

HETA 88-207-2195
MARCH 1992
NORTHWEST INCINERATOR
PHILADELPHIA, PENNSYLVANIA

NIOSH INVESTIGATORS:
Gregory M. Kinnes
Charles J. Bryant

I. SUMMARY

In response to a request for a Health Hazard Evaluation (HHE), a National Institute for Occupational Safety and Health (NIOSH) industrial hygienist conducted an initial site visit at the City of Philadelphia's Northwest Incinerator on June 9, 1988. A return visit was made to the incinerator on June 22-26, 1988, during which environmental sampling was conducted to determine if a potential health hazard existed from employee exposures to polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), metals, silica, total dust and respirable dust.

The Northwest Incinerator burned municipal waste and disposed of the resultant ash on sites directly adjacent to the facility. The Environmental Protection Agency (EPA) and the Agency for Toxic Substances and Disease Registry (ATSDR) had previously conducted sampling and issued a March 1988 report which recommended that the City request NIOSH to evaluate potential worker exposures.

Six air samples collected for PCDDs/PCDFs, expressed as 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin (TCDD) equivalents using the 1987 EPA criteria, ranged from 0.01 to 12.8 picograms per cubic meter (pg/m³), one of which was above the National Research Council (NRC) evaluation criteria of 10 pg/m³. Five surface wipe samples for PCDDs/PCDFs, also expressed as 2,3,7,8-TCDD equivalents using the 1987 EPA criteria, ranged from less than 0.001 to 28.2 nanograms per square meter (ng/m²). One of these samples was above the NRC guideline of 25 ng/m². Both the airborne and wipe sample results were also expressed as 2,3,7,8-TCDD equivalents using the 1989 International criteria. Using this criteria, the air samples ranged from less than 0.001 to 24.2 pg/m³ while the surface samples ranged from less than 0.001 to 47.0 ng/m². Neither the Occupational Safety and Health Administration (OSHA) nor the American Conference of Governmental Industrial Hygienists (ACGIH) have evaluation criteria for PCDDs/PCDFs. However, NIOSH does consider the 2,3,7,8-TCDD isomer to be a potential human carcinogen.

Airborne concentrations of respirable nuisance dust (27 samples) were all well below the OSHA Permissible Exposure Limit (PEL) of 5 milligrams per cubic meter (mg/m³). Trace levels of silica were also detected on two of these samples. Twenty-seven total nuisance dust samples were collected from the same employees and areas as the respirable dust samples. Airborne concentrations of total dust ranged from 0.04 to 24.34 mg/m³, which included one sample that was above the ACGIH Threshold Limit Value (TLV) of 10 mg/m³ and one sample that was above both the ACGIH TLV and the OSHA PEL of 15 mg/m³. Analysis of the samples for individual metals indicated that overexposure to both cadmium and lead occurred in one sample, while two other samples indicated overexposures to nickel. For these samples, the use of the evaluation criteria for respirable and total dust may not be entirely appropriate, because exposures to these dusts also involves potential exposure to PCDDs/PCDFs and metals.

Seven surface wipe samples collected for metals indicated that the major constituents of the surface dust were metals with relatively low toxicity. However, one sample did have a significant amount (1100 micrograms) of lead present. These surface wipe samples suggest that incinerator ash is being transported from the work areas on the surface of work clothes and shoes.

The environmental sampling data indicates that the potential exists for employee exposure to both PCDDs/PCDFs and metals via inhalation and surface contact from the incinerator ash. Other concerns, including safety issues and the use of personal protective equipment, are also discussed.

KEYWORDS: SIC 4953 (Refuse Systems), ash, incinerator, metals, silica, lead, cadmium, nickel, polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans.

II. INTRODUCTION

In March 1988, NIOSH received a joint request from the City of Philadelphia and the American Federation of State, County and Municipal Employees, District Council 33, Local 427 to evaluate potential employee exposures at the city's Northwest Incinerator. This request was submitted in response to a joint Environmental Protection Agency (EPA) and Agency for Toxic Substances and Disease Registry (ATSDR) report which recommended that NIOSH be contacted to conduct a HHE. The EPA and ATSDR had conducted sampling in 1986 and the fall of 1987 in response to community concern about possible health hazards posed by releases from the ash pile and emissions from the Northwest Incinerator. In their report, EPA and ATSDR announced that they had found no significant health hazard for the community but named workers at the incinerator as "the potentially-exposed population of most concern."

In response to this request, an initial site visit was conducted at the Northwest Incinerator on June 9, 1988. A return visit was made to the incinerator on June 22-26, 1988, during which environmental sampling was conducted to determine if a potential health hazard existed from employee exposures to polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), metals, silica, total dust and respirable dust. Preliminary environmental sampling results were distributed, as attachments, in a letter dated April 9, 1990.

III. BACKGROUND AND PROCESS DESCRIPTION

The Northwest Incinerator was built in 1959 with two furnaces, each approximately 42 feet long. Garbage is dumped into two concrete storage bins located in front of the two furnaces. Crane operators in enclosed cabs pick up loads of garbage and dump them directly into hoppers which lead to the inclined stoker and the horizontal conveyer belt inside of each combustion chamber (furnace). The two furnaces can burn approximately 700 tons of garbage per day. Both furnaces operate from 1650-1900°F with garbage as the only fuel. The emission control system for each furnace consists of a cooling tower, drying tower, and an electrostatic precipitator (ESP) which are fed by an induced draft. Both fly ash from the emission system and ash from the incinerator are quenched with water and then cooled in a residue tank. The ash is then dumped into a truck and transported to a landfill by a private contractor. Prior to July 1987, the ash was deposited on the incinerator grounds and made up the 5-acre ashpile located on the site.

IV. EVALUATION DESIGN AND SAMPLING METHODS

The environmental evaluation consisted of determining potential inhalation exposures by collecting full-shift personal breathing zone and general area air samples for PCDDs/PCDFs, total dust, respirable dust, crystalline silica, and metals. Employees were asked to wear two personal sampling pumps which were used to evaluate potential exposures to respirable dust and silica, on one sample, and total dust and metals, on the other sample. Six area samples were collected to be analyzed for PCDDs/PCDFs. Five of

these area samples were collected side-by-side with the two samples using the same sampling technique as the employee personal breathing zone samples. The sixth PCDD/PCDF sample was collected as an area sample outside an incinerator door during the slagging (cleaning) operation. Other samples were collected in various areas for respirable silica, metals, and total and respirable dust. Also, to determine the potential for dermal exposure to PCDDs/PCDFs and metals, a number of wipe samples were obtained from various working surfaces.

