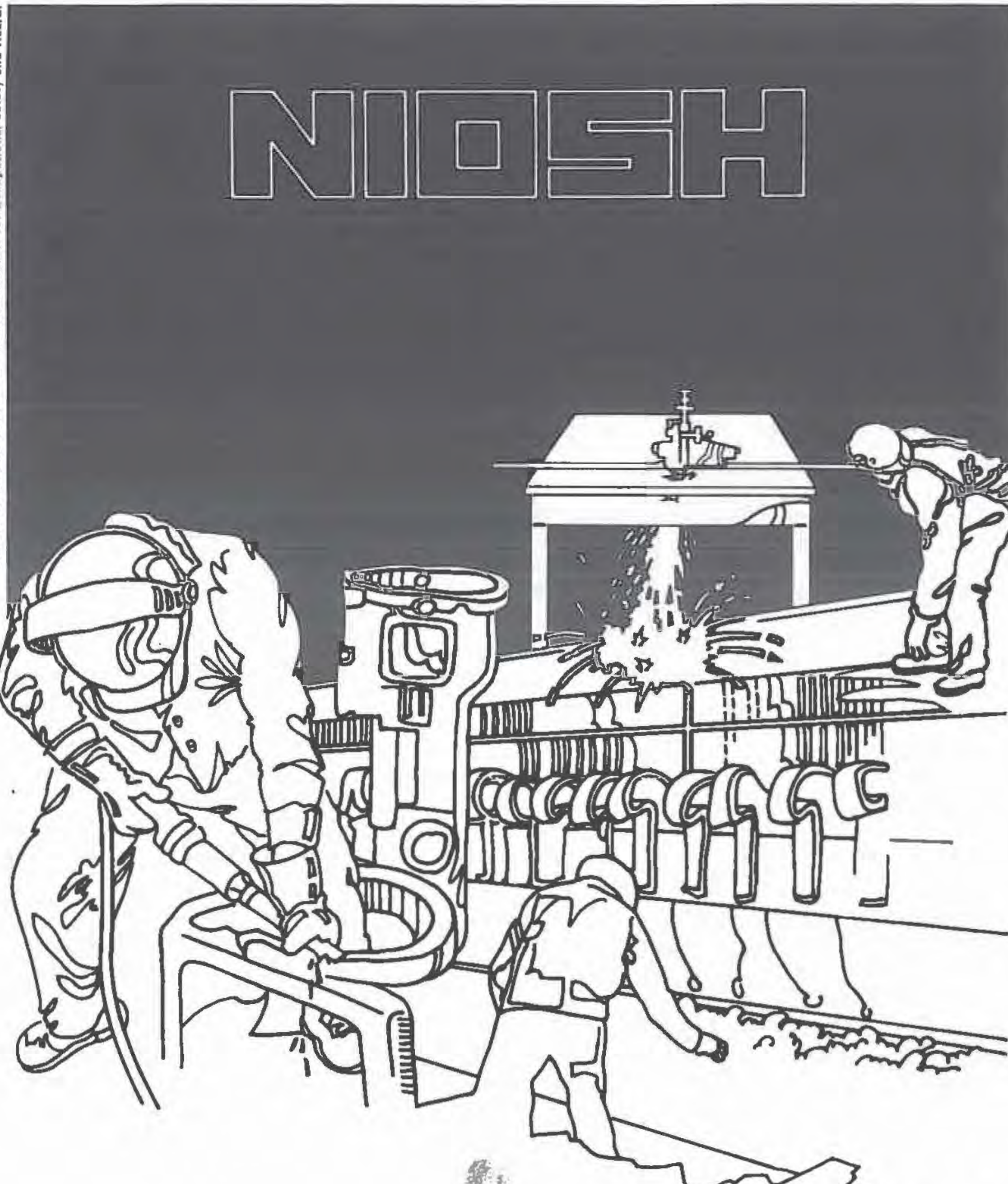
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

79-022-789

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 699(a)(6), which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

NIOSH also provides, upon request, medical nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Composite Report
TA 79-022-789 Hyde Park Landfill
HE 79-069-789 Niagara Steel Finishing Co.
HE 79-070-789 Greif Brothers Corporation
HE 79-071-789 NL Industries, Inc.
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I. SUMMARY

In 1979 the National Institute for Occupational Safety and Health (NIOSH) investigated the environmental exposures and health status of people living and working near the Hyde Park Landfill, Niagara County, New York. The investigation included a historical and qualitative environmental evaluation, measurement of direct occupational exposures to hazardous substances at three industries near the landfill, and a cross-sectional medical study of 428 persons.

Settled dust and other environmental samples from the workplaces and surrounding area were analyzed for lindane, mirex, and dioxins. Occupational exposures to inorganic lead, soluble barium, zirconium, total particulates, ultraviolet radiation, infrared radiation, visible light radiation, copper fume and dust, iron oxide fume and dust, methyl ethyl ketone, n-butyl acetate, methyl cellosolve acetate, xylene, toluene, n-butanol, isopropanol, ethanol, and asbestos were measured at one or more of the workplaces. The medical study included a health history questionnaire, a limited physical examination, and blood and urine tests, including measurement of lindane and mirex in blood.

Lindane, mirex, and/or dioxins were found in part per billion levels in settled dust samples from rafters at all three industries. None of these compounds was identified in water or sediment from the heating tunnels at nearby Niagara University. Substantial amounts were found, however, in sediment from an abandoned elevator shaft at NL Industries and in sediment from Bloody Run Creek as it flows through a conduit under Greif Brothers Corporation. Excessive occupational exposures were found for inorganic lead, soluble barium, zirconium, total particulates, and ultraviolet, infrared, and visible light radiation at NL Industries, and for copper fume at Niagara Steel Finishing Company. No excessive exposures were found at Greif Brothers Corporation.

Compared to data from the Health and Nutrition Examination Survey of 1971-1973, participants in this study had higher prevalences of musculoskeletal symptoms, gastrointestinal surgery, skin problems, and respiratory symptoms; the latter was accounted for mainly by employees of NL Industries. There was no apparent excess of liver dsyfunction, hematologic abnormalities, renal impairment, urinary abnormalities, or miscarriages. No chloracne was found. No mirex was detected in blood, but three persons had a lindane level $\geq$ 0.5 ppb.

This study documented occupational health hazards due to inorganic lead, soluble barium, zirconium, nuisance dust, and ultraviolet, infrared, and visible light radiation at NL Industries, and to copper fume at Niagara Steel Finishing Company. No occupational health hazards were documented at Greif Brothers Corporation. The study did not document any consistent pattern of health effects attributable to exposure to substances from the landfill. The scope of the study, however, was limited to the evaluation of currently recognizable health effects. Thus, the study does not address health effects not yet manifest or manifested in ways that might have prevented persons from participating in the study. Recommendations concerning correction of occupational health hazards and environmental decontamination are contained in Appendix C. Since the major danger posed by chemical landfills is the long-term release of chemicals into the environment, the failure of this study to demonstrate adverse health effects does not lessen the need to contain the Hyde Park Landfill.

KEYWORDS: chemical waste; chemical dumps; chemical landfills; health survey; HANES; metal sand manufacturing [SIC 3390]; fabricated structural metal products [SIC 3443]; metal shipping drum manufacturing [SIC 3412]; colleges, universities, and professional schools [SIC 8221]; welding; arc furnacing; dioxin; mirex; lindane; zirconium; barium; lead; titanates, zircon; optical radiation; ultraviolet radiation; infrared radiation; copper (fume); solvents

II. INTRODUCTION

On March 13, 1979 the Occupational Safety and Health Administration (OSHA) requested technical assistance from NIOSH to evaluate reported adverse health effects among people who worked in the vicinity of a chemical disposal site in the town of Niagara, Niagara County, New York, known as the Hyde Park Landfill. The workplaces (Figure 1) were NL Industries, Inc. (NL)*, Niagara Steel Finishing Company (NSF), Niagara Monument Works, and Plaza Self-Service Mobil Station, all located adjacent to the landfill; Greif Brothers Corporation (GB), located approximately 100 meters from the landfill; and Niagara University (NU), located approximately 300 meters from the landfill. On March 19, 1979 the United Steel Workers of America, representing NL and GB workers, and the Oil, Chemical and Atomic Workers International Union, representing NSF workers, jointly requested health hazard evaluations at these three plants. The request concerned potential health effects of past and present exposure to landfill chemicals.

*Subsequent to NIOSH's investigation this facility underwent a change of ownership and is now known as TAM Ceramics. In this report, however, it will be referred to as NL Industries.

III. BACKGROUND

The Hyde Park Landfill is situated in an industrial area in the town of Niagara, just north of the city of Niagara Falls, New York. Bloody Run Creek, which drains the landfill, runs north from the landfill, through a conduit under the GB Plant, through a residential neighborhood, and - as an underground storm drain - along the edge of NU. It eventually drains into the Niagara River 8 km below Niagara Falls. The landfill, operated by Hooker Chemical and Plastics Corporation from about 1953 to about 1975, served as a depository for drummed and non-drummed chemical wastes totaling an estimated 80,200 tons.[1] This waste included a variety of aliphatic and aromatic organic chemical compounds, including many chlorinated hydrocarbons (Table 1). Many of these compounds are known or suspected carcinogens.

According to the Interagency Task Force Report on Hazardous Waste Disposal in Erie and Niagara Counties, New York,[1] the site was operated rather carelessly until the early 1970's. The landfill was uncovered, and large amounts of chemical leachate undoubtedly escaped from the site, contaminating the nearby surrounding areas. On 12 occasions from about 1967 to mid-1972 workers at nearby workplaces complained of odors and irritating vapors coming from the landfill, and a letter from NL to Hooker mentions premature deterioration of metal surfaces. A closure plan for the landfill was approved by the New York State Department of Environmental Conservation and the Niagara County Health Department in August 1972. A compacted clay cover was installed over the entire site by autumn 1978. At the time of NIOSH's study, a drainage system to collect leachate was being installed around the perimeter of the landfill. The drainage would be pumped into a collecting lagoon and subsequently removed by tanker truck. At the time of the NIOSH study this lagoon was open to the air; a plastic cover has since been installed.

On April 23 to 27, 1979, NIOSH industrial hygiene and medical personnel (a) conducted walk-through surveys of the premises of the six employers and the landfill, and (b) surveyed the neighborhood near the landfill. Information about the six factories and businesses is summarized in Table 2; detailed process descriptions and reported health effects are presented in Appendix A.

Participants in the medical study were notified by letter of their test results. Companies and unions were notified of environmental findings as they became available during 1979 and 1980. On December 19, 1979, the authors of this report met with company and union representatives, and later with workers at a public meeting, to present the environmental and medical findings to date.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

The employees of the workplaces near the landfill have been potentially exposed both to chemicals from the landfill and to chemical and physical agents used or generated in their places of employment. Consequently, it was necessary to characterize and evaluate both potential exposure sources in order to evaluate the health effects data.

NIOSH conducted industrial hygiene surveys at NL on June 12-14, 1979; NSF on June 26-28, 1979; and GB on June 26-28 and July 17-18, 1979. Water and sediment samples were obtained at Niagara University June 28, 1979, and additional environmental samples were obtained at GB on November 10 and December 27, 1979. The surveys involved:

1. NL Industries, Inc., which manufacturers from zircon sands and other metal-containing materials various metal alloy powders and sands by heating (including arc furnacing), calcining, milling, drying, and packaging.

a. Collection of personal breathing zone samples for inorganic lead, soluble barium, zirconium and total particulate.

b. Characterization of the ultraviolet, infrared, and visible light radiation generated at two direct arc furnaces.

c. Collection of settled dust samples from the rafters of the building nearest the landfill (Building 145) for analysis of dioxins,* lindane, and mirex. Although these samples would provide only a limited retrospective determination of past airborne exposures, they were considered to be the best indicator of whether the workers were exposed to these compounds via their adsorption on soil/dust particles.

d. Collection of a sediment sample from the sand elevator pit in Building 145 for dioxins, lindane, and mirex. Odors characteristic of those emanating from the landfill were detected in this pit.

2. Niagara Steel Finishing Company, which fabricates various large industrial steel products by welding of mild carbon steel, stainless steel, and copper cathode.

a. Collection of personal breathing zone samples for copper and iron oxides and total particulates, and work area measurements for carbon monoxide and oxides of nitrogen.

b. Collection of settled dust samples from rafters and the main ventilation duct for dioxins, lindane, and mirex.

