either an OSHA PEL (for total dust) or a NIOSH REL (for crystalline silica). These overexposures, it should be stressed, remain even when the concentrations are averaged over an 8- to 10-hour work day. Although short-term exposures of this type are not expected to produce occupational disease among otherwise healthy workers, conditions could and should be improved.

RECOMMENDATIONS

Exposures to dust could be reduced through improved work practices and by more extensive use of personal protective equipment. Specific recommendations are listed here:

1. In order to reduce dust levels, the ash should be sprayed with water before employees enter the furnace to sweep the grates. A light spray of water could be applied from the door at the top of the inclined grate. The use of water to suppress dust during sweeping or other cleaning operations is a fairly standard technique in many industries, and it should be applicable here.

2. Employees and management should determine whether the direction of air movement inside the furnace can be controlled by opening and closing doors and/or by running the induced draft fan. The direction of air should be controlled so dust is carried from the high end of the grate down toward the low end. In general, policies and procedures should be developed that keep employees working "up-wind" of the dust.

3. Because total dust levels in the under-fire area were high, workers should not enter until after the upper chamber is completely cleaned.

4. Based on NIOSH criteria, a potential exists for workers to be overexposed to crystalline silica during the incinerator clean-up operations. Because crystalline silica is considered a suspected human carcinogen, NIOSH recommends that only the most reliable and protective respirators be used. These include (1) a self-contained breathing apparatus (SCBA) that has a full facepiece and is operated in a positive-pressure mode, or (2) a supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode.

   If airline respirators or SCBAs are not feasible for this operation, an alternative (based on OSHA criteria which does not yet consider crystalline silica to be a suspected human carcinogen) would be to provide employees performing the weekly incinerator clean-out with NIOSH approved half-mask respirators equipped with particulate filters. These respirators would replace the disposable dust masks that are currently worn by the employees. Full-face piece respirators equipped with particulate filters could also be used which would offer both a higher protection factor than half-mask respirators and provide eye protection for the wearer. Regardless of the type of respirator(s) chosen, a respirator program that meets the OSHA requirements found in the General Industry Standard, 29 Code of Federal Regulation Part 1910.134 should be implemented. Standard operating procedures should be developed concerning respirator use, maintenance, selection, fit-testing, and storage.

5. Management should provide additional protective equipment including goggles and disposable coveralls. Due to the lead content of the ash, workers should shower and change before leaving the work site. This will help minimize possible exposures to employees and their families that could occur at home.

6. In addition to the health hazards that might be associated with exposure to ash, there are also potential safety hazards associated with cleaning the under-fire area. In particular, the person entering the under-fire area should be required to wear a safety line, and a "buddy system" that prohibits working alone should be instituted. In addition, some workers described incidents in which hot ash was blown back toward the workers when the under-fire area was opened. Although this investigation did not allow us to develop a recommended procedure that would prevent this, the issue should be addressed by employees and management.

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2. Confidential Requester
3. OSHA, Region V
4. NIOSH, Cincinnati

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table I
Metal Content Of Bulk Ash Samples
Expressed As Percent of Total Weight

Grosse Pointes - Clinton Refuse Disposal Authority
Mount Clemens, Michigan
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Sample Location	Cadmium	Nickel	Chromium	Zinc	Lead
North furnace under-fire area	0.002	0.012	0.014	0.350	0.130
South furnace under-fire area	0.001	0.005	0.012	0.320	0.088
South furnace combustion chamber	0.003	0.018	0.017	0.400	0.047
ESP fly ash conveyor	0.068	0.006	0.014	2.500	0.580

Table II
Average Concentrations of Total Dust and Metals

Grosse Pointes - Clinton Refuse Disposal Authority
Mount Clemens, Michigan
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Sample Location or Activity	Total Dust	Lead	Cadmium**	Nickel	Chromium	Zinc
Areas Samples						
South furnace combustion chamber	11.7	ND	ND	ND	0.010	0.05
North furnace combustion chamber	65.3*	0.04	ND	0.010	0.030	0.27
Under burner grate	78.0*	0.11*	0.003	0.003	0.070	0.36
Stairway between furnaces	0.5	ND	ND	ND	ND	ND
Personal Samples						
Supervisor	2.0	ND	ND	ND	0.004	0.01
Furnace clean-out	2.5	ND	ND	ND	ND	0.01
Furnace clean-out	6.3	0.05*	ND	ND	0.010	0.06
Furnace clean-out	57.0*	0.08*	0.002	0.010	0.030	0.30
Furnace and under-fire clean-out	6.9	0.02	ND	0.003	0.010	0.07
Furnace and under-fire clean-out	3.3	ND	ND	ND	0.003	0.02

All values are expressed in milligrams contaminant per cubic meter of air.