A. PCDDs and PCDFs

1. Air Samples

The air sampling device for PCDD/PCDF compounds consists of two stages. The first stage is a 47 millimeter (mm) glass microfiber filter (EM 2000, 0.3 micrometer) for collecting particulates. The second stage, a glass cartridge containing eight grams of 140°C activated 30/70 mesh silica gel adsorbent, is used to collect vapors. The silica gel cartridge is spiked with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin-¹³C₁₂ (TCDD) and 2,3,7,8-tetrachlorodibenzofuran-¹³C₁₂ before sampling for quantification and to account for any retention losses during sampling. The glass cartridge containing the spiked silica gel adsorbent is sealed in a rugged Teflon® housing with fluorelastomer Viton® "O" rings.

For sample collection, the sampler is placed in a vertical position and attached via Tygon tubing to a 20 liter per minute (lpm) rotary vane vacuum pump. Flow rates are regulated using precision control valves and appropriate flow measurement devices.

2. Surface Wipe Samples

A wet-wipe protocol was used to assess the surface concentrations of PCDDs/PCDFs. The surface wipe samples were collected using 3" x 3" Soxhlet-extracted cotton gauze pads which had been wetted with 8 milliliters (ml) of pesticide-grade hexane. The sampling procedure consisted of marking the boundaries of a 0.25 m² area on the desired surface and wiping this area with the gauze pad. The sample pad was held with a gloved hand; a fresh non-linear polyethylene, unplasticized glove was used for each sample. The surface was wiped in two directions (the second direction was at a 90° angle to the first direction). Each gauze pad was used to wipe only one area. The gauze pad sample was then placed in a glass sample container equipped with a Teflon-lined lid. To attain an acceptable detection limit, each PCDD/PCDF wipe sample consisted of a composite of four 0.25 m² wipe samples, for a total area of 1.0 m². Therefore, four gauze pads were placed in each container. The wipe samples are extracted with toluene for 16 hours using a Soxhlet apparatus to dissolve the PCDD and PCDF from the samples. The resulting

toluene solution is concentrated to near dryness on a rotary evaporator. An extensive purification process is then used to prepare the samples for analysis.

The air and surface samples are analyzed by a gas chromatograph/mass spectrometer equipped with a DB-5 (screening) column and by DB-17 and SP 2331 columns in tandem (for isomer confirmation). Selected ¹³C and ³⁷Cl labeled PCDD and PCDF isomers are included as internal standards and recovery (surrogate) standards.

Analyses are performed to measure total tetra-, penta-, hexa-, hepta-, and octachlorinated dibenzofurans; total tetra-, penta-, hexa-, hepta-, and octachlorinated dibenzodioxins; and specific PCDD and PCDF isomers containing chlorine substitution in the 2, 3, 7, and 8 positions. The analytical limits of detection were variable and ranged between 0.001 and 0.468 nanograms per sample.

B. Respirable Particulate and Silica

The respirable particulate and silica samples were collected on tared 37 mm, 5 micrometer (µm) PVC membrane filters mounted in 10 mm nylon Dorr-Oliver cyclones. The samples were attached via flexible Tygon tubing to personal sampling pumps calibrated to draw air through the filter at a flow rate of 1.7 lpm. High-volume air samples were also collected on PVC filters, with a stainless steel cyclone, using a Gast sampling pump operated at a flow rate of 9 lpm. These samples were collected to provide a reference for the analysis of the silica content. The samples were analyzed for total weight by gravimetric analysis according to NIOSH Method 0500⁽¹⁾ with two modifications. The filters were stored in an environmentally controlled room to reduce the stabilization time between tare weighings to 5-10 minutes, and the filters and backup pads were not vacuum desiccated. The instrumental precision of the weighings was 0.01 mg.

After analysis for total weight, the samples were then analyzed for silica (quartz and cristobalite) using x-ray diffraction. NIOSH Method 7500 was used with the following modifications: 1) filters were dissolved in tetrahydrofuran rather than being ashed in a furnace; and 2) standards and samples were run concurrently and an external calibration curve was prepared from the integrated intensities rather than using the suggested normalization procedure.

C. Total Particulate and Metals

1. Air Samples

These samples were collected using the same method as the respirable samples with one modification. The nylon cyclone, which separates respirable particulates from the total fraction, was not used in the sample train. These samples were then analyzed for total weight using the same method. High-volume air samples were also collected, without the use of the stainless steel cyclone, to provide a reference during the analysis for metal content.

After the total weight was determined, the samples were analyzed for metals using NIOSH Method 7300. Samples were diluted to 25 ml after digestion. A Thermo Jarrell Ash ICAP 61 simultaneous scanning inductively coupled plasma emission spectrometer controlled by an IBM Personal Computer-AT was used for all measurements. The analytical limits of detection (LOD) for this method are listed below:

LIMITS OF DETECTION (Micrograms per Filter)

Analyte	LOD (:g/filter)	Analyte	LOD (:g/filter)
Aluminum	10	Lead	2
Arsenic	5	Phosphorous	10
Barium	1	Platinum	10
Beryllium	1	Selenium	10
Calcium	5	Silver	2
Cadmium	1	Sodium	50
Cobalt	1	Tin	10
Chromium	1	Tellurium	10
Copper	1	Thallium	10
Iron	1	Titanium	10
Lithium	5	Tungsten	10
Magnesium	1	Vanadium	1
Manganese	1	Yttrium	1
Molybdenum	1	Zinc	1
Nickel	1	Zirconium	10

2. Wipe Samples

Wet-wipe samples were collected to detect the presence of metals on surfaces using gauze saturated with deionized water. Surfaces were wiped down and the gauze pads were then placed in glass sample containers. These samples were then analyzed using the same methods as used for the air samples. The analytical LODs were the same as above.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to 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 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 criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are:

1) NIOSH Recommended Exposure Limits (RELs),⁽²⁾ 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs)⁽³⁾, and 3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).⁽⁴⁾ The OSHA PELs may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH RELs, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that the most stringent standard was used; however, industry is legally required to meet those levels specified by the OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

A. PCDDs/PCDFs

PCDDs and PCDFs are two series of tricyclic aromatic compounds. The number of chlorine atoms can vary between 1 and 8 (mono- through octa-chloro homologs), resulting in 75 PCDDs and 135 PCDF positional isomers.