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*Unless otherwise specified, the term "dioxins" and "dioxin" in this report refer to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

3. Greif Brothers Corporation, which makes both steel and plastic-lined composite drums which are spray-painted and/or coated with lacquer or a phenolic or epoxy resin.

a. Collection of personal breathing zone samples for methyl ethyl ketone, n-butyl acetate, methyl cellosolve acetate, xylene, toluene, ethanol, n-butanol, and isopropanol.

b. Sampling of the atmospheres, water, and sediment in two manholes inside the plant, one located along production line No. 2 and the other approximately 25 meters to the south. (These manholes provide access to a 24-inch diameter conduit located beneath the Greif Brothers plant where drainage water and chemical leachate flow from the landfill). Primary emphasis was directed at determining the presence of airborne dioxins, but the atmospheres were also tested for other identifiable organic compounds. Sediment and water were analyzed for dioxins, lindane, and mirex.

c. Collection of settled dust from rafters and the ventilation system for mirex, lindane, and polychlorinated biphenyls (PCB's).

d. Collection of sediment samples in the conduit at its effluent end for dioxins, lindane, and mirex.

e. Collection of soil from a low, wet area of ground between the plant and a parking lot to the east for mirex, lindane, and PCB's.

4. Niagara University, a private college.

a. Three samples were collected for dioxins, lindane, and mirex: (a) sediment in the heating tunnel beneath Mead Hall (the priests' residence), (b) water in the heating tunnel beneath Lynch Hall (a students' residence), and (c) standing water in a pumping station manhole located at the southwest side of the Science Building.

b. A sample of the insulation from the steam pipes in the main heating tunnel was analyzed for asbestos.

Sampling and analytical procedures are referenced in Appendix B.

B. <u>Medical</u>

1. Rationale

The medical evaluation was not designed to be a comprehensive study of all possible health effects resulting from exposure to all of the chemicals from the landfill. Rather, it was intended as an expeditious, targeted response to the specific concerns of affected employees (as expressed by their union representatives) and public officials. The medical study was designed as a cross-sectional morbidity study using already existing population health data (see below) for comparison. The components of the study were selected to address the specific health effects of concern to the affected employees, as presented by their representatives at a meeting with NIOSH personnel on May 10, 1979. At that meeting NIOSH distributed a draft report of its investigation to date. The components of the medical study are presented below. Medical examinations were conducted at a facility provided by Niagara University on June 4-8 and August 6-8, 1979.

2. Content

The medical study included the following:

a. Administration of a questionnaire that covered general medical and occupational history. The medical history questions were excerpted without modification from the Health and Nutrition Examination Survey (HANES) conducted by the National Center for Health Statistics from 1971 to 1973.[2]

b. A limited physical examination, including measurement of blood pressure, inspection of the skin of the upper half of the body, inspection of the mucous membranes of the nose and oral cavity, palpation of the thyroid gland, and measurement of liver size by percussion.

c. Blood tests, including a complete blood count with differential white blood cell count, liver enzymes (GGTP, SGOT, SGPT, alkaline phosphatase), and serum creatinine.

d. A routine urinalysis with microscopic examination.

e. Blood analyses for lindane and mirex in a 20% sample of participants.* Lindane and mirex were chosen as indicators of exposure to chemicals in the landfill since, of those chemicals known to be present, they were considered the most likely to be detectable several years after cessation of exposure. These analyses were done by an electron capture-gas chromatography technique following the method described in the U.S. Environmental Protection Agency's Manual of Methods, Pesticide Residues in Human and Environmental Samples, revised December 1974.

All persons age 18 and over were eligible for all parts of the study. Persons 12-17, with parental consent, participated only in the

*All participants were assigned a 4-digit identification number at the reception station. Numbers were assigned sequentially within each series, the series being identified by the first digit and designating the participant's employer or status as a neighborhood resident. Persons whose number had either of two randomly selected fourth digits constituted the sample.

questionnaire and physical examination. Anyone under 12 was included in the mother's questionnaire and received as much of the physical examination as possible.

3. Study Population

All current employees of NL, NSF, GB, Niagara Monument Works, Plaza Self-Service Mobil Station; all NU maintenance department personnel; and all residents of the neighborhood between GB and NU (Figure 1) were invited to attend the June 4-8 testing. Employees were notified (a) by announcements posted and/or distributed by the companies, and (b) by requests to union representatives to inform their members. Neighborhood residents were notified by handbills delivered door-to-door by NIOSH representatives to each residence in the target area. In addition, announcements were distributed to area newspapers and broadcasters.

The August testing was arranged for former employees of NL, NSF, and GB since they could not be notified in time for the June testing. Notification was accomplished by (a) sending a letter with a return postcard to all former employees of NL, NSF, and GB whose last known address was in the Buffalo/Niagara Falls, New York area (including adjacent Canada) and who had worked at one of these companies for at least one year since 1952, and (b) sending notices to all radio and television stations and all general circulation and community newspapers in the Buffalo/Niagara Falls area. Anyone returning the postcard (or otherwise contacting NIOSH) was called and given an appointment that was convenient for him. In addition to former employees of NL, NSF, and GB, employees of Lafayette Machine Corporation, a small business formerly located at the site now occupied by part of the GB facility, were invited to participate after the manager had contacted NIOSH to express their interest. Finally, the companies, unions, and news media were informed that eligible persons who missed the June 4-8 testing could come to the August testing.

NIOSH personnel were available to examine participants both day and evening during both weeks of testing.

4. Data Analysis

The plan of the investigation was to compare the prevalence of diseases and symptoms in workers from plants around the landfill with the HANES data, which was derived from a sample of people chosen from throughout the United States. The target of the HANES was a probability sample of the U.S. population weighted toward lower income groups. Individuals from the NIOSH study were matched with individuals in the HANES sample, and the responses to the same questions were compared. The groups were matched on the following variables: age (within 3 years), sex, race, income (by categories, corrected for inflation), and marital status. Further socio-economic comparability was ensured by initially choosing a subset from the HANES sample of only usually employed people. This subset comprised the pool for matching. Two HANES persons for each

NIOSH study participant were selected randomly from among the available matches. Comparisons were made between the total NIOSH study group and the HANES matches, as well as between employees of each of the four major employers and their HANES matches.

V. EVALUATION CRITERIA

A. Environmental

Evaluation criteria for the various process-related substances considered are shown in Table 3. Potential adverse health effects are discussed in Appendix A.

Since mirex would not be expected to be present in the general environment,[3] its presence in air, water, sediment, or dust implies unintentional contamination, presumably from the landfill. Lindane implies contamination from the landfill with less certainty since it is more widely found in the environment.[3] Dioxins are by-products of the manufacture of certain chlorinated hydrocarbons (such as 2,4,5-trichlorophenol) and might be present in association with them. The presence of dioxins suggests contamination from the landfill, but if found in association with PCB's might be from another source. (PCB's were not known to be present in the landfill but were formerly used extensively in electrical equipment. Such equipment is commonly found in industrial settings and could also be present in the area of the Hyde Park Landfill because of nearby high-voltage electrical transmission lines.)

B. Medical

1. Medical History

The determination of whether or not the Hyde Park Landfill was a health hazard is based on the extent to which the rates for various health effects found in the exposed group exceed those found in an unexposed comparison group. This epidemiologic approach is necessary since there are few, if any, health effects that are uniquely the result of exposure to substances in the landfill.

The presence of many different substances in the landfill necessitated a broad view of health problems. No particular target organ was evident as a point of focus. Consequently, a multi-system set of questions was used.

2. Physical Examination and Laboratory Tests

The skin examination was intended primarily to detect evidence of chloracne. We considered active acneiform lesions or scarring to be due to chloracne rather than common acne (acne vulgaris) if (a) the onset occurred during adulthood, (b) the distribution of lesions included areas other than the face, neck, chest, or upper back, or (c) there were cystic lesions persisting into adulthood.

The results of the rest of the physical examinations and the laboratory tests other than lindane and mirex determinations were evaluated against generally accepted "normal" values and by comparison with HANES findings when available. (Results of the physical examinations and laboratory tests were also evaluated by NIOSH physicians on a case by case basis for purposes of informing individuals of their own results.) "Normal" values for laboratory tests other than lindane and mirex are presented in Table 4. Participants in this investigation who had no HANES matches included everyone younger than age 25, retired workers, neighborhood residents, and employees of the small businesses. Their questionnaires, physical examinations, and laboratory tests were evaluated qualitatively against "normal" values.

As discussed earlier, mirex would be less likely than lindane to be present in the general environment and thus less likely to be found in human blood. Unless someone was involved in the manufacture or use of mirex, or had lived in an area where mirex was used as an insecticide, no mirex would be expected to be present in the blood. Lindane, on the other hand, because of its more extensive use as an insecticide and its use as topical medication for lice and scabies, might be present in the absence of exposure to chemicals from the landfill.

VI. RESULTS

A. Environmental

The environmental findings are summarized in Table 5, and detailed reports are included in Appendix C.

Part per billion quantities of dioxins, mirex, and lindane were present in settled dust samples taken from factories near the landfill and in bottom sediment taken from Bloody Run Creek. These data suggest that worker exposure to these compounds may have occurred in the past, and they conclusively show that Bloody Run Creek is contaminated with these toxic chemicals. No dioxins, mirex, or lindane were detected in any air samples, including samples taken within the Bloody Run Creek conduit under the Greif Brothers plant.

Industrial process hazards were identified in two of the three factories near the landfill. At NL Industries there were excessive airborne concentrations of inorganic lead, barium, zirconium, and nuisance dust. In addition, there were excessive exposures to infrared, ultraviolet, and visible light radiation from electric arc furnaces. These radiation exposures were minimized, however, by personal protective equipment and shielding devices. At Niagara Steel Finishing Company welders were excessively exposed to copper fume.

B. Medical

1. Participation

Participation rates by current employees of the four major employers during the June testing period ranged from 42% to 84%, and about 90% of the estimated 50 community residents participated (Table 6). The participation rate of former employees was less than a quarter of those presumably notified and less than one sixth of those who we attempted to notify (Table 6). Overall, 428 people participated, including 13 children under age 12 and five people aged 12-17.

2. Medical Histories and Laboratory Tests

a. Hyde Park Industries as a Whole

Analysis of the data gathered by questionnaire showed a variety of health conditions with greater prevalence rates in the Hyde Park group than in the HANES comparison group. Of 180 variables involving reported health conditions, laboratory analyses, or health risk factors, 26 (14%) were significantly ($p < 0.025$) more prevalent in the Hyde Park group than in the HANES group. Few of these conditions, however, represented a cohesive complex of effects indicative of a problem with common target organs or systems. Most noticeable were indicators of musculoskeletal dysfunction; prior abdominal surgery, especially for hiatus hernia and gall bladder; a history of some skin conditions such as acne, moles and hives; and indicators of respiratory distress, particularly increased cough and phlegm.

The prevalence odds ratios are shown in Table 7 for conditions which were statistically significantly different. The odds ratio (the ratio of the prevalence of a given condition in the Hyde Park group to that in the HANES group) is a measure of the strength of association and indicates how many times more prevalent a condition is in one group (Hyde Park) than another (HANES). Some of the conditions with large odds ratios include surgery for hiatus hernia, 7.6; other abdominal surgery, 4.6; loss of blood from stomach or bowels, 5.6; hiatus hernia, 4.5; benign tumor, 3.4; frequent cough, 3.7; use of skin medicine, 2.6; skin moles, 2.5; and leg pain, 2.5.

Based on the participants' questionnaires and laboratory tests, there was no indication of excess cancer, heart disease, thyroid problems, jaundice, nervous system dysfunction, or anemia.

Overall, the Hyde Park group had some slightly different blood and urine test results than the HANES group, but none were outside the range of normal, and none appeared to be of any biological significance. Red blood cells in the urine, in excess of two cells/high power field, were found in 7 (3%) of 246 people, but no comparable HANES data were available because of apparent differences in reporting or coding the test results. Results of none of the various laboratory tests differed significantly among the four Hyde Park groups at the $p \leq 0.01$ level.

Compared to the HANES data, none of the four Hyde Park groups, individually or when combined, had higher serum creatinine or liver enzymes or lower red blood cell count, hemoglobin, or hematocrit. There was a consistent, significant difference in the differential white blood cell counts. All four Hyde Park groups, individually and combined, had higher monocyte and basophil counts and lower lymphocyte counts. In our opinion the most likely explanation for the complementary differences in lymphocytes and monocytes is a systematic misreading of some lymphocytes as monocytes. The higher basophil counts in the Hyde Park groups are within the "normal" range.