*Average concentration would exceed NIOSH or OSHA criteria if exposures were extended to full shift.
** Due to possible carcinogenic effects, NIOSH recommends that exposures be limited to the lowest feasible limit.

Table IIA
Eight-Hour Time Weighted Average
Concentrations of Total Dust and Metals

Grosse Pointes - Clinton Refuse Disposal Authority
Mount Clemens, Michigan
HETA 90-348

Sample Location or Activity	Total Dust	Lead	Cadmium**	Nickel	Chromium	Zinc
Areas Samples						
South furnace combustion chamber	0.9	ND	ND	ND	0.001	0.004
North furnace combustion chamber	11.8	0.01	ND	0.002	0.005	0.050
Under burner grate	19.5*	0.03	ND	0.001	0.018	0.090
Stairway between furnaces	0.1	ND	ND	ND	ND	ND
Personal Samples						
Supervisor	0.46	ND	ND	ND	0.001	0.002
Furnace clean-out	0.60	ND	ND	ND	ND	0.024
Furnace clean-out	2.20	0.02	ND	ND	0.004	0.021
Furnace clean-out	20.50*	0.03	0.001	0.004	0.011	0.110
Furnace and under-fire clean-out	1.70	0.01	ND	0.001	0.002	0.017
Furnace and under-fire clean-out	0.82	ND	ND	ND	0.001	0.005

Evaluation Criteria		Total Dust	Lead	Cadmium	Nickel	Chromium	Zinc
	NIOSH	--	<0.1+	LFL**	0.015	0.5	5++
	OSHA	15	0.05	0.2	1	1	10++
	ACGIH	10	0.15	0.05	1	0.5	10++

All values are expressed in milligrams contaminant per cubic meter of air.

*Measured exposure exceeds NIOSH or OSHA criteria.
** Due to possible carcinogenic effects, NIOSH recommends that exposures be limited to the lowest feasible limit.
+Air level to be maintained so that worker blood levels remain <0.060 mg/100g of whole blood.
++criteria based on zinc oxide.

Table III
Average Concentrations of Respirable Dust and Silica

Grosse Pointes - Clinton Refuse Disposal Authority
Mount Clemens, Michigan
HETA 90-348

Sample Location or Activity	Dust	Quartz	Cristobalite
Area Samples			
South furnace combustion chamber	1.0	ND	0.3*
North furnace combustion chamber	4.0	ND	0.2*
Under-fire area	2.8	0.1*	0.1*
Stairway between furnaces	0.1	ND	0.1*
Personal Samples			
Supervisor	0.7	ND	0.1*
Furnace clean-out	0.1	ND	0.1*
Furnace clean-out	4.2	0.1*	0.2*
Furnace clean-out	1.0	ND	0.1*
Furnace and under-fire clean-out	1.2	ND	0.1*
Furnace and under-fire clean-out	0.4	ND	0.1*

All values are expressed in milligrams contaminant per cubic meter of air.

*Average concentration would exceed NIOSH or OSHA criteria if exposures were extended to a full eight-hour shift.

Table IIIA
Eight-Hour Time Weighted Average
Concentrations of Respirable Dust and Silica

Grosse Pointes - Clinton Refuse Disposal Authority
Mount Clemens, Michigan
HETA 90-348

Sample Location or Activity	Dust	Quartz	Cristobalite
Area Samples			
South furnace combustion chamber	0.075	ND	0.02
North furnace combustion chamber	0.725	ND	0.04
Under-fire area	0.700	0.03	0.03
Stairway between furnaces	0.022	ND	0.02
Personal Samples			
Supervisor	0.160	ND	0.02
Furnace clean-out	0.024	ND	0.02
Furnace clean-out	1.409	0.03	0.07*
Furnace clean-out	0.356	ND	0.04
Furnace and under-fire clean-out	0.290	ND	0.02
Furnace and under-fire clean-out	0.098	ND	0.02

		Dust	Quartz	Cristobalite
Evaluation Criteria	NIOSH	--	0.05+	0.05+
	OSHA	5	0.1	0.05
	ACGIH	--	0.1	0.05

All values are expressed in milligrams contaminant per cubic meter of air.

*Measured exposure exceeds NIOSH criteria of 0.05.

+NIOSH considers both quartz and cristobalite to be potential occupational carcinogens.

Table IV
Analysis of Air Samples for Mercury Vapor and Particulate

Grosse Pointes - Clinton Refuse Disposal Authority
Mount Clemens, Michigan
HETA 90-348

Sample Location	Particulate	Vapor
North furnace combustion chamber	ND	ND
North furnace combustion chamber	ND	ND
South furnace combustion chamber	ND	ND
South furnace combustion chamber	0.2*	ND
Under the burner grate	ND	ND

All values are expressed in milligrams contaminant per cubic meter of air.

*Would exceed NIOSH or OSHA criteria if exposures were extended to a full for eight-hour shift.