The toxic effects of these compounds are associated with the number and specific placement of the chlorine atoms in the molecule. The tetra-, penta- and hexachlorinated isomer groups exhibit greater toxicity than the other chlorinated forms.⁽⁵⁻⁷⁾ PCDDs and PCDFs with chlorine at positions 2,3,7, and 8 are particularly toxic.⁽⁸⁻¹⁰⁾ PCDDs and PCDFs are highly toxic in experimental animals when administered acutely, subchronically, or chronically.⁽¹⁰⁻¹⁸⁾ Toxic effects include severe weight loss, liver necrosis and hypertrophy, skin lesions, immunosuppression, reproductive toxicity, teratogenesis and death. Of the 75 PCDD and 135 PCDF isomers, only 2,3,7,8-TCDD and a mixture of hexachlorinated dibenzo-*p*-dioxins with four of the six chlorines in positions 2,3,7, and 8 have been tested for carcinogenicity. Two independent studies of 2,3,7,8-TCDD showed significant increases in the incidence of liver and/or lung tumors in exposed rodents.^(18,19) A mixture of two 2,3,7,8-substituted hexachlorinated dibenzodioxins was found to produce an increased incidence of liver tumors or neoplastic nodules in exposed rats and mice.⁽²⁰⁾ Exposure to PCDD can cause chloracne and liver toxicity in humans.^(16,21) There is suggestive evidence of an association between increased incidence of cancer in people exposed to PCB containing substantial amounts of PCDF^(22,23) and in people exposed to phenoxyacetic herbicides contaminated with PCDD, including TCDD.^(24,25) Due to the inadequately defined study populations and the influences of mixed exposures, definite causal relationships between exposure and carcinogenic effects in humans remain unclear.

NIOSH recommends that 2,3,7,8-TCDD be regarded as a potential occupational carcinogen, that occupational exposure to 2,3,7,8-TCDD be controlled to the lowest feasible level, and that decontamination measures be used for 2,3,7,8-TCDD-contaminated work environments. This recommendation is based on a number of reliable studies demonstrating carcinogenicity in rats and mice.⁽¹⁶⁾

Air and surface guideline criteria for PCDDs/PCDFs are expressed as 2,3,7,8-TCDD equivalents. 2,3,7,8-TCDD equivalents are defined as the concentration of 2,3,7,8-TCDD which, by itself, would exhibit the same biological potency as the mixture of structurally-related compounds, PCDDs and PCDFs, actually present in a sample. The structurally-related PCDDs and PCDFs that are considered in the calculation of 2,3,7,8-TCDD equivalents include the tetra- through octachloro homologs and 2,3,7,8-substituted isomers.⁽²⁶⁾

This procedure, initially developed by the New York State Department of Health, estimates the amount of 2,3,7,8-TCDD that would have to be present to exhibit a similar toxicity as the measured amounts of all of the other PCDDs and PCDFs. The procedure assumes certain weighting factors (ratios of toxicities) between 2,3,7,8-TCDD and the other PCDDs and PCDFs.⁽²⁷⁾ The weighting factors (called toxicity equivalency factors [TEFs] by EPA) were those proposed in 1987 by the EPA

(Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Dibenzo-p-Dioxins and Dibenzofurans [CDDs and CDFs], Risk Assessment Forum, EPA 625/3-87/012, 1987). In a 1989 update to this document, the EPA adopted the International TEFs. Both the 1987 EPA and 1989 International TEFs are listed below:

TOXICITY EQUIVALENCY FACTORS

Compound	EPA-TEFs/87	I-TEFs/89
Mono-,Di-, and TriCDDs	0	0
2,3,7,8-TCDD	1	1
Other TCDDs	0.01	0
2,3,7,8-PeCDD	0.5	0.5
Other PeCDDs	0.005	0
2,3,7,8-HxCDDs	0.04	0.1
Other HxCDDs	0.0004	0
2,3,7,8-HpCDDs	0.001	0.01
Other HpCDDs	0.00001	0
OCDD	0	0.001
Mono-,Di-, and TriCDFs	0	0
2,3,7,8-TCDF	0.1	0.1
Other TCDFs	0.001	0
1,2,3,7,8-PeCDF	0.1	0.05
2,3,4,7,8-PeCDF	0.1	0.5
Other PeCDFs	0.001	0
2,3,7,8-HxCDFs	0.01	0.1
Other HxCDFs	0.0001	0
2,3,7,8-HpCDFs	0.001	0.01
Other HpCDFs	0.00001	0
OCDF	0	0.001

The concentrations of the PCDD and PCDF compounds are converted to TCDD equivalents by multiplying measured values by the appropriate factor. The TCDD equivalents are then summed and compared to the guideline value.

The dioxin subcommittee of the National Research Council (NRC) released a report on acceptable levels of dioxin contamination in office buildings following transformer fires.⁽²⁸⁾ The exposure guidelines adopted by the subcommittee were 10 pg/m³ for air and 25 ng/m² for surfaces expressed as 2,3,7,8-TCDD equivalents calculated using the 1987 EPA TEFs. Reported lifetime cancer risk estimates were 9×10^{-8} to 2×10^{-4} at the recommended guideline. Risks correspond to a single source contamination, either air or surface. Risks and exposures for simultaneous exposure are additive. For example, risks apply for exposure to 10 pg/m³ of air only, 25 ng/m² of surface only, or 5 pg/m³ of air plus 12.5 ng/m² of surface. Simultaneous exposure at 10 pg/m³ of air and 25 ng/m² of surface implies risks twice as large as given values.

B. Substance-Specific Evaluation Criteria and Health Effects Summary

A list of the remaining contaminants evaluated in this survey is presented in Table I, along with a brief summary of their primary health effects. For trace metals, only those elements which have the greatest toxicological significance are included in the table. The evaluation criteria for these contaminants are included in Tables III and V.

VI. RESULTS AND DISCUSSION

Five surface wipe samples (Table II) were collected for tetra- through octa-chlorinated PCDD and PCDF homologs and the 2,3,7,8-tetra isomers. The calculated concentrations of TCDD-equivalents using the 1987 EPA TEFs ranged from less than 0.001 to 28.2 ng/m², with one of the samples above the NRC guideline of 25 ng/m². These concentrations ranged from less than 0.001 to 47.0 ng/m² when calculated using the 1989 International TEFs. These samples were collected from the main office, lunchroom, change room, incinerator floor and hotel room. The sample that was at the NRC guideline was collected from the center of the incinerator building floor, an area with the highest probability of PCDD/PCDF contamination. A background sample (less than 0.001 ng/m²) was also collected from the investigator's hotel. The remaining samples were collected from areas where PCDD/PCDF contamination should not be present if proper control measures were taken. The results for these samples indicated that PCDDs/PCDFs were being transported to the office, lunchroom, and change room via air or on the clothes and shoes of employees. Presence of PCDD/PCDF contamination on a table top in the lunchroom indicates that there may have been a potential for ingestion of contaminants.

Six general area air samples (Table II) were collected for tetra- through octa-chlorinated PCDD and PCDF homologs and the 2,3,7,8-tetra isomers. The collection of personal samples was impracticable due to the size of the sampling media. The calculated concentrations of TCDD-equivalents ranged from 0.01 to 12.8 pg/m³ using the 1987 EPA TEFs and less than 0.001 to 24.2 pg/m³ using the 1989 International TEFs. The sample with the highest concentration (12.8 pg/m³) was collected during furnace cleaning from outside an open incinerator door. This sample was collected over the entire shift (8 hrs) and was above the NRC guideline of 10.0 pg/m³. However, employees performing this function were wearing airline respirators during the time that this sample was collected. Another sample, collected from the Southside ashpile, had a concentration of 2.3 pg/m³. The remaining samples had concentrations below

0.2 pg/m³, which included samples collected from the center of the incinerator area (0.2 pg/m³), the Northside ashpile (0.01 pg/m³), and the East Central Incinerator (0.01 pg/m³). The ambient concentration was determined to be 0.01 pg/m³ from a sample collected in a Chestnut Hill residential yard. Although all of the above samples had detectable levels of PCDDs/PCDFs, expressed as TCDD-equivalents, no 2,3,7,8-TCDD was detected on any of these airborne samples.