Simple reproductive histories were included in the questionnaires administered to women. Of 91 pregnancies, seven (8%) resulted in miscarriages in the Hyde Park group, compared with a rate of 14% for HANES.

b. NL Industries

The symptoms most prominently reported by NL workers were musculoskeletal. NL workers accounted for the majority of the overall prevalence of pain in one or both legs, arthritis, and cough. Odds ratios (NL workers compared to their HANES matches) of statistically significantly different conditions were: cough, 8.5; hiatus hernia, 7.4; leg pain, 4.7; pain or aching of joints, 3.7; abdominal surgery, 3.4; back pain, 2.4; hip joint pain, 2.6; joint stiffness, 2.7; skin moles, 2.7; and shortness of breath, 2.2. NL workers had lower systolic and diastolic blood pressure than their HANES matches. The miscarriage rate among women participants was 8%, compared with 16% in the corresponding HANES matches. An excess number of red blood cells was found in the urine of 5 (5%) of 95 workers studied (comparable HANES data are not available).

c. Niagara Steel Finishing

This group had only 21 members; all were men. There was no excess prevalence of any symptom or health condition, and no one had an excess number of red blood cells in the urine.

d. Greif Brothers

Surgery for hiatus hernia was the most excessively prevalent condition in this group, with an odds ratio of 21.7. Other significantly more prevalent conditions (with their odds ratios) included other abdominal surgery (7.6) and skin moles (2.6). The miscarriage rate was 9%, compared with 25% in the corresponding HANES matches. One (2%) of 65 workers had an excess number of red blood cells in the urine.

e. Niagara University

Workers at Niagara University reported an excess of hiatus hernia, odds ratio 11.2, and surgery for hiatus hernia, 21.3. They also reported more undefined chest conditions which worsened in the 12 months prior to the study. The miscarriage rate was 8%, compared with 10% in the corresponding HANES matches. An excess number of red blood cells was found in the urine of 3 (5%) of the 60 workers.

f. Neighborhood Residents and Other Participants

We found no clusters of unusual health effects (including markedly abnormal test results) among the neighborhood residents, retired workers, employees under age 25, or other study participants not included in the statistical analyses. The relatively small numbers of people in these groups, and the lack of a suitable comparison population, precludes epidemiologically meaningful analyses of symptoms, health conditions, and laboratory test results.

3. Physical Examination

We found no evidence of chloracne. There was one thyroid nodule; this was known to the participant for several years and was previously diagnosed as a "cold" nodule (i.e., a cyst rather than a tumor). Systolic and diastolic blood pressures were lower in the Hyde Park group than in the HANES matches.

Mean liver size measurements differed significantly between examiners and thus could not be reliably used in analyses. (HANES had the same problem and does not include liver measurements in it's "published" results.)

4. Lindane and Mirex Determination

Forty-five (14%) of the 333 June participants over age 17 had a blood specimen analyzed for lindane and mirex. Nineteen persons who, according to the sampling procedure, should have had a specimen taken did not, most apparently because of oversight. Both of the above groups included comparable proportions from each major employer and the community; 12-15% of each had the tests, and 3-7% of each inadvertently did not. No one had a detectable amount of mirex (limit of detection 2.0 ppb). Three people, two employees of GB and one employee of NU had detectable lindane, ranging from 0.99-3.0 ppb (limit of detection 0.5 ppb).

Ten (13%) of the 77 August participants had the tests for lindane and mirex. Seven were former employees of NL, who accounted for 57% of the August participants. Again, all specimens were negative for mirex, even though the limit of detection was lower (0.5 ppm). Six people - five former NL employees and one employee of Lafayette Machine Corporation - had detectable lindane, ranging from 0.03 to 0.43 ppb, all below the June limit of detection (new limit of detection 0.03 ppb).

VII. DISCUSSION

This study was designed to provide a relatively rapid assessment of the health status of people who lived or worked in the vicinity of the Hyde Park Landfill. The approach utilized a cross-sectional prevalence study, an approach which is useful in identifying existing disease. Only the prevalence of disease, however, and not the incidence or risk can be detected. Such a study, moreover, is limited only to those people who actually participate. People who do not participate because of illness, death, or lack of interest could actually be the people who have the adverse health effects of greatest concern. We do not know why participation rates were so relatively low; much publicity had been given to the issue of landfills and chemical dumps around Niagara Falls. NIOSH sent out many letters but got little response despite cooperation of the unions and most of the companies.

Determination of whether the prevalences of health conditions identified in the study participants were excessive was made by using comparison groups chosen from a probability sample of the whole U.S. population. This group was made comparable to the Hyde Park group by selecting only those usually employed and matched on age, race, sex, income, and marital status. The Hyde Park groups were generally found to be similar to their corresponding HANES comparison groups with respect to smoking and alcohol consumption. Thus, the two populations appeared quite comparable, and the choice of HANES as a comparison population was probably a good substitute for a control group from the Niagara Falls area. The fact that the HANES group was surveyed seven years earlier than the Hyde Park group probably did not substantially affect the results.

The reason for the relatively large odds ratios for hiatus hernia and related surgery is not apparent. Hiatus hernia is a common radiologic finding,[4] and otherwise unexplained gastrointestinal symptoms may be attributed to it. The apparent excess of hiatus hernia, then, might actually be an indicator of an increased prevalence of gastrointestinal symptoms of unknown cause, possibly chemicals from the landfill. Other conditions such as skin moles, benign tumor, and cough might be indicative of exposure to environmental agents, including landfill materials, but the data do not verify this.

Some of the health effects of concern in this study may not have yet appeared because adequate time between exposure and the study had not elapsed. The latent period for various chronic diseases, such as cancer, would not have been reached for many of the participants. Since the latent period for some diseases caused by chemicals is sometimes inversely related to dose (exposure) the intermittent exposures encountered near the landfill most likely would result in longer latent periods. No quantitative measures of exposure were available. In fact, whether exposures to the most potent substances in the landfill actually occurred cannot be determined. The absence of significant excesses of adverse health conditions in the study may be the result of a lack of biologically significant exposure as well as the limitations of the methodology. Reports of eye, nose, and throat irritation in past years, however, were most likely the result of exposure to some landfill substances. Whether these irritant substances had other effects, or were associated with other substances that did, is not known. The prevailing winds over the landfill were out of the southwest, which would result in landfill materials generally being carried away from the adjacent businesses. Thus, exposure would be intermittent, irregular, and often of short duration.

We do not know whether the few health effects found were due to occupational exposure, landfill exposure, or some other cause. No adverse effects were consistently reported by workers in the adjacent industries. If they had occurred, one explanation would have been a common source, such as the landfill. The fact that in 14% of the symptoms and conditions studied the prevalence rates in the Hyde Park group significantly ($p < 0.025$) exceeded those in the HANES group may be interpreted as being more than would occur by chance. When performing multiple comparisons, such as in this study, it is common practice to use a more stringent criterion for significance, such as 0.001. When this is done, 8% of the Hyde Park prevalences were still significantly greater than the corresponding HANES prevalences. Much of this excess could be accounted for by methodologic factors such as non-comparability between cases and controls, differences in the way questionnaires were administered, and the statistical non-independence of the data.

Although this study showed no consistent pattern of health effects, the environmental findings should not be overlooked. There is no reasonable source, other than the landfill, of the mirex found in the buildings and in the sediment of Bloody Run Creek. This illustrates the major danger posed by chemical landfills, the release of chemicals into the surrounding environment, most ominously into water sources and the food chain.

VIII. RECOMMENDATIONS

A. Occupational Health Hazards

Recommendations concerning both the correction of process-related health hazards and the removal of landfill-contaminated dust are discussed in the reports in Appendix C.

B. General

The experience and data from this study do not suggest that expanding the study to include additional people working or living in the area of the landfill would be useful. Nor would it seem productive to undertake additional medical studies of the participants in this study.

This study supports the impression of many chronic disease epidemiologists and public health agencies that the use of cross-sectional morbidity studies to evaluate the public health effects of chemical disposal sites is inefficient, insensitive, and thus destined to be inconclusive. The apparent negative results of such studies, including this one, should not be construed as minimizing the public health problems posed by inadequate methods of chemical waste disposal. Such studies should not be promoted or endorsed by public health agencies as a primary method of addressing the issue.

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X. REFERENCES

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2. National Center for Health Statistics: Plan and Operation of the Health and Nutrition Examination Survey United States - 1971-1973. DHEW Publication No. (HRA) 76-1310

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XI. DISTRIBUTION AND AVAILABILITY

For the purpose of informing the "affected employees" the employers should post this report for at least 30 days in prominent places near where employees work.

Copies of this report will be available from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226 for 90 days. Thereafter, copies will be available from the National Technical Information Service (NTIS), Springfield, Virginia. Information concerning its availability through NTIS can be obtained from the NIOSH Publications Office at the above Cincinnati address.

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NL Industries, Inc.
TAM Ceramics
Niagara Steel Finishing Company
Greif Brothers Corp.
Niagara University
Niagara Monument Works
Plaza Self-Service Mobil Station
Lafayette Machine Corporation
Hooker Chemical and Plastics Corp.

FIGURE 1
HYDE PARK LANDFILL AND VICINITY
NIAGARA FALLS, NEW YORK

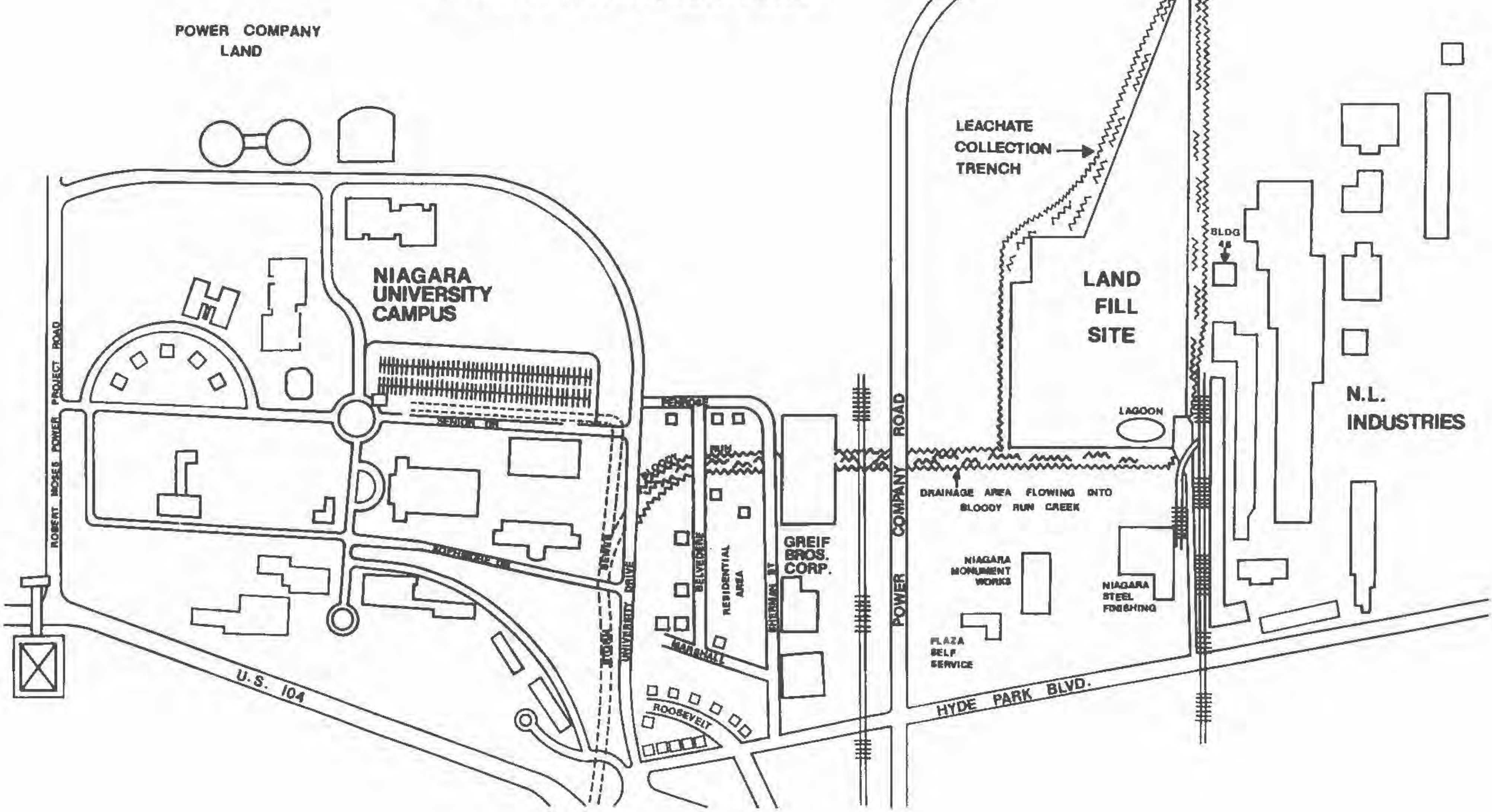

TABLE 1

Chemicals Known to Have Been Disposed of at the Hyde Park Landfill (See Reference 1)

Type of Waste Category	Physical State	Total Estimated Quality - Tons	Container
Benzylchorides - includes benzyl dichloride, benzyl alcohol, benzyl thiocyanate	L,S	3,400	D
Thiodan (Endosulfan)	L,S	1,000	D,B
Sulfides - sodium sulfides/sulfhydrates	S	6,600	D
Hexachlorocyclopentadiene (C-56)	L,S	1,000	D
C-56 Derivatives - includes Dechlorane Plus, Dechlorane 602 and 604, Pentac	L,S	4,500	D,B
Hexachlorocyclohexane (Lindane)	S	2,000	D
Chlorobenzenes	L,S	16,500	D,B
Benzoyl chlorides	L,S	6,200	D,B
Benzotrichlorides	L,S	1,700	D,B
Liquid disulfides and chlorotoluenes	L,S	900	D,B
Chlorotoluenes	L	1,700	D,B
Metal Chlorides	S	100	D
Benzotrifluorides - organic residues	L,S	5,600	D,B
Calcium fluorides	S	400	B
Benzotrifluoride derivatives	L,S	2,900	D,B
Dodecyl (Lauryl) mercaptans (DDM), chlorides and misc. sulfur compounds	L,S	4,500	D
Trichlorophenol (TCP)	L,S	3,300	D
Chlorendic Acid (HET)	L,S	2,100	D,B
Misc. acid chlorides	L,S	1,200	D
Dichlorane (Mirex)	S	200	D
Organic Phosphates	L,S	4,400	D,B
Phosphorous and inorganic phosphorous	L,S	< 100	D
Sodium hypophosphite	S	1,000	B
Mercury brine sludge	S	< 100	D
Misc. unidentified materials 10% of above		7,300	

L = Liquid
S = Solid or semi-solid
D = Drum
B = Bulk

TABLE 2

Potential Occupational Health Hazards at Workplaces
Hyde Park Landfill Study
Niagara Falls, New York, 1979

Workplace	Employees	Potential Hazard Substances or Processes
NL Industries	260	Soluble barium compounds Titanium dioxide Crystalline silica Inorganic lead Zirconium "Nuisance" dust Ultraviolet radiation Infrared radiation
Niagara Steel Finishing Company	50	Copper fume Nickel fume Iron oxide fume Fluorides Nitrogen oxides Ozone Carbon monoxide
Greif Brothers Corporation	90	Lead chromate Vinyl chloride Epoxy resins Phenolic resins Xylene o-cresol Isopropanol Ethanol n-butanol Methanol Methyl ethyl ketone Methyl cellosolve acetate Ethyl glycol monobutyl ether n-butyl acetate Toluene
Niagara University Maintenance Employees	90	None relevant to this investigation
Niagara Monument Workers	5	Crystalline silica Solvents
Plaza Self-Service Mobil Station	2	Auto exhaust Gasoline Benzene Tetraethyl lead

TABLE 3

Environmental Evaluation Criteria for Substances Measured at NL Industries, Niagara Steel Finishing Company and Greif Brothers Corporation

Substances	Criteria[A]	References
Inorganic lead	50 ug/M^3	OSHA standard (29 CFR 1910.1025)
Soluble barium	0.50 mg/M^3	ACGIH[B]
Total particulates	10.0 mg/M^3	ACGIH
Zirconium	5.0 mg/M^3	ACGIH
Ultraviolet radiation		
Actinic UV (200-315 nm)	0.1 uW·cm^{-2}	ACGIH
Near UV (320-400 nm)	1.0 mW·cm^{-2}	ACGIH
Infrared radiation	10.0 mW·cm^{-2}	ACGIH
Visible light	200 cd·cm^{-2}	ACGIH
Methyl ethyl ketone	200 ppm	ACGIH
n-butyl acetate	150 ppm	ACGIH
Methyl cellosolve acetate	25 ppm	ACGIH
Xylene	100 ppm	NIOSH[C] (1973)
Toluene	100 ppm	NIOSH (1975)
n-butanol	50 ppm	ACGIH
Isopropanol	400 ppm	NIOSH (1976)
Ethanol	1000 ppm	ACGIH
Copper fume	0.20 mg/M^3	ACGIH
Copper dust	1.0 mg/M^3	ACGIH
Iron oxide fume	5.0 mg/M^3	ACGIH
Iron oxide dust	10 mg/M^3	ACGIH

A - All evaluation criteria for chemical substances are 8- or 10-hour time-weighted averages.

B - American Conference of Governmental Industrial Hygienists Threshold Limit Values for 1980.

C - NIOSH: Criteria for a Recommended Standard ... Occupational Exposure to [substance].

TABLE 4

Blood and Urine Tests
Hyde Park Landfill Study
June and August 1979

Blood	Usual Results for Adults[A]
Tests of liver function	
Alkaline phosphatase	10-50 IU/l
Gamma glutamyl transpeptidase (GGTP)	1-40 units/l
Glutamic oxalacetic transaminase (SGOT)	1-70 IU/l
Glutamic pyruvic transaminase (SGTP)	1-70 IU/l
Test of kidney function	
Creatinine	0.5-1.7 mg/dl
Tests of red blood cell formation	
Red blood cell count (RBC)[B]	Men 4.6-6.2x10^6 cells/ul Women 4.2-5.4x10^6 cells/ul
Hemoglobin (HGB)[B]	Men 14-18 gm/dl Women 12-16 gm/dl
Hematocrit (HCT)[B]	Men 42-52% Women 37-47%
Mean Corpuscular volume (MCV)	80-100 um^3
Mean corpuscular hemoglobin (MCH)	26-33 uug
Mean corpuscular hemoglobin concentration (MCHC)	31-36%
White blood cell tests	
Total white blood cell count (WBC)	4000-11600 cells/ul
Types of white blood cells	
Polymorphonucelar cells (including "juvenile" and "band" forms) (poly)	1650-8330 cells/ul
Lymphocytes (lymph)	1049-3581 cells/ul
Monocytes (mono)	61-929 cells/ul
Eosinophils (eos)	40-423 cells/ul
Basophils (baso)	10-148 cells/ul
Tests for lindane and mirex	See text
Urine	
Acetone (qualitative)	None
Protein (qualitative)[C]	No more than trace amount
Glucose (qualitative)	None
Blood (qualitative)	None
White blood cells[D]	0-2 cells/high power field
Red blood cells[D]	0-2 cells/high power field
Epithelial cells[D]	0-2 cells/high power field

A - Unless otherwise specified, the range of usual results is derived by the laboratory performing the tests from its previous experience.

B - Isselbacher KJ, Adams RD, Braunwald E, Petersdorf RG, Wilson JD: Harrison's Principles of Internal Medicine, 9th ed. New York, McGraw-Hill Book Co., 1980, p A-7

C - Ibid., pp 215-216

D - Wallach J: Interpretation of Diagnostic Tests, 3rd ed. Boston, Little Brown and Co., 1978, p 18

TABLE 5
Summary of Environmental Sampling Results
(See Appendix C for Additional Information)
Hyde Park Landfill Study
Niagara Falls, New York
1979-1980

Workplace and Substances Measured	Number of Samples[A]	Evaluation Criteria	Findings[B]
NL Industries, Inc.			
Zirconium	41	5.0 mg/M^3	36 < 5.0; 5 from 6.0 to 147.0 mg/M^3
Inorganic lead	3	50 ug/M^3	174; 275; 570 mg/M^3
Soluble barium	12	0.5 mg/M^3	10 < 0.5; 1.0; 1.7 mg/M^3
Total particulate	41	10 mg/m^3	37 < 10.0; 15 from 12.5 to 233.5 mg/M^3
Ultraviolet radiation	2 direct arc air furnaces		
Actinic (200-315 mm)		0.1 uW·cm^{-2}	17.4 uW·cm^{-2} max. value
Near UV (320-400 mm)		1.0 mW·cm^{-2}	0.22 mW·cm^{-2} max. value
Infrared radiation	2 direct arc air furnaces	10.0 mW·cm^{-2}	> 200 mW·cm^{-2} max. value
Luminance	2 direct arc air furnaces	1.0 cd·cm^{-2}	200 cd·cm^{-2} max. value
Lindane	1 elevator shaft sediment	-[C]	30,200 ppb
	3 dust from rafters		5; 22; 79 ppb
Mirex	1 elevator shaft sediment	-	47,000 ppb
	3 dust from rafters		<7; 12; 17 ppb
Dioxin[D]	1 elevator shaft sediment	-	present[E]
	3 dust from rafters		0.7 ppb in one sample; present in a mixture of the other two
Niagara Steel Finishing Co.			
Cooper fume	5	0.2 mg/M^3	0.47 to 1.11 mg/M^3
Copper dust	6	1.0 mg/M^3	all ≤ 0.62 mg/M^3
Iron oxide fume	5	5.0 mg/M^3	all ≤ 0.51 mg/M^3
Iron oxide dust	23	10.0 mg/M^3	all ≤ 2.26 mg/M^3
Total particulate	28	10.0 mg/M^3	all ≤ 6.38 mg/M^3
Lindane			
Outside	1 drainage ditch water	-	< 2 ppb
	1 dust from equipment sufrace	-	< 1 ppb
Inside	1 dust from rafter	-	12 ppb
	1 dust from ventilation duct	-	33 ppb

TABLE 5 (Continued)

Workplace and Substances Measured	Number of Samples	Evaluation Criteria	Findings
Mirex			
Outside	1 drainage ditch water	-	< 2 ppb
	1 dust from equipment surface	-	< 3 ppb
Inside	1 dust from rafter	-	< 12 ppb
	1 dust from ventilation duct	-	280 ppb
Dioxin			
Outside	1 drainage ditch water	-	< 0.2 ppb
	1 dust from equipment surface	-	present
Inside	1 dust from rafter	-	present
	1 dust from ventilation duct	-	present
Greif Brothers			
Methyl ethyl ketone	9	200 ppm	all ≤ 6.9 ppm
n-butyl acetate	4	150 ppm	all ≤ 0.01 ppm
Methyl cellosolve acetate	9	25 ppm	all ≤ 2.2 ppm
Xylene	17	100 ppm	all ≤ 8.6 ppm
Toluene	10	100 ppm	all ≤ 2.2 ppm
n-butanol	4	50 ppm	all ≤ 3.1 ppm
Isopropanol	2	400 ppm	2.4; 4.9 ppm
Ethanol	5	1000 ppm	all ≤ 7.7 ppm
Combined organic vapor	11	1	all ≤ 0.21
Lindane			
Bloody Run Creek conduit	2 sediment	-	< 8; 14 ppb
	1 water	-	< 2 ppb
Outside, surface	1 sediment from low wet area	-	< 1 ppb
Inside	1 dust from rafter	-	< 1 ppb
	1 dust from ventilation duct	-	31 ppb
Mirex			
Bloody Run Creek conduit	2 sediment	-	16; 88 ppb
	1 water	-	< 2 ppb
Outside, surface	1 sediment from low wet area	-	< 8 ppb
Inside	1 dust from rafter	-	13 ppb
	1 dust from ventilation duct	-	< 6 ppb

TABLE 5 (Continued)

Workplace and Substances Measured	Number of Samples	Evaluation Criteria	Findings
Dioxin			
Bloody Run Creek conduit	2 sediment	-	0.3; 4.5 ppb[F]
	1 water		< 0.2 ppb
	1 air, conduit		< 2 ppb
PCB's			
Inside	1 dust from ventilation dust	-	< 40 ppb
Inside	1 dust from rafter		400 ppb
Outside	1 sediment from low wet area	-	< 30 ppb
Niagara University			
Asbestos	1 bulk (steam pipe insulation)	-[G]	not present
Dioxin	1 sediment, heating tunnel	-	< 0.7 ppb
	2 water, heating tunnel and pumping station		< 0.3 ppb
Mirex	1 sediment, heating tunnel	-	< 2 ppb
	2 water, heating tunnel and pumping station		< 2 ppb
Lindane	1 sediment, heating tunnel	-	< 6 ppb
	2 water, heating tunnel and pumping station		

A - All samples are full-shift personal breathing zone samples unless otherwise specified.
B - All results are expressed in the same units as the evaluation criterion and, unless otherwise specified, are full-shift time-weighted averages.
C - No numerical evaluation criteria applicable. See text for discussion.
D - Unless otherwise specified, dioxin results refer to the 2,3,7,8 isomer of tetrachlorodibenzo-p-dioxin (TCDD).
E - Amount of dioxin not quantified because of polychlorinated biphenyl (PCB) interference or other technical problems.
F - Also contained 9.7 ppb of 1,3,6,8-TCDD, 0.4 ppb 1,2,3,4-TCDD, and 1.9 ppb of an unidentified isomer.
G - No numerical evaluation criteria available for bulk samples. The assessment of the potential hazard depends on the amount and type of asbestos in the material, its friability, and external factors (vibration, bumping, scraping, etc.).