The results of the environmental sampling for respirable dust and silica are presented in Table III. The airborne concentrations of respirable dust (15 personal breathing zone and 12 general area) ranged from 0.01 to 0.72 mg/m³ with a mean concentration of 0.17 mg/m³. The 15 personal samples ranged from 0.02 to 0.72 mg/m³, while the 12 general area samples ranged from 0.01 to 0.18 mg/m³. The three highest personal airborne concentrations occurred during duct cleaning (0.63 mg/m³), furnace slagging (0.71 mg/m³), and cooling tower washing (0.72 mg/m³). These are tasks that employees perform as part of the weekly general maintenance. All the samples were below the OSHA PEL for respirable dust; however, the use of the evaluation criteria for the respirable dust and total dust, as discussed later, may not be entirely appropriate, because potential exposure to these dusts also involves potential exposure to PCDDs/PCDFs and metals. These air samples were also analyzed for respirable silica content; however, only two of the samples had trace levels detected. These trace levels were somewhere between the analytical LOD and limit of quantitation which corresponded to air concentrations ranging from approximately 0.018-0.036 mg/m³.

Table IV presents the results of the surface wipe samples for metals. These results indicate either that metals were present in the air (at some point in time) at those locations or that metals are being transported (shoe and clothing surfaces, etc.) from one area to another. The results of these wipe samples indicated that the major constituents of the surface dust consisted of aluminum, calcium, iron, magnesium, phosphorous, sodium and zinc. The surfaces with the most metal present were the incinerator floor and the bulldozer hand controls. These samples had significantly higher amounts of all the metals identified. The samples taken from these surfaces also had small amounts of cadmium and chromium. The incinerator floor sample also had a significant amount of lead and detected the presence of arsenic. While the wipe samples collected from the office, lunchroom and change room revealed a consistent presence of metals in smaller amounts, the samples still indicate that metals are being transported on the surface of work clothes and shoes. These samples also indicate that ingestion of these metals can potentially occur.

The results for airborne metals, including total dust, are presented in Table V. A total of 27 samples were collected from the same employees and areas as sampled for the respirable dust. This included 15 personal breathing zone and 12 general area air samples. All the samples were weighed to obtain the total amount of particulate and then analyzed for metal content. The airborne concentrations of total dust ranged from 0.04 to 24.34 mg/m³, which included one sample that was above the ACGIH TLV of 10 mg/m³ and one sample that was above both the ACGIH TLV and the OSHA PEL of 15 mg/m³. The sample that was above both criteria was collected from a laborer, and the sample above the ACGIH TLV was collected from a worker during furnace slagging. Another total dust sample (9.4 mg/m³), collected from a plant helper during the washing of a cooling tower, was near the TLV. None of the remaining samples had airborne concentrations greater than 3.3 mg/m³.

Analysis of the samples for individual metals indicated that overexposure to both cadmium and lead occurred in one sample, while two other samples indicated overexposure to nickel. The sample which indicated overexposure to both cadmium and lead was collected from the same laborer whose exposure to total dust was 24.34 mg/m³. The metal analyses indicated that this laborer had exposures to cadmium of 0.021 mg/m³ and lead of 0.49 mg/m³. The airborne concentration of cadmium was above the ACGIH TLV of 0.01 mg/m³ but below the OSHA PEL of 0.2 mg/m³. NIOSH considers cadmium to be a potential human carcinogen and recommends that exposure be reduced to the lowest feasible concentration. The airborne concentration of lead for this sample was also above the OSHA PEL of 0.05 mg/m³. The samples which indicated overexposure to nickel were collected from another laborer (0.034 mg/m³) and an area on the northside ashpile (0.026 mg/m³). Both of these samples were above the NIOSH REL of 0.015 mg/m³, but below both the ACGIH TLV and OSHA PEL of 1.0 mg/m³. However, NIOSH also considers nickel to be a potential human carcinogen, and current reasoning suggests that exposures be reduced to the lowest feasible level. Furthermore, nickel is included in the 1991-1992 ACGIH Notice of Intended Changes, which proposes a limit of 0.05 mg/m³ and lists nickel compounds as confirmed human carcinogens.

VII. CONCLUSIONS

The environmental sampling data indicates that the potential exists for employee overexposure to both PCDDs/PCDFs and metals via inhalation and surface contact from the incinerator ash.

VIII. RECOMMENDATIONS

- A. Due to the fact that the Northwest Incinerator ceased operations immediately following the NIOSH survey, traditional recommendations concerning engineering controls, work practices and the interim use of personal protective equipment will not be offered at this time. However, should the site be reopened for continued use or remediation, the following recommendations should be implemented:
1. Remediation or reopening of the site should follow all requirements in the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to ensure that personnel entering the site will be adequately protected.
 2. Should a decision be made to reopen the facility, competent industrial hygiene and safety professionals should be utilized to help establish an adequate health and safety program at this facility. This program should include provisions for the interim use of personal protective equipment until permanent engineering and administrative controls can be implemented. This program should also address reducing dust exposures, as well as safety hazards observed during the NIOSH survey (electrical, confined spaces, walking and working surfaces).
- B. The primary purpose of occupational medical surveillance is to identify excessive exposure and work-related health effects. If excessive exposure is found, measures can be taken to reduce it. Similarly, if a work-related health effect is found, the exposure should be interrupted. Since the Northwest Incinerator is no longer in operation, these reasons for medical surveillance of its (former) workers no longer apply. If early detection of a work-related disease with a long latency (time from exposure to onset of illness) would result in some benefit to the affected individual, this would be a reason to maintain medical surveillance of former workers. But some of the conditions of concern (silicosis, chronic heavy metal toxicity) are "treated" primarily by eliminating exposure, and others (certain cancers) either are not readily detectable at an early stage or are not more successfully treated even if found before the occurrence of symptoms. Thus, we have no health-based recommendations for medical surveillance of former Northwest Incinerator workers. (It is possible that some type of medical surveillance would be appropriate for exposures related to their current jobs, but our investigation was limited to the Northwest Incinerator and provided no information upon which to make any such recommendations. It is also possible that there might be other, non-medical reasons for occupational health surveillance of former workers, such as documentation of health status for economic, legal, or personal planning purposes.)