TABLE 6

Participation in Hyde Park Landfill Study
Niagara Falls, New York, June and August 1979

Participants by age and time of testing

	June	August	Total
Under age 12	13	0	13
Ages 12-17	5	0	5
Over age 17	333	77	410
Total	351	77	428

Participants by employer/neighborhood

	Number eligible	Number of participants and (% of No. eligible)
Current residents of target neighborhood (excluding children age 12)	50[A]	35 (68)
Current employees[B]		
NL	260	110 (42)
NSF	50	33 (66)
GB	90	76 (84)
NU (maintenance employees only)	90	71 (79)
Total	490	290 (59)
Former employees[C]		
NL	280	44 (16)
NSF	102	12 (12)
GB	145	10 (7)
Total	527	66 (13)
Others (employees of small businesses currently or formerly in area, former neighborhood residents, and people with other connections to target neighborhood)		25
Children under age 12		13
Total		428

Participation by former employees

	Number	% of eligible
Eligible[C]	527	100
Not in Niagara Falls/Buffalo area	48	9.1
Inadequate address	13	2.5
Notice mailed	466	88
Returned as undeliverable	180	
Presumed delivered	286	54
Returned postcard expressing interest	86	16
Unable to contact	4	
Not available week of study	5	
Agreed to participate	77	15
Participated	66[D]	13

A - NIOSH estimate of current population (excluding children under 12) of target neighborhood.

B - All current employees were eligible to participate in study.

C - All former employees who worked at one of the companies for at least one year since 1952 were eligible.

D - Includes 2 former employees who didn't return the postcard.

TABLE 7

Prevalence Odds Ratios for Statistically Significant* Health Conditions in the Hyde Park Groups

Group	All Hyde Park	NL Industries	Niagara Steel Finishing	Grief Brothers Corp.	Niagara University
Number of people (see text)	246	97	21	65	60
Conditions (prevalence odds ratio)	Hiatus hernia surgery (7.6) Other abdominal surgery (4.6) Loss of blood from stomach and bowels (5.6) Hiatus hernia (4.5) Benign tumor (3.4) Frequent cough (3.7) Use of skin medicine (2.6) Skin moles (2.5) Leg pain (2.5)	Cough (8.5) Hiatus hernia (7.4) Leg pain (4.7) Pain or aching of joints (3.7) Abdominal surgery (3.4) Back pain (2.4) Joint stiffness (2.7) Shortness of breath (2.2) Skin moles (2.7) Hip joint pain (2.6)	No significantly different prevalences	Hiatus hernia surgery (21.7) Abdominal surgery (7.6) Skin moles (2.6)	Hiatus hernia (11.2) Surgery for Hiatus hernia (21.3)

*Chi-square (p < .025)

APPENDIX A

Findings of NIOSH's Preliminary Investigation of Factories and Businesses Located Near the Hyde Park Landfill

This information is adapted from a draft report released May 7, 1979 and reflects only what NIOSH knew at that time concerning potential process-related exposures and health problems.

A. NL Industries, Inc.

1. Demographic Data

At the time of the NIOSH survey NL Industries employed approximately 260 people, including 160 in the production area, and 14 in the furnace room (alloy department).

Over the preceding 10 years, there had been an estimated 450 employees. Because of past hiring patterns, the age distribution of then current employees was somewhat unusual; most tended to be under 30 or over 50, with relatively few between 30 and 50.

2. Processes

NL Industries is a manufacturer of various metal alloy powders and sands used by the electronics, optical, refactory, and foundry industries. Basically there are three product systems: (a) Inorganic titanates; (b) Zirconium oxides; and (c) Zirconium silicates. A brief general overview of the associated processes follows:

a. Inorganic Titanates

The inorganic titanates include both alkaline earth metal titanates and alkaline metal titanates. The alkaline earth metal titanates are synthesized by mixing the oxide or other salts of the alkaline earths with titanium dioxide in the proper stoichiometric proportions and heating the mixture at elevated temperature until conversion to the desired titanate is completed. The titanate is then milled and packaged. The alkaline metal titanates are prepared by heating appropriate mixtures of sodium or potassium carbonates and titanium dioxide. The material is then either dry milled and packaged, or wet milled, dried, and packaged. The source of titanium dioxide is rutile.

b. Zirconium Oxides

The zirconium oxides are produced by direct arc furnacing of zircon sand (zirconium silicate), with volatilization of silicon dioxide and recovery of molten zirconium oxide. Arc furnacing of the zircon sand in the presence of sufficient carbon yields pigs of zirconium carbonitride. The zirconium carbonitride is burned in air yielding zirconium dioxide. Depending upon the minimum percent zirconium oxide desired in the product, the material may be calcined, milled, sized and bagged, or simply crushed, sized, then bagged. The latter may yield technical grade zirconium oxide containing approximately 88 percent minimum of zirconium oxide and 7 percent maximum of silicon dioxide.

c. Zirconium Silicates

The zirconium silicates are prepared from Australian zircon sand using standard calcining, milling (dry and wet) and drying techniques. The desired percent minimum purity of the zirconium silicate proouct will determine the nature of the material flow. Certain products having a minimum purity of 96.5 percent zirconium silicate require additional refining techniques.

3. Potential Process-Related Exposures

Substance	Principal Health Effects
Soluble barium compounds	Ingestion yields hypokalemia (low potassium level), decreased pulse rate, cardiac arrhythmia, muscular paralysis, gastrointestinal effects
Alkaline metal titanates	Considered physiologically inert
Alkaline earth metal titanates	Considered physiologically inert
Titanium oioxide	May cause pulmonary fibrosis
Crystalline silica	Pulmonary fibrosis (silicosis)

4. Health Problems

According to a union representative, eye and respiratory tract irritation were recognized as problems in the early 1970's, especially among workers in the yard area (which is immediately outside the furnace room and was within a few meters of the landfill runoff at the time). The union conducted a questionnaire survey of 165 production employees. Of the 91 respondents, 45 reported "sinus problems", 14 chronic bronchitis, 9 emphysema, 8 asthma, 10 "heart", 23 high blood pressure, 41 rashes, 35 "low or no energy", 26 eye irritation, 23 "tense (hyper)" (not all the same 23 with high blood pressure), 34 "sleep a lot", 14 "cysts", 11 "voice raspy", 15 "no sense of smell", 5 miscarriages, 5 menstrual problems among family members, and 14 cancer. We reviewed the respiratory data and found that 17 persons (19% of the respondents) had one or more of the three respiratory disorders (asthma, emphysema, chronic bronchitis); only one of these had asthma only.

NIOSH interviewed about 30 employees on April 4 and 5, 1979. Ten reported a rash, 6 high blood pressure, 5 respiratory problems, and lesser numbers other problems, including headache, sinus problems, gastrointestinal problems, miscarriages, and congenital or developmental disorders in offspring. Only two reported no health problem.

Six cases of skin cancer were reported. In four cases, the employee had worked in or near the furnace room, but in one case the employee had been out of the area about 10 years before the problem occurred, and in another the employee had been out for an unknown number of years (he died of cancer of the colon 28 years after being out of the furnace room).

The total number of reported skin cancer cases does not seem unexpected, but there is a suggestion of clustering around the furnace room.

Of the 11 reported cancers other than skin, only one definitely worked in or near the furnace room. Of the two reported cases of cancer in which the anatomic site is unknown, neither employee worked in or near the furnace room.

The company had 61 death certificates of persons who died while still employed or after having retired, but not for persons who died after having left without "retiring". The earliest certificate was 1959, but prior to the 1970's the collection seemed to be quite incomplete. The causes of death were cardiovascular (excluding stroke) - 25 persons, stroke - 8, cancer - 18, other - 9, unreadable - 1. The 18 cancer deaths include lung - 5; leukemia, colon, pancreas, and prostate - 2 each; stomach, tongue, breast, larynx, and fibrosarcoma (anatomic site not stated) - 1 each. Considering the number of deaths, neither the proportion of cancer deaths nor the distribution of anatomic sites seems unexpected.

B. Niagara Steel Finishing Company

1. Demographic Data

At the time of the NIOSH survey Niagara Steel Finishing Co. employed 50 to 55 people, all but nine in the production area. Over the previous 10 years, there had been an estimated 150 to 200 employees, but most of the turnover had been among new employees.

2. Processes

Niagara Steel Finishing Co. fabricates products varying from structural steel weldments, to complete process equipment and systems. Specific items are structural steel beams and plates, metal hoppers and chlorination tanks. The bulk material used is mild carbon steel (approximately 75%), with lesser amounts of stainless steel (approximately 10-15%) and copper cathode (approximately 10%). The metal components are assembled using electric arc, mig, or submerged arc welding.

3. Potential Process Related Exposures

Substance	Principal Health Effects
Copper fume	Metal fume fever; metallic taste; discoloration of hair and skin
Nickel fume	Dermatitis; lung and nasal cancer; metal fume fever
Iron oxide fume	Siderosis (a "benign" pneumoconiosis)
Fluorides	Eye and respiratory tract irritation; kidney and bone effects
Nitrogen oxides	Lung damage
Ozone	Headache and mucous membrane irritation

4. Health Problems

A report prepared by a local union representative cites a variety of health problems: skin cancer (3 persons); other skin problems (25); headache (9); bleeding from the nose (8); adverse reproductive events (6); lesser numbers of cases of eye, liver, lung, kidney, gastrointestinal, and arthritic problems; and rashes and other disorders in family members. In all, 34 employees reportedly had some health problem, 31 if reproductive problems and problems in other family members are excluded. Of these 31, 13 had problems involving only the skin. Nineteen of the 31 had what appeared to be more than one problem. Of the 12 with only a single problem, 10 had a skin problem.

Other data obtained from company and union representatives and from employees included one lung cancer death, one leukemia death, and possibly one other cancer death (anatomic site unknown). Employees reported a variety of health problems, including rashes. We examined some of these rashes and discerned no common pattern to them. Some were limited to a single location on unexposed skin and were thus most likely due to causes other than exposure to an airborne substance. Two cases were temporally associated with being outdoors near the landfill; the description in one case suggested angioneurotic edema involving the face and mouth.

The report of the a medical study conducted by the Oil, Chemical and Atomic Workers International Union on March 24, 1979 states that a "high percentage of the examined workers had abnormal findings by history, physical examination and/or laboratory testing of the following systems and organs: skin, respiratory, nervous, musculoskeletal, genitourinary, hematopoietic, reproductive and liver". It concludes that "these findings may at least in part be caused by exposure to welding fumes and noise ... within the plant but are primarily the result of exposures to chemical residues in the Hyde Park Landfill - probably via fumes".

C. Greif Brothers Corporation

1. Demographic Data

At the time of the NIOSH study Greif Brothers had about 89 employees, 59 of them in the production area. Over the preceding 10 years there had been an estimated 140 to 150 employees.

2. Processes

Greif Brothers Corporation is engaged in the fabrication of steel drums and plastic-lined composite drums ranging in size from 5 to 55 gallons. The drums are fabricated from light to heavy gauge steel and then spray painted in conventional booths. Approxiamately 50% of the drums also are coated with either a phenolic or epoxy resin or lacquer. The coatings are applied in the same manner as the external surface paints. Polyvinylchloride flow-in type gaskets are installed in certain types of drums.

3. Potential Process-Related Exposures

Substance	Principal Health Effects
Lead chromate	Lung cancer; neurologic, gastrointestinal, and hematologic disturbances
Vinyl chloride monomer	Angiosarcoma (a liver cancer)
Epoxy and phenolic resins	Eye and skin irritation
Xylene	Central nervous system effects; mucous membrane irritation
o-creosol	Skin, liver, kidney and pancreas effects
Isopropanol, ethanol, and n-butanol	Central nervous system effects; mucous membrane irritation
Methanol	Central nervous system effects; mucous membrane irritaton; metabolic acidosis; blindness
Methyl ethyl ketone	Dermatitis; central nervous system effects
Methyl cellosolve acetate	Eye irritation; dermatitis
Ethyl glycol monobutyl ether	Eye irritation; dermatitis; hemolytic anemia in animals

4. Health Problems

An employee questionnaire survey (number of respondents not known) found eight cancer deaths in the preceding eight years, 17 cases of rash, 10 cases of respiratory problems, and two cases of blood diseases. The questionnaire was identical to the one used at NL Industries. The summary data did not define what constituted a respiratory proolem. Also, the period of time during which these health problems occurred was not specified.

NIOSH interviews with the employees with the "blood diseases" revealed that neither case was actually a blood disease; one was a medical problem clearly not of occupational origin, and the other was a finding not generally suspected of being occupationally related. We did not interview a sufficient number of employees to evaluate other health problems.

We reviewed death certificates and other company death records. From these, and from interviews with company and union representatives, we found 27 deaths during or since 1959, 30 of them during or since 1970. The cause of death was known in 15 cases (nine from death certificates), all among the 20 who died during or since 1970. The causes of death were cardiovascular disorders - 6 persons, pulmonary disorders - 1, combined pulmonary/cardiovascular - 1, and cancer - 8 (lung - 2, colon -1, retroperitoneal sarcoma - 1, uncertain gastrointestinal site - 1, unknown site - 3).

Of the eight cancer deaths reported by the union, four were verified by death certificates; death certificates were not available for the other four. If all eight deaths were due to cancer, the proportion of cancer deaths is unexpectedly high. However, the small number of deaths precludes any statistically significant comparisons.

D. Niagara University

At the time of the NIOSH survey there were approximately 1060 employees, including 120 maintenance employees, 150 faculty members, and 890 employed students.

Neither administrative, student health, faculty, nor employee representatives knew of any health problems at Niagara University that might be related to exposure to substances coming from the landfill or from Bloody Run Creek. They were, however, concerned with the potential effects of such exposures.

The closest University buildings are located approximately 300 meters northwest of the landfill site, separated by Greif Brothers Corporation and a residential area. Blood Run Creek enters a 24-inch reinforced concrete sewer pipe approximately 60 meters from the nearest University buildings. This conduit then turns southwest and continues underground to its discharge point at the Niagara River approximately 400 meters to the southwest. Depths of the conduit increase steadily from approximately two to six meters as it parallels Niagara University's property line to the river.

The only preceived potential problem regarding Bloody Run Creek as it passes underground to the river is that the storm runoff drains in the parking lots and other locations are connected to Bloody Run culvert. These areas conceivably could become contaminated via back-drafting of vapors and gases.

A concern voiced by the president of the Fireman and Oilers Union (the University maintenance workers union) pertains to the possibility of contaminated ground water leaking into low basement areas and, most importantly, the heating tunnel. A maintenance project planned for the summer of 1979 would require employees to work in the tunnel for approximately three months. During the April 4 visit we observed water penetration through the walls. We thought it unlikely that this was contaminated by Bloody Run Creek since drainage from the University area is toward the creek, but thought the possibility should be ivestigated anyway.

E. Niagara Monument Works, Inc. and Plaza Self-Service Mobil Station

Niagara Monument Works and the Mobil station had five and two employees, respectively, at the time of the NIOSH survey. The owner and manager, respectively, reported health problems among themselves and/or their employees. These included respiratory, psychiatric, and dermatologic problems. The owner of Niagara Monument Works also expressed concern regarding whether vegetables grown in a garden located directly behind the company and as near as 3 meters from the chemical dump were safe to eat.

APPENDIX

Environmental Sampling and A[illegible]ical Procedures*

Hyde Park Landfill Study

Niagara Falls, New York

1979-1980

Substance	Sampling and Analytical Procedure
Inorganic lead	NIOSH P&CA Method 173: 0.8 um DM-800 membrane filter; atomic asborption spectrophotometry.
Soluble barium	NIOSH P&CA Method S198-1: 0.8 um DM-800 membrane filter; atomic absorption spectrophotometry.
Zirconium	NIOSH P&CA Method S185: 0.8 um DM-800 membrane filter; atomic absorption spectrophotometry.
Total dust	0.8 um DM-800 membrane filter; total dust determined gravimetrically be weight gain.
Optical radiation	Refer to Appendix C, Document 6.
Copper	NIOSH P&CA Method 173: 0.8 um DM-800 membrane filter; atomic absorption spectrophotometry.
Iron	NIOSH P&CA Method 173: 0.8 um DM-800 membrane filter; atomic absorption spectrophotometry.
Organic compounds (xylene, toluene, ethanol, methyl ethyl ketone, n-butyl alcohol, methyl cellosolve acetate)	NIOSH P&CA Method 127: 150 mg activated charcoal, carbon disulfide desorption, electron-capture gas chromatography.
Lindane	NIOSH P&CA Method S290: Electron-capture gas chromatography.
Mirex	Electron-capture gas chromatography.
Dioxin	Capillary column gas chromatography - mass spectrophotometry.

*National Institute for Occupational Safety and Health: NIOSH Manual of Analytical Methods, 2nd ed., volumes 1-5, 1977 (vols. 1-3), 1978 (vol. 4), 1979 (vol. 5), DHEW (NIOSH) Publication Nos. 77-157-A, 77-157-B, 77-157-C, 78-175, 79-141.

APPENDIX C

NIOSH Reports of Environmental Findings and Recommendations for Correcting Health Hazards.

Document 1 - Synopsis of Investigation, December 19, 1979.

Document 2 - Summary of Mirex, Lindane and Tetrachlorodibenzo-p-dioxin Sample Analysis, January 1980.

Document 3 - Interim Report: NL Industries, Inc., July 12, 1980.

Document 4 - Interim Report: NL Industries, Inc., August 22, 1979.

Document 5 - Interim Report: NL Industries, Inc., October 23, 1979.

Document 6 - Optical Radiation Levels Produced by Direct Arc Furnaces: NL Industries, Inc., June 1980.

Document 7 - Interim Report: Niagara Steel Finishing Company, September 7, 1979.

Document 8 - Interim Report: Greif Brothers Corporation, October 1, 1979.

Document 9 - Interim Report No. 2: Greif Brothers Corporation, April 1980.

APPENDIX C
Document 1

SYNOPSIS OF INVESTIGATION*

HYDE PARK LANDFILL CHEMICAL DISPOSAL SITE
NIAGARA FALLS, NEW YOIR

PROJECT NO. TA 79-22
HAZARD EVALUATION AND TECHNICAL ASSISTANCE BRANCH
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

Since March 1979, NIOSH has been involved in a multiple agency effort to determine the health and environmental impacts of the Hyde Park Landfill Site. NIOSH's involvement resulted from OSHA's Technical Support Directorrate and representatives of the United Steel Workers of America and Oil, Chemical and Atomic Workers International Unions independent requests for Health Hazard Evaluations of workplaces adjacent to the Landfill Site. NIOSH's investigatory effort has focused primarily on employees of the three industrial plants which abut the Landfill Site (NL Industries, Inc., Greif Brothers Corporation, and Niagara Steel Finishing Company), Niagara University maintenance employees, and adults and children who resided to the east of Hyde Park Boulevard between the Greif Brother's plant and Niagara University.

Environmental Effort:

The environmental investigation has involved a cooperative effort between NIOSH, OSHA, and U.S. EPA. NIOSH and OSHA evaluated the potential occupational exposures related to the manufacturing processes and the Landfill; U.S. EPA evaluated the ambient air quality on the Landfill site. Both environmental, as well as in-plant occupational exposures were evaluated, in order that NIOSH could separate any adverse health effects due to exposures to chemicals from the Landfill and from those due to process exposures.

NIOSH conducted environmental testing at NL Industries, Inc., on June 11-15, 1979. Samples of settled dust collected from the rafters of a building nearest the south border of the Landfill suggest that airborne exposures to 2,3,7,8-tetrachlorodibenzo-p-dioxins (2,3,7,8-TCDD) have occurred in the past. The extent, degree, or timing of possible past worker exposures is, however, well beyond conjecture, and cannot be determined from these sample results. A sample of sediment collected from the elevator shaft in the same building indicates possible migration of dibenzodioxins from the Landfill. Quantification of 2,3,7,8-TCDD in this sample was impossible because of the presence

*Presented at a meeting with the affected labor unions, industry and community residents on December 19, 1979, Niagara Falls, New York. Prepared by John R. Kominisky, Mitchell Singal, M.D. and Philip J. Landrigan, M.D.

of polychlorinated biphenyl's (PCB). Process exposures by workers in the Dielectric's Department to airborne inorganic lead and total soluble barium exceeded the OSHA health standards. Process exposures by workers in the Alloy and Ceramics Departments to airborne zirconium and nuisance particulates, respectively, exceeded the OSHA health standards. Exposures by persons working at the electric arc furnaces to actinic ultraviolet, visible and infrared radiation regions of the spectrum emitted exceeded recommended occupational health standards. Worker exposure to the radiation, however, was minimized by use of personal protective equipment and other shielding devices.

Environmental testing was conducted at Greif Brothers Corporation on June 25-29, July 17-18 and November 10-11, 1979. Testing was conducted of the environments within two manholes which provided access to a 24" diameter conduit located beneath the facility. Drainage water and chemical leachate from the Landfill did or still flows through the conduit. The atmosphere within the first manhole (located outside of the facility) contained <2.0 ng/m^3 of 2,3,7,8-TCDD. A sediment sample contained 3.7 ng 2,3,7,8-TCDD and 5.0 ng 1,2,3,4-TCDD. A water sample contained <1.8 ng/2,3,7,8-TCDD. Analysis of the samples obtained within the second manhole (located within the facility) has not been completed. A sediment sample obtained at the effluent end of the conduit contained 33 ng 2,3,7,8-TCDD, 71 ng 1,3,6,8-TCDD, and 14 ng of an unidentified TCDD isomer. Process exposures by spray painters to xylene, toluene, methyl ethyl ketone, n-butyl acetate, methyl cellosolve acetate, and isopropanol were not toxic to the workers when considered either individually or combined.

NIOSH conducted environmental testing at Niagara Steel Finishing Company on June 25-28, 1979. Samples of settled dust collected from within the main ventilation duct and from a rafter contained 2,3,7,8-RCDD. Quantification of the TCDD was impossible because of the presence of PCB's. These results also suggest that exposures to airborne dibenzodioxins have occurred in the past. A water sample obtained from a "wet area" in the assembly yard contained no detectable (<1 ng 2,3,7,8-TCDD). Process exposures by "Class A" welders to copper fume exceeded the OSHA health standard.

Environmental testing was conducted at Niagara University on June 28, 1979. Samples of sediment and water obtained from two heating tunnels and a pumping station contained no detectable (<1 ng 2,3,7,8-TCDD). A sample of the insulation around the steam pipes in the main heating tunnel did not contain asbestos.

During March and April 1979, OSHA established a comprehensive network of air sampling sites to document occupational exposures to chemicals associated with the Landfill. The OSHA air sampling data show that the workers were potentially exposed to minimal levels of many organic chemicals most probably originating from the Landfill. The exposures measured do not represent an inhalation hazard (by current occupational health standards) to the workers potentially exposed. These results, however, only reflect the exposures which existed during the period of the environmental investigation. They certainly do not reflect the exposures that may have occurred prior to installation of the compacted clay cover over the entire Landfill site, and the other associated remedial activities as part of the 1972 closure plan. Prior to that time, workers complained of coughing and sore throats resulting from what they described as "obnoxious and corrosive fumes permeating from the disposal site." During such exposures workers had to sometimes evacuate their workplaces.

U.S. EPA conducted air sampling at the Landfill during the week of July 9, 1979. Analysis of these test results is in progress by U.S. EPA.

Approximately 425 people participated in the medical testing, which was conducted June 4-8 and August 6-8, 1979. Participants included approximately 290 current employees, 75 former employees, and 60 current and former area residents (including children). Approximate participation rates for current employees were: NL Industries - 42%, Niagara Steel Finishing Co. - 66%, Greif Brothers Corp. - 84%, Niagara University maintenance personnel - 79%. About 90% of current residents of the target neighborhood participated.

Of 527 former employees, 466 had a last known address in the Niagara Falls/ Buffalo area. We attempted to notify all of them by mail, but 180 letters were undeliverable. (We also notified every radio and television station and every general circulation and community newspaper in the Niagara Falls/ Buffalo area.) Ninety-five (33%) of the 286 persons who presumably received the notification letter returned the enclosed post card, to express interest in the study, and 65 of these (14% of the 466) subsequently participated.