Should the Northwest Incinerator resume operation, workers should have a medical surveillance program tailored to their exposures. Appropriate substance-specific NIOSH recommendations and OSHA standards regarding medical monitoring should be followed. In addition, NIOSH has published recommendations regarding medical evaluation of employees for fitness to use respirators:

National Institute for Occupational Safety and Health. NIOSH guide to industrial respiratory protection. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1987; DHHS (NIOSH) Publication No. 87-116. Appendix E. NIOSH Respirator Decision Logic, Pages 30-39.

IX. REFERENCES

1. NIOSH [1984]. NIOSH manual of analytical methods. Vol. 3. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-100.
2. CDC [1988]. NIOSH recommendations for occupational safety and health standards 1988. Centers for Disease Control. Morbidity and Mortality Weekly Report 37, S-7.
3. ACGIH [1992]. Threshold limit values and biological exposure indices for 1991-92. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
4. OSHA [1989]. OSHA safety and health standards. 29 CFR 1910.1000. Occupational Safety and Health Administration, revised.
5. Goldstein JA [1979]. The structure-activity relationships of halogenated biphenyls as enzyme inducers. *Ann NY Acad Sci* 320:164-78.
6. Youshimura H, Youshihara S, Ozawa N, Miki M [1979]. Possible correlation between induction modes of hepatic enzymes by PCBs and their toxicity in rats. *Ann NY Acad Sci* 320:179-92.
7. Poland A, Greenlee W, Kende AS [1979]. Studies on the mechanism of action of the chlorinated dibenzo-*p*-dioxins and related compounds. *Ann NY Acad Sci* 320:214-30.
8. McConnell EE, Moore JA, Haseman JK, Harris MW [1978]. The comparative toxicity of chlorinated dibenzo-*p*-dioxins in mice and guinea pigs. *Toxicity Appl Pharmacol* 44:335-56.
9. Nagayama J, Kuroki H, Masuda Y, Kuratsune M [1983]. A comparative study of polychlorinated dibenzofurans, polychlorinated biphenyls and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin on aryl hydrocarbon hydroxylase inducing potency in rats. *Arch Toxicol* 53:177-84.
10. Yoshihara S, Nagata K, Youshimura H, Kuroki H, Masuda Y [1981]. Inductive effect on hepatic enzymes and acute toxicity of individual polychlorinated dibenzofuran congeners in rats. *Toxicol Appl Pharmacol* 59:580-8.
11. Moore JA, McConnell EE, Dalgard DW, Harris MW [1979]. Comparative toxicity of three halogenated dibenzofurans in guinea pigs, mice, and rhesus monkeys. *Ann NY Acad Sci* 320:151-63.
12. Schwetz BA, Norris JM, Sparschu GL, et al. [1973]. Toxicology of chlorinated dibenzo-*p*-dioxins. *Environ Health Perspect* 5:87-99.

13. McConnell EE, Moore JA, Dalgard DW [1978]. Toxicity of 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin in rhesus monkeys (*Macaca mulatta*) following a single oral dose. *Toxicol Appl Pharmacol* 43:175-87.
14. Garthoff LH, Cerra FE, Marks EM [1981]. Blood chemistry alterations in rats after single multiple gavage administration of polychlorinated biphenyl. *Toxicol appl Pharmacol* 60:33-44.
15. Moore JA, Gupta BN, Vos JG [1976]. Toxicity of 2,3,7,8-tetrachlorodibenzo-furan - preliminary results. In: *Proceedings of the National Conference on Polychlorinated Biphenyls*. Chicago, IL: Environmental Protection Agency, Office of Toxic Substances, EPA-560/6-75-004, pp. 77-80.
16. NIOSH [1984]. Current intelligence bulletin 40 - 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-104.
17. Hassoun E, d'Argy R, Deneker L [1984]. Teratogenicity of 2,3,7,8-tetrachloro-dibenzofuran in the mouse. *J Toxicol Environ Health* 14:337-51.
18. Kociba RJ, Keyes DG, Beyer JE, et al. [1978]. Results of a two-year chronic toxicity and oncogenicity study of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin in rats. *Toxicol Appl Pharmacol* 46:279-303.
19. NTP [1982]. Bioassay of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin for possible carcinogenicity (gavage study). Bethesda, MD and Research Triangle Park, NC: National Toxicology Program, DHHS (NIH) Publication No. 82-1765.
20. NTP [1980]. Bioassay of 1,2,3,6,7,8- and 1,2,3,7,8,9-hexachlorodibenzo-*p*-dioxin for possible carcinogenicity (gavage study). Bethesda, MD and Research Triangle Park, North Carolina: National Toxicology Program, DHHS (NIH) Publication No. 80-1758.
21. Ideo G, Bellati G, Bellobuono A, Bissanti L [1985]. Urinary D-glucaric acid excretion in the Seveso area, polluted by tetrachlorodibenzo-*p*-dioxin (TCDD): five years of experience. *Environ Health Perspect* 60:151-7.
22. Urabe H, Koda H, Asahi M [1979]. Present state of Yusho patients. *Ann NY Acad Sci* 320:273-6.
23. Kuratsune M [1976]. Epidemiologic studies on Yusho. In: Higuchi K, ed. *PCB poisoning and pollution*. Tokyo, Japan: Kodansha Ltd., pp. 9-23.
24. Hardell L, Sandstrom A [1979]. Case-control study: soft tissue sarcomas and exposure to phenoxyacetic acids or chlorophenols. *Br J Cancer* 39:711-7.
25. Hardell L [1979]. Malignant lymphoma of histiocytic type and exposure to phenoxyacetic acids or chlorophenols. *Lancet* 55-6.
26. NIOSH [1987]. Health hazard evaluation report no. HETA 85-414-1805. Cincinnati, OH: National Institute for Occupational Safety and Health.

27. Eadon G, Aldouos K, Frenkel G, et al. [1982]. Comparisons of chemical and biological data on soot samples from the Binghamton State Office building. Albany, NY: Center for Laboratories and Research, New York State Department of Health.
28. NRC [1988]. Acceptable levels of dioxin contamination in an office building following a transformer fire. National Academy Press. Washington, DC.
29. NIOSH [1975]. Criteria for a recommended standard: occupational exposure to crystalline silica. National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75-120.
30. Proctor NH, Hughes JP, and Fischman ML [1988]. Chemical hazards of the workplace. 2nd ed. Lippincott: Philadelphia.
31. NIOSH [1984]. Current intelligence bulletin 42: cadmium (Cd). National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-116.
32. Blair A, Mason TJ [1980]. Cancer mortality in the United States counties with metal electroplating industries. *Arch Environ Health* 35(2):92-94.
33. Franchini I, Magnani F, Mutti A [1983]. Mortality experience among chromeplating workers. Initial findings. *Scand J Work Environ Health* 9:247-252.
34. Royle H [1975]. Toxicity of chromic acid in the chromium plating industry. *Environ Res* 10:39-53.
35. Silverstein M, Mirer F, Kotelchuck D, Silverstein B, Bennett M [1981]. Mortality among workers in a die-casting and electroplating plant. *Scand J Work Environ Health* 7(Suppl 4):156-165.
36. Sorahan T, Burges DCL, Waterhouse JAH [1987]. A mortality study of nickel/chromium platers. *Br J Ind Med* 44:250-258.
37. NIOSH [1985]. NIOSH pocket guide to chemical hazards, 2nd printing. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 85-114.
38. NIOSH [1977]. Occupational diseases: a guide to their recognition. Revised ed. National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-181.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by: Gregory M. Kinnes, M.S.
Industrial Hygienist