Data analysis is currently in progress. Thus far we have only the following definitive data:

A) Concerning all adult participants
   (1) There is no current evidence of chloracne by physical examination.
   (2) There is no evidence of excess occurrence of thyroid nodules.

B) Concerning a 55 person random sample of adult participants.
   (1) There were no detectable blood levels of mirex (limit of detection: 2 ppb).
   (2) Three persons (2 from Greif Brothers, 1 from Niagara University) had blood levels of lindane between 0.5 and 3 ppb. The epidemiologic and medical significance of this finding is unknown since lindane is available as prescription medication and has been available in pesticides for household use.

C) Concerning each of the three major industrial establishments, we found no excess prevalence of blood cell, liver, or kidney abnormalities.

Further evaluations of the medical data are in progress and will be made public as soon as they are available. Two major issues to be considered in this evaluation will be (1) that there may be individual cases in Niagara Falls of disease caused by chemicals from the Landfill despite the absence of any detectable overall increases in disease incidence; and (2) that persons exposed to chemicals from the Landfill may be at risk of delayed illness, including cancer, caused by exposure to chemicals from the Landfill, which has not yet become evident because of prolonged latency periods.

APPENDIX C
Document 2

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Center for Disease Control
National Institute for Occupational Safety and Health
Cincinnati, Ohio 45226

HAZARD EVALUATION AND TECHNICAL ASSISTANCE BRANCH
PROJECT NO. TA 79-22

SUMMARY OF MIREX, LINDANE AND TETRACHLORODIBENZO-p-DIOXIN SAMPLE ANALYSIS*
HYDE PARK LANDFILL CHEMICAL DISPOSAL SITE
NIAGARA FALLS, NEW YORK

January 1980

The National Institute for Occupational Safety and Health (NIOSH) collected environmental samples for mirex, lindane and tetrachlorodibenzo-p-dioxins (TCDD) at NL Industries, Inc., Niagara Steel Finishing Company, Greif Brothers Corporation, and Niagara University during June 11 through December 27, 1979. This report summarizes the available results (Table I).

Samples of settled dust collected from the rafters at NL Industries, and from within the central ventilation duct and a rafter at Niagara Steel Finishing Company suggest that airborne exposures to mirex, lindane, and TCDD have occurred in the past. A sample of bottom sediment collected from a sand elevator pit in Building 145 at NL Industries indicates migration of these three chemicals from the Landfill. High concentrations of polychlorinated biphenyls (PCB) were also determined present in this sample. Samples of bottom sediment taken from within the Bloody Run Creek conduit beneath the Greif Brothers Corporation plant contained mirex, lindane and four isomers of TCDD. No TCDD was detected in air samples taken from within the influent end of the Bloody Run conduit on July 17 and 18, 1979. Samples of bottom sediment and water obtained from two heating tunnels and from a pumping station at Niagara University contained no detectable mirex, lindane or TCDD.

No definitive assessment of the hazard to the workers potentially exposed to the settled dust containing mirex, lindane and TCDD can be made. However, because these chemicals are known or suspected of causing cancer and reproductive effects, and because they may become re-entrained into the workplace atmosphere, maximum protection of human health must be effected. Therefore, it is recommended that NL Industries, Inc. and Niagara Steel Finishing Company remove the contaminated dust. Vacuum procedures or other methods which would minimize re-entrainement of the particulate should be used. Additionally, NL Industries should seal-off or remove the contaminated sediment from the elevator shaft in Building 145. NIOSH personnel are available to offer recommendations concerning the use of personal protective equipment by the workers involved in the clean-up.

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*Prepared by John R. Kominsky and Philip J. Landrigan, M.D., NIOSH, Cincinnati, Ohio 45226

The available sample results clearly document that Bloody Run Creek is contaminated with mirex, lindane and TCCD. However, the health significance of these data with respect to Greif Brothers employees can not be interpreted until all of the samples obtained at Greif Brothers have been analyzed.

Bloody Run Creek does not appear to be presenting any apparent health hazard to the employees at Niagara University.

TABLE 1

SUMMARY OF MIREX, LINDANE AND 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN SAMPLE ANALYSIS

HYDE PARK LANDFILL CHEMICAL DISPOSAL SITE
NIAGARA FALLS, NEW YORK

PROJECT NO. TA 79-22
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

JANUARY, 1980

Sample Date	Sample No.	Sample Location	Sample Type/Description	Concentration - ppb Mirex	Lindane	2,3,7,8,-TCCD	Remarks
6-14-79	B-01	NL Industries, Inc.	Sediment: Bldg. 145 - bottom sand elevator shaft.	47,000	30200		TCDD present; PCB interferences prevented quantification.
"	B-02	" " "	Settled dust: Bldg. 145 - rafters.	<7*	5	0.7	
"	B-03	" " "	" " " "	17	79		Samples B-03/B-04 were combined. TCDD was present in mixture; poor recoveries of internal TCDD standard prevented quantification.
"	B-04	" " "	" " " "	12	22		
6-27-79	B-08	Niagara Steel Finishing Co.	Settled dust: Rafter along north wall.	<12	12		TCDD present; PCB interferences prevented quantification.
"	B-09	" " "	Water: Assembly yard drainage ditch	<2	<2	<0.2	
"	B-10	" " "	Settled dust: Assembly yard - roof of structure housing ventilation system fan.	<3	<1		TCDD present; PCB interferences prevented quantification.
"	B-11	" " "	Settled dust: Central ventilation duct along Bay 3.	280	33		" " " "
6-[illegible]-79	B-05	Niagara University	Sediment: Heating tunnel beneath Mead Hall.	<2	<6	<0.7	
"	B-06	" "	Water: Pumping station at SW side of Science Bldg.	<2	<2	<0.3	
"	B-07	" "	Water: Heating tunnel beneath Lynch Hall	<2	<2	<0.3	
7-17-79	B-100	Greif Brothers Corp.	Sediment: Influent end - conduit beneath plant.	16	14	0.3	Also contained 0.4 ppb 1,2,3,4-TCDD.
"	B-101	" " "	Water: Influent end - conduit beneath plant.	<2	<2	<0.2	
"	I-01	" " "	Air: Influent end - conduit beneath plant			<2	Sample was not analyzed for mirex and lindane.
"	B-102	" " "	Sediment: Effluent end-conduit beneath plant.	88	<8	4.5	Also contained 9.7 ppb 1,3,6,8-TCDD and 1.9 ppb of an unidentified TCDD isomer.

*The less than (<) value is the limit of analytical detection for the sample.

APPENDIX C
Document 3

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

INTERIM REPORT
HEALTH HAZARD EVALUATION PROJECT NO.
HE 79-71

NL INDUSTRIES, INC.
NIAGARA FALLS, NEW YORK

JULY 12, 1979

I. INTRODUCTION

This interim report presents available results of the environmental sampling conducted by the National Institute for Occupational Safety and Health (NIOSH) in the Dielectrics Department of NL Industries during June 11-15, 1979. This survey was conducted as part of NIOSH's involvement in the multiple agency effort to assess the health and environmental impacts of the Hyde Park Landfill Chemical Disposal Site in Niagara Falls, New York. Interim Report No. 1 (May 7, 1979) detailed background information and plans for the NIOSH investigatory effort.

II. METHODS

Air sampling was conducted on three consecutive days to evaluate the jet mill operators exposures to inorganic lead dust. The sampled operation consisted of the manual screening of TAMTRON® 5036 - a lead bearing barium titanate dielectric powder. Lead-in-air samples were collected and analyzed in accordance with the NIOSH recommended methods (P&CAM 173) using calibrated personal sampling pumps operating at 1.5 liters per minute and 0.8 μm DM-800 membrane filters in 2-piece, closed face cassettes. The filters were digested with nitric acid and analyzed using atomic absorption spectrophotometry.

III. FINDINGS AND DISCUSSION

The results of the air sampling are shown in Table I. All (3/3) of the samples exceeded the 8-hour time-weighted average (TWA) 50 $\mu g/M^3$ OSHA Standard for inorganic lead (29 C.F.R. 1910.1025) as well as the 100 $\mu g/M^3$ NIOSH Recommended Criteria. Sixty-six percent (2/3) of the samples exceeded 200 $\mu g/M^3$.

The OSHA 8-hour TWA for inorganic lead standard was reduced from 200 $\mu g/M^3$ to 50 $\mu g/M^3$. However, pending current litigation of the 50 $\mu g/M^3$ lead standard, employers must achieve the 200 $\mu g/M^3$ level through engineering and administrative controls, and must protect workers at the 50 $\mu g/M^3$ level through any combination of controls including the use of proper respirators. The jet mill operators wore approved respirators for inorganic lead during the period of the evaluation.

IV. RECOMMENDATIONS

The jet mill operators were exposed to toxic concentrations of inorganic lead during screening of a lead bearing barium titanate. It is recommended that NL Industries' existing environmental and medical surveillance programs be thoroughly reviewed and amended according to the OSHA inorganic lead standard (29 C.F.R. 1910.1025).

Submitted By: John R. Kominsky

John R. Kominsky, M.S.
Project Officer
Hazard Evaluations and Technical Assistance Branch

Originating Office: Jerome P. Flesch
Acting Chief
Hazard Evaluations and Technical Assistance Branch

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Mr. Rinker, USWA
Mr. Wright, USWA
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Dr. Heins, OSHA

JRK/dm

Table I

Personal Exposures to Inorganic Lead Dust During Manual Screening of TAMTRON® 5036

NL Industries, Inc.
Niagara Falls, New York

June 12-15, 1979

Date	Job Classification	Sample Period	Sample Volume - Liters	Air Concentration - ug Pb/M^3
6/12	Jet Mill Operator	0631-1152 1234-1429	654	275
6/13	Jet Mill Operator	0637-1151 1234-1422	633	174
6/14	Jet Mill Operator	0645-1154 1236-1428	631	570

APPENDIX C
Document 4

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

INTERIM REPORT
HEALTH HAZARD EVALUATION PROJECT NO.
HHE 79-71

NL INDUSTRIES, INC.
NIAGARA FALLS, NEW YORK

August 22, 1979

I. INTRODUCTION

This Interim Report presents the final set of results of the environmental sampling conducted by the National Institute for Occupational Safety and Health (NIOSH) in the Dielectric's Department of NL Industries during June 11-14, 1979. This survey was conducted as part of NIOSH's involvement in the multiple agency effort to assess the health and environmental impacts of the Hyde Park Landfill Chemical Disposal Site in Niagara Falls, New York. Interim Report No. 1 (May 7, 1979) detailed background information and plans for the NIOSH investigation. Interim Report No. 2 (July 31, 1979) provided a summary of NIOSH's progress and future plans.

II. METHODS

Air sampling was conducted on three consecutive days to evaluate the workers' exposures to total soluble barium and total particulate during the manufacture of a barium dielectric powder. Basically, the process consisted of mixing barium carbonate with titanium dioxide; heating the mixture to effect conversion to barium titanate; dry or wet milling to achieve the desired particle size; completed with packaging of the metatitanate. Total soluble barium and total particulate samples were concurrently collected using calibrated personal sampling pumps operating at 1.5 L/min and 0.8 um DM-800 membrane filters in 2-piece, closed faced cassettes. Each filter was prepared and analyzed for total soluble barium as barium by atomic absorption spectrophotometry according to NIOSH Method S198-1; total particulate was determined gravimetrically by weight gain.

III. FINDINGS AND DISCUSSION

The personal exposures to total soluble barium and total particulate measured on June 12, 13 and 14 are presented in Table 1. On two of the three days sampled, exposures by the dryer operator to total soluble barium and total particulate exceeded the 0.5 mg/m^3 and 10.0 mg/m^3

Threshold Limit Values (TLV), respectively, recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Although the data is limited, it (mean 0.96, S.D. ± 0.77 and mean 22.0, S.D. ± 21,5, respectively) indicates that there is a significant variation in the exposure concentrations each day. This may be attributable to a variety of reasons including variation in the operating characteristics of the manufacturing process, the efficacy of its ventilation system, and employee work practices. Unfortunately, time and limited manpower resources afforded the NIOSH investigatory team did not permit close observation of these considerations during the June survey.

Inhalation of certain barium compounds can cause irritation of the respiratory tract. Certain barium compounds can also irritate the eyes and skin. Ingestion of soluble barium compounds may have toxic effects on muscles, however, this is not ordinarily a problem for occupational exposure.

Exposures of the millmen, calciner, and dust collector tender to total soluble barium and total particulate did not exceed the referenced ACGIH TLV's.