Charles J. Bryant, M.S., C.I.H.
Industrial Hygienist
Industrial Hygiene Section

Field Assistance: Richard Hartle, C.I.H.
Industrial Hygienist

Larry DeArmond
Industrial Hygiene Technician
Industrial Hygiene Section

Originating Office: Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations, and Field Studies

Analytical Support: Measurements Research and Support
Branch
Division of Physical Sciences and
Engineering
Cincinnati, Ohio 45226

Triangle Laboratories, Inc.
Research Triangle Park
North Carolina 27713

DataChem Laboratories
Salt Lake City, Utah 84123

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report may be freely reproduced and are not copyrighted. Single copies of this report will be available for a period of 90 days from the date of this report from the NIOSH Publications Office, 4676 Columbia Parkway, Cincinnati, Ohio 45226. To expedite your request, include a self-address mailing label along with your written request. After this time, copies may be purchased from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161. Information regarding the NTIS stock number may be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Department of Streets, City of Philadelphia
2. American Federation of State, County, and Municipal Employees, Local 427
3. Kirschner, Walters, and Willig
4. OSHA, Region III
5. 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

Health Effects Summary

Northwest Incinerator
Philadelphia, Pennsylvania

HETA 88-207

June 23-25, 1988

Substance	Primary Health Effects
Crystalline Silica (quartz and cristobalite)	Crystalline silica or free silica causes silicosis, a disabling, progressive and sometimes fatal Crystalline pulmonary fibrosis. This disease generally occurs and following years of exposure and is characterized by nodulation in the lungs. ⁽²⁹⁾ Symptoms include cough, wheezing, shortness of breath, and non-specific chest illness. ⁽³⁰⁾ Impairment of pulmonary function is generally progressive, with the progression of symptoms often continuing after dust exposure has ceased.
Total and Respirable Particulates	Particulate samples were obtained during this survey to assess overall particulate burden. Although TLVs and PELs have been established for nuisance dusts (particulates not otherwise regulated/classified), these criteria do not apply when specific toxic elements are present, such as fly ash particles, which contain several trace metals (see below).
Aluminum	Metallic aluminum dust is considered a relatively benign "inert dust". ⁽³⁰⁾
Cadmium	NIOSH recommends that exposure to cadmium and its compounds be reduced to the lowest feasible level, as it is considered a potential carcinogen. NIOSH based this recommendation on epidemiologic evidence of a significant excess of cancer deaths among a group of cadmium production workers. ⁽³¹⁾ Chronic exposure has also been associated with gastrointestinal symptoms, emphysema, kidney disease, and rhinitis. ⁽³⁰⁾

Table I (continued)
Health Effects Summary
Northwest Incinerator
Philadelphia, Pennsylvania
HETA 88-207
June 23-25, 1988

Substance	Primary Health Effects
Chromium	Chromium (Cr) exists in a variety of chemical forms and toxicity varies among the different forms. For example, elemental chromium is relatively non-toxic. ⁽³⁰⁾ Other chromium compounds may cause skin irritation, sensitization, and allergic dermatitis. In the hexavalent form (Cr(VI)), Cr compounds are corrosive, and possibly carcinogenic. Until recently, the less water-soluble Cr(VI) forms were considered carcinogenic while the water-soluble forms were not considered carcinogenic. Recent epidemiological evidence indicates carcinogenicity among workers exposed to soluble Cr(VI) compounds. ⁽³²⁻³⁶⁾ Based on this new evidence, NIOSH recommends that all Cr(VI) compounds be considered as potential carcinogens.
Copper	Copper fumes and dust can cause irritation of the upper respiratory tract, metallic taste in the mouth, nausea, and congestion of nasal mucous membranes. ⁽³⁷⁾
Iron	Inhalation of iron oxide dust may cause a benign pneumoconiosis called siderosis. ⁽³⁸⁾
Nickel	Metallic nickel compounds cause sensitization dermatitis. ⁽³⁰⁾ NIOSH considers nickel a potential carcinogen, as nickel refining has been associated with an increased risk of nasal and lung cancer. ⁽³⁷⁾
Lead	Chronic lead exposure has resulted in nephropathy (kidney damage), gastrointestinal disturbances, anemia, and neurologic effects. ⁽³⁰⁾ These effects may be felt as weakness, fatigue, irritability, high blood pressure, mental deficiency or slowed reaction times. Lead absorption is cumulative and its elimination from the body is slow. Inhalation of lead dust and fume is the major route of lead absorption in industry, however, significant amounts of lead can be ingested from contaminated food, cigarettes or other objects. Chronic lead exposure also has been associated with infertility and fetal damage in exposed pregnant women.

Table II

Surface and Airborne Concentrations of
2,3,7,8-TCDD Equivalents

Northwest Incinerator
Philadelphia, Pennsylvania
HETA 88-207
June 23-25, 1988

Sample Description	Results using 1987 TEFs	Results using 1989 TEFs
Surface Concentrations of 2,3,7,8-TCDD Equivalents in ng/m²		
Main Office - Desk Top	0.2	0.4
Incinerator Floor - Center	28.2	47.0
Lunchroom - Tabletop	0.4	0.8
Change Room - Bench	0.3	0.8
Background (Hotel Room)	<0.001	<0.001
Airborne Concentrations of 2,3,7,8-TCDD Equivalents in pg/m³		
Incinerator Area - Center	0.2	0.2
Southside Ashpile - Service Building	1.8	2.3
Northside Ashpile - Service Building	0.01	<0.001
Ambient (Chestnut Hill)	0.01	0.06
East Central Incinerator - Eastside	0.01	<0.001
Outside Open Incinerator Door (while cleaning)	12.8	24.2
Evaluation Criteria: National Research Council Surface - 25.0 ng/m ² Airborne - 10.0 pg/m³		

TCDD - Tetra chlorinated dibenzo-*p*-dioxin.
1987 TEFs - U.S. Environmental Protection Agency Toxicity Equivalency Factors.
1989 TEFs - International Toxicity Equivalency Factors.
ng/m² - nanograms per square meter of surface area.
pg/m³ - picograms per cubic meter of air.

Table III
 Airborne Concentrations of Respirable Dust and Respirable Silica Dust
 Northwest Incinerator, Philadelphia, Pennsylvania
 HETA 88-207 / June 23-25, 1988

Type-Location/Job	Respirable Dust (mg/m ³)	Respirable Silica (mg/m ³)
<u>June 23, 1988</u>		
PBZ, Mechanic #1	0.09	ND
PBZ, Furnace Operator (Plant Helper #2)	0.02	ND
Area, Main Office	0.06	ND
Area, Incinerator Room	0.06	ND
PBZ, Bulldozer Operator	0.40	Trace
PBZ, Truck Driver	0.17	ND
PBZ, Plant Helper #1	0.19	ND
PBZ, Laborer	0.09	ND
Area, Lunchroom (Top of Refrigerator)	0.05	ND
Area, Northside Ashpile (Dioxin Samplers)	0.07	ND
Area, Southside Ashpile (Dioxin Samplers)	0.18	ND
<u>June 24, 1988</u>		
Area, Overhead Crane Operator	0.08	ND
PBZ, Plant Helper #1	0.07	ND
PBZ, Mechanic	0.10	ND
PBZ, Plant Helper #2	0.12	ND
PBZ, Truck Driver	0.09	ND
PBZ, Laborer	0.32	ND
PBZ, Bulldozer Operator	0.07	ND
Area, Office	0.08	ND
Area, Incinerator Room	0.06	ND
Area, Lunchroom (Top of Refrigerator)	0.05	ND
Area, Ambient (Chestnut Hills)	0.01	ND
Area, East-Central Incinerator	0.04	ND
<u>June 25, 1988</u>		
PBZ, Cooling Tower Cleaning	0.72	ND
PBZ, Slagging Furnaces	0.71	ND
PBZ, Cleaning Ducts	0.63	Trace
Area, Between Incinerators	0.11	ND
Evaluation Criteria:	NIOSH	0.05
	ACGIH	0.05-0.1*
	OSHA	0.05-0.1*

mg/m³ = milligrams of substance per cubic meter of air

ND = none detected

Trace = substances were present in trace quantities, between the LOD (0.015) and LOQ (0.03). Atmospheric concentration range of 0.018-0.036 mg/m³ with air sample volume of 816 liters.

* = cristobalite (0.05), quartz (0.1)

PBZ = personal breathing zone

Table IV

Wipe Samples for Metals

Northwest Incinerator
Philadelphia, Pennsylvania
HETA 88-207
June 23-25, 1988

Location	Metals ug/Wipe Sample*						
	AL	AS	BA	CA	CD	CO	CR
Office - Desktop	41	ND	1	150	ND	ND	ND
Incinerator - Middle Floor	10000	12	55	23000	78	6	110
Lunchroom - Tabletop	110	ND	5	300	ND	ND	1
Changeroom - Benchtopy	330	ND	15	910	1	ND	3
Bulldozer - Hand Controls	680	ND	15	990	5	ND	8
Bulldozer - Hand Controls	2900	ND	67	4400	8	2	33
Ambient - Hotel Room	17	ND	ND	47	ND	ND	ND

Location	Metals ug/Wipe Sample*						
	CU	FE	LI	MG	MN	MO	NI
Office - Desktop	5	71	ND	35	2	ND	ND
Incinerator - Middle Floor	200	4300	9	4700	230	2	17
Lunchroom - Tabletop	11	140	ND	75	3	ND	ND
Changeroom - Benchtopy	18	520	ND	210	10	ND	1
Bulldozer - Hand Controls	63	1700	ND	270	21	ND	15
Bulldozer - Hand Controls	320	7500	ND	1200	91	ND	18
Ambient - Hotel Room	ND	13	ND	17	ND	ND	ND

* = Concentrations of the various metals are presented in micrograms per sample. AL-aluminum, AS-arsenic, BA-barium, CA-calcium, CD-cadmium, CO-cobalt, CR-chromium, CU-copper, FE-iron, LI-lithium, MG-magnesium, MN-manganese, MO-molybdenum, NI-nickel.

ND = Non-detectable

Table IV (Continued)

Wipe Samples for Metals

Northwest Incinerator
Philadelphia, Pennsylvania
HETA 88-207
June 23-25, 1988

Location	Metals ug/Wipe Sample*						
	PB	P	AG	NA	SN	TL	TI
Office - Desktop	5	ND	ND	350	ND	ND	ND
Incinerator - Middle Floor	1100	1000	2	8500	ND	110	240
Lunchroom - Tabletop	16	31	ND	510	ND	ND	ND
Changeroom - Benchtopy	59	76	ND	460	ND	17	19
Bulldozer - Hand Controls	56	66	ND	450	ND	45	37
Bulldozer - Hand Controls	260	340	ND	1200	27	180	130
Ambient - Hotel Room	ND	33	ND	190	ND	ND	ND

Location	Metals ug/Wipe Sample*			
	W	V	Y	ZN
Office - Desktop	ND	ND	ND	16
Incinerator - Middle Floor	88	13	3	4200
Lunchroom - Tabletop	ND	ND	ND	30
Changeroom - Benchtopy	ND	ND	ND	110
Bulldozer - Hand Controls	ND	ND	ND	160
Bulldozer - Hand Controls	13	3	ND	580
Ambient - Hotel Room	ND	ND	ND	2

* = Concentrations of the various metals are presented in micrograms per sample. W-tungsten, V-vanadium, Y-yttrium, Z-zinc, PB-lead, P-phosphorus, AG-silver, NA-sodium, SN-tin, TL-thallium, TI-titanium.
ND = Non-detectable

Table V
 Samples for Airborne Metals
 Northwest Incinerator
 Philadelphia, Pennsylvania
 HETA 88-207
 June 23-25, 1988

Location/Job	Sampling Period	T.W.	Airborne Concentrations of Metals (mg/m ³)																
			AL	BA	CA	CD	CO	CR	CU	FE	MG	MN	NI	PB	P	NA	TI	W	ZN
PBZ, Mechanic #1	08:17 - 15:32	0.47	ND	ND	0.023	ND	ND	ND	ND	0.01	0.006	ND	ND	ND	ND	ND	ND	ND	0.002
PBZ, Furnace Operator (Helper #2)	08:28 - 16:20	0.73	0.03	0.001	0.06	ND	ND	ND	ND	0.01	0.01	ND	ND	0.003	ND	ND	ND	ND	0.005
Area, Main Office	08:33 - 16:30	0.09	ND	ND	0.006	ND	ND	ND	ND	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND
Area, Incinerator Room	08:48 - 16:57	0.11	ND	ND	0.009	ND	ND	ND	ND	0.002	0.001	ND	ND	0.003	ND	ND	ND	ND	0.006
PBZ, Bulldozer Operator	08:09 - 14:14	3.11	0.14	0.003	0.16	ND	ND	0.001	0.005	0.22	0.04	0.004	ND	0.009	ND	ND	ND	ND	0.027
PBZ, Truck Driver	08:10 - 16:06	0.69	0.02	ND	0.04	ND	ND	ND	ND	0.036	0.009	ND	ND	ND	ND	ND	ND	ND	0.006
PBZ, Plant Helper #1	08:14 - 15:45	0.21	ND	ND	0.007	ND	ND	ND	ND	0.007	0.001	ND	ND	ND	ND	ND	ND	ND	0.001
PBZ, Laborer	08:15 - 13:42	0.50	ND	ND	0.043	ND	ND	ND	ND	0.009	0.007	ND	0.034	ND	ND	ND	ND	ND	0.003
Area, Lunchroom (Top Refrigerator)	08:52 - 16:54	0.09	ND	ND	ND	ND	ND	ND	ND	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND
Area, Northside Ashpile	10:15 - 18:05	0.04	ND	ND	0.011	ND	ND	ND	0.014	0.019	0.003	ND	0.026	ND	ND	ND	ND	ND	0.002
Area, Southside Ashpile	10:20 - 18:05	0.98	0.05	ND	0.048	ND	ND	ND	0.003	0.054	0.011	ND	0.003	0.003	ND	ND	ND	ND	0.009
Area, Overhead Crane Operator	08:10 - 16:17	0.33	ND	ND	0.042	ND	ND	ND	ND	0.007	0.008	ND	ND	ND	ND	ND	ND	ND	ND
PBZ, Plant Helper #1	08:20 - 16:13	0.22	ND	ND	0.01	ND	ND	ND	ND	0.007	0.002	ND	0.001	ND	ND	ND	ND	ND	0.003
PBZ, Mechanic	08:22 - 15:42	0.29	ND	ND	0.019	ND	ND	ND	ND	0.008	0.003	ND	ND	ND	ND	ND	ND	ND	0.001
PBZ, Plant Helper #2	08:23 - 12:37	2.08	0.07	0.002	0.24	ND	ND	0.002	ND	0.042	0.04	0.002	0.013	0.013	ND	ND	ND	ND	0.02
Evaluation Criteria:	ACGIH	10	10	0.5	10	0.01	0.05	0.05	1.0	5.0	10	5	0.05	0.15	0.1	-	10.0	1.0	10.0
	OSHA	15	15	0.5	15	0.2	0.2	1.0	1.0	10.0	10	5	0.1	0.05	0.1	-	10.0	1.0	10.0
	NIOSH	-	-	-	-	LFL	-	-	-	-	-	-	0.015	-	-	-	-	1.0	-

mg/m³ = milligrams of substance per cubic meter of air, T.W. = total airborne particulate, ND = none detected, PBZ = personal breathing zone, LFL = lowest feasible level
 T.W.-total particulate weight, AL-aluminum, BA-barium, CA-calcium, CD-cadmium, CO-cobalt, CR-chromium, CU-copper, FE-iron, MG-magnesium, MN-manganese, NI-nickel, PB-lead,
 P-phosphorus, NA-sodium, TI-titanium, W-tungsten, ZN-zinc

Table V (Continued)

Samples for Airborne Metals

Northwest Incinerator
Philadelphia, Pennsylvania
HETA 88-207
June 23-25, 1988

Location/Job	Sampling Period	T.W.	Airborne Concentrations of Metals (mg/m ³)																
			AL	BA	CA	CD	CO	CR	CU	FE	MG	MN	NI	PB	P	NA	TI	W	ZN
PBZ, Truck Driver	08:25 - 15:48	0.32	ND	ND	ND	ND	ND	ND	ND	0.01	0.002	ND	ND	ND	ND	ND	ND	ND	0.001
PBZ, Laborer	08:30 - 15:18	24.34	0.82	0.02	1.47	0.021	ND	0.013	0.021	0.22	0.29	0.015	ND	0.49	ND	1.07	0.033	0.024	1.20
PBZ, Bulldozer Operator	08:32 - 14:05	0.6	0.02	ND	0.03	ND	ND	ND	ND	0.05	0.005	ND	ND	ND	ND	ND	ND	ND	0.005
Area, Office	08:45 - 17:11	0.11	ND	ND	0.006	ND	ND	0.001	ND	0.003	0.001	ND	ND	ND	ND	ND	ND	ND	ND
Area, Incinerator Room	08:58 - 17:06	0.6	0.015	ND	0.034	ND	ND	ND	ND	0.007	0.007	ND	ND	0.013	ND	ND	ND	ND	0.028
Area, Lunchroom (Top Refrigerator)	09:01 - 17:07	0.13	ND	ND	0.006	ND	ND	ND	ND	0.005	ND	ND	ND	ND	ND	ND	ND	ND	0.001
Area, Ambient (Chestnut Hills)	09:15 - 17:16	0.06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Area, East Central Incinerator	15:10 - 23:30	0.1	ND	ND	0.006	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND	ND	ND	ND	ND
PBZ, Plant Helper #2	09:00 - 14:35	9.4	0.54	0.012	1.03	ND	ND	0.012	0.004	0.28	0.21	0.013	0.003	0.02	0.083	0.224	0.11	ND	0.164
PBZ, Slag Furnaces	09:02 - 14:35	10.8	0.62	0.015	1.37	ND	ND	0.015	0.006	0.195	0.27	0.013	0.002	0.015	0.111	0.210	0.126	ND	0.126
PBZ, Cleaning Ducts	09:05 - 15:05	3.3	0.07	0.002	0.25	ND	ND	0.002	ND	0.25	0.043	0.003	ND	0.012	ND	ND	ND	ND	0.025
Area, Between Incinerators	09:20 - 16:30	0.6	0.01	ND	0.03	ND	ND	ND	ND	0.012	0.006	ND	ND	0.010	ND	ND	ND	ND	0.019
Evaluation Criteria:	ACGIH	10	10	0.5	10	0.01	0.05	0.05	1.0	5.0	10	5	0.05	0.15	0.1	-	10.0	1.0	10.0
	OSHA	15	15	0.5	15	0.2	0.2	1.0	1.0	10.0	10	5	0.1	0.05	0.1	-	10.0	1.0	10.0
	NIOSH	-	-	-	-	-	LFL	-	-	-	-	-	-	0.015	-	-	-	-	1.0

mg/m³ = milligrams of substance per cubic meter of air, T.W. = total airborne particulate, ND = none detected, PBZ = personal breathing zone, LFL = lowest feasible level

T.W.-total particulate weight, AL-aluminum, BA-barium, CA-calcium, CD-cadmium, CO-cobalt, CR-chromium, CU-copper, FE-iron, MG-magnesium, MN-manganese, NI-nickel, PB-lead, P-phosphorus, NA-sodium, TI-titanium, W-tungsten, ZN-zinc