IV. RECOMMENDATIONS

The dryer operator's were exposed to potentially harmful concentrations of total soluble barium and total particulate. Although NIOSH approved respirators were available, their use by the dryer operators was intermittent. It's recommended that NL Industries review the subject manufacturing process with respect to its particulate control systems, operating characteristics, and conditions of employee exposure and work practices. The above considerations should be coupled with additional environmental testing. The dryer operators should wear NIOSH approved respirators, until the levels of the said contaminants remain below the referenced occupational health criteria.

V. FUTURE ACTIONS

Environmental testing results remain to be reported for:

1. Zirconium and its related particulate.
2. Ultraviolet radiation testing.
3. Mirex, lindane and dioxins in sediment and rafter dust samples in Building 145.

Submitted By:

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Mr. Wright, USWA, International
Honorable John La Falce
Mr. Bernard - OSHA
Mr. Heins - OSHA
Mr. Barden - OSHA

JRK/cs

TABLE I

Personal Exposures to Total Soluble Barium and Total Particulate
NL Industries, Inc.
Niagara Falls, New York
June 12-15, 1979

Date	Sample Description	Sample Volume Liters	Airborne Concentration - mg/m³: Total Soluble Barium	Mean	S.D.±	Total Particulate	Mean	S.D.±
6/12	Dryer Operator	667	1.7			18.9		
6/13	Dryer Operator	639	1.0			44.9		
6/14	Dryer Operator	649	0.17			2.3		
				0.96	0.77		22.0	21.5
6/12	Millmen	657	0.12			1.8		
6/13	Millmen	634	0.16			1.5		
6/14	Millmen	649	0.42			3.3		
				0.23	0.16		2.2	0.96
6/12	Calciner	654	0.13			5.8		
6/13	Calciner	630	0.11			2.0		
6/14	Calciner	645	0.20			2.9		
				0.15	0.05		3.6	2.0
6/12	Dust Collector Tender	669	0.08			2.2		
6/13	Dust Collector Tender	664	0.02			0.94		
6/14	Dust Collector Tender	672	0.22			2.3	1.8	0.76
				0.11	0.10			
Environmental Criteria[1]			0.50			10.0		

[1] ACGIH TLV (1978), 8-hour Time-Weighted Average.

APPENDIX C
Document 5

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

INTERIM REPORT
HEALTH HAZARD EVALUATION PROJECT NO.
HHE 79-71

NL INDUSTRIES, INC.
NIAGARA FALLS, NEW YORK 14305

October 23, 1979

I. INTRODUCTION

This Interim Report presents the results of the aerometric testing conducted by the National Institute for Occupational Safety and Health (NIOSH) in the Alloy and Ceramics Departments, and ST Plant during June 11-14, 1979. This survey was conducted as part of NIOSH's involvement in the multiple agency effort to assess the health and environmental impacts of the Hyde Park Landfill Chemical Disposal Site in Niagara Falls, New York. Interim Reports I and II (May 7 and July 31, 1979, respectively) provide background information on the NIOSH investigation.

II. METHODS

Aerometric testing was conducted in the Alloy and Ceramics Departments to evaluate concurrent exposures by workers to total zirconium and total particulate on June 12-14. Aerometric testing was conducted in the ST Plant to evaluate exposures by workers to total particulate. Total zirconium and total particulate samples were collected using calibrated personal sampling pumps operating at 1.5 L/min and 0.8 µm DM-800 membrane filters in 2-piece, closed-faced cassettes. Each filter was prepared and analyzed for total zirconium as zirconium by atomic absorption spectrophotometry according to NIOSH Method S185. The total particulate was determined gravimetrically by weight gain.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends an 8-hour Time-Weighted Average (TWA) Threshold Limit Value (TLV) of 5.0 mg/M^3 total zirconium. The 5.0 mg/M^3 TLV was set by the ACGIH on the basis of the lack of effect of zirconium dioxide dust and zirconium tetrachloride mist in animals exposed for one year to approximately 3.5 mg/M^3, as well as the recognized low toxicity of

APPENDIX C
Document 5

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

INTERIM REPORT
HEALTH HAZARD EVALUATION PROJECT NO.
HHE 79-71

NL INDUSTRIES, INC.
NIAGARA FALLS, NEW YORK 14305

October 23, 1979

I. INTRODUCTION

This Interim Report presents the results of the aerometric testing conducted by the National Institute for Occupational Safety and Health (NIOSH) in the Alloy and Ceramics Departments, and ST Plant during June 11-14, 1979. This survey was conducted as part of NIOSH's involvement in the multiple agency effort to assess the health and environmental impacts of the Hyde Park Landfill Chemical Disposal Site in Niagara Falls, New York. Interim Reports I and II (May 7 and July 31, 1979, respectively) provide background information on the NIOSH investigation.

II. METHODS

Aerometric testing was conducted in the Alloy and Ceramics Departments to evaluate concurrent exposures by workers to total zirconium and total particulate on June 12-14. Aerometric testing was conducted in the ST Plant to evaluate exposures by workers to total particulate. Total zirconium and total particulate samples were collected using calibrated personal sampling pumps operating at 1.5 L/min and 0.8 μm DM-800 membrane filters in 2-piece, closed-faced cassettes. Each filter was prepared and analyzed for total zirconium as zirconium by atomic absorption spectrophotometry according to NIOSH Method S185. The total particulate was determined gravimetrically by weight gain.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends an 8-hour Time-Weighted Average (TWA) Threshold Limit Value (TLV) of 5.0 mg/M^3 total zirconium. The 5.0 mg/M^3 TLV was set by the ACGIH on the basis of the lack of effect of zirconium dioxide dust and zirconium tetrachloride mist in animals exposed for one year to approximately 3.5 mg/M^3, as well as the recognized low toxicity of zirconium compounds by most routes. The ACGIH recommends an 8-hour TWA TLV of 10.0 mg/M^3 for total (nuisance) particulates. Current literature indicates that inhalation of excessive amounts of nuisance particulates cause no adverse effects in the lung; elevated concentrations reduce visibility and may result in unpleasant deposits in the eyes and nose, plus injury to the mucous membranes through mechanical action.

III. FINDINGS AND DISCUSSION

Table I presents the personal exposures to total zirconium and total particulates measured in the Alloy Department of June 12-14. The most significant exposures were associated with remedial activities. The highest exposure (147.0 mg/M^3 total zirconium and 233.5 mg/M^3 total particulates) was determined for a laborer while cleaning the conveyor bucket pit in the burning room. A dust collector tender and roll crusher operator were exposed to excessive levels of total zirconium (46.5 and 6.0 mg/M^3, respectively) and total particulates (114.3 and 43.3 mg/M^3, respectively). A significant portion of the exposures of these latter employees was contributed by their activity in re-bagging of a dust collector. The dust collector tender re-bagged for 2.5 hours resulting in a total zirconium and total particulate exposure of 115.0 and 229.3 mg/M^3, respectively. The crusher operator re-bagged for 1.9 hours resulting in a total zirconium and total particulate exposure of 16.9 and 140.6 mg/M^3, respectively. Although, these workers wore single-use particulate removing type respirators (3M #9900 or Wilson #1400), their measured exposures exceeded the maximum concentration of the contaminants against which these respirators may be used. The maxiumum concentration for which these respirators can be used is 25 mg/M^3, calculated as five times the permissible exposure limit (5 mg/M^3). Five (5) is the established protection factor for single-use particulate removing respirators. Three other workers, including a furnace operator, laborer, and roll crusher refractory operator, were exposed to excessive concentrations of total particulates.

Table II presents the personal exposures to total zirconium and total particulate measured in the Ceramics Department on June 12-14. All of the exposures were less than the referenced occupational health criteria, except those for the dust collector tender. On June 12, the dust collector tender was exposed to 76.8 mg/M^3 total zirconium and 187.7 mg/M^3 total particulates. The high exposure in part is attributable to the worker emptying dust collectors for 16 houses. The same worker also was exposed to total particulate levels (25.0 and 18.2 mg/M^3) in excess of the referenced criteria on June 13 and 14. This worker also wore a single-use particulate removing respirator; however, its respiratory protection capabilities were exceeded, as described above.

Table III presents the personal exposures of total particulate measured in the ST Plant on June 13-14. On both days, the mixman was exposed to total particulates (average concentration of 17.7 mg/M^3) in excess of the 10.0 mg/M^3 criteria. Two laborers were exposed to excessive concentrations of total particulates (14.7 and 14.1 mg/M^3) while packing granular rutile. A third laborer was exposed to excessive concentrations of total particulate (13.8 mg/M^3) while screening sodium titanate and operating the hammer mill. These workers were not observed wearing respirators.

IV. RECOMMENDATIONS

1. Until the levels of airborne total zirconium and total particulates are reduced below the referenced occupational health criteria, the affected workers should wear appropriate respirators. Respiratory protection should be selected according to the measured workplace contaminant exposure concentrations. In describing use of protection factors in respirator selection, it is assumed that a complete respirator program is in force. A protection factor is not applicable if the wearer cannot satisfactorily seal the respirator to his/her face or head. Anything (such as facial hair) that prevents satisfactory sealing of a respirator nullifies application of a respirator protection factor. A protection factor can be used only if the respirator is in good operating condition. Appendix I provides respirator protection factors that should be considered in selecting respirators.*

V. FUTURE ACTIONS

1. Environmental testing results remain to be reported for the sediment and rafter dust samples obtained in Building #145. To date, the analysis of these samples for Mirex, lindane, and dioxins have not been received.

2. Analysis of the results of the medical testing conducted June 4-8 and August 6-8, 1979, is in progress.

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*Appendix I, which has been omitted from this report reproduction, is a copy of pages 54-56 of A Guide to Industrial Respiratory Protection, DHEW (NIOSH) Publication No. 76-189, 1976.

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JRK/mw

TABLE I

ALLOY DEPARTMENT - PERSONAL EXPOSURES TO TOTAL ZIRCONIUM AND TOTAL PARTICULATE

NL INDUSTRIES, INC.
NIAGARA FALLS, NEW YORK

June 12-14, 1979

			AIRBORNE CONCENTRATION - mg/M3					
DATE	SAMPLE DESCRIPTION	SAMPLE VOLUME LITERS	TOTAL ZIRCONIUM	MEAN	S.D.±	TOTAL PARTICULATE	MEAN	S.D.±
6/12	Furnace Operator I	648	1.7			7.0		
6/13	Furnace Operator I	720	0.69			2.9		
6/14	Furnace Operator I	720	1.7			5.5		
				1.4	0.58		5.2	2.1
6/12	Furnace Operator II	711	2.1			6.6		
6/13	Furnace Operator II	720	3.2			12.8		
6/14	Furnace Operator II	720	1.9			6.0		
				2.4	0.70		8.5	3.8
6/12	Crane Operator	741	0.94			3.1		
6/13	Crane Operator	724	0.83			2.6		
6/14	Crane Operator	717	3.2			6.6		
				1.7	1.3		4.1	2.2
6/12	Laborer	735	2.2			5.5		
6/13	Laborer	739	1.2			3.7		
6/14	Laborer	735	4.6			13.6		
				2.6	1.8		7.6	5.3
6/12	Dust Collector Tender	715	1.1			4.4		
6/13	Dust Collector Tender	679	1.3			5.6		
6/14	Dust Collector Tender	613	*46.5			*114.5		
				16.3	26.2		41.5	63.2
6/12	Roll Crusher Refractory Operator	654	4.3			17.1		
6/13	Roll Crusher Refractory Operator	675	6.8			12.5		
6/14	Roll Crusher Refractory Operator	709	**6.0			**43.3		
				5.7	1.3		24.3	16.6
6/12	Laborer	694	***147.0			233.5		
Environmental Criteria (1)			5.0			10.0		

* Re-bagged dust collector for 2.5 hours of the 8-hour workday. The zirconium and total particulate exposure concentrations contributed by this activity were 115.0 and 229.3 mg/M^3, respectively.

** Re-bagged dust collector for 1.9 hours of the 8-hour workday. The zirconium and total particulate exposure concentrations contributed by this activity were 16.9 and 140.6 mg/M^3, respectively.

*** Cleaned the conveyor bucket pit in the burning room.

(1) ACGIH TLV's (1979), 8-hour Time-Weighted Averages.

TABLE II

*CERAMICS DEPARTMENT - PERSONAL EXPOSURES TO TOTAL ZIRCONIUM AND TOTAL PARTICULATE

NL INDUSTRIES, INC.
NIAGARA FALLS, NEW YORK

June 12-1-, 1979

DATE	SAMPLE DESCRIPTION	SAMPLE VOLUME LITERS	AIRBORNE CONCENTRATION mg/M^3 TOTAL ZIRCONIUM	TOTAL PARTICULATE	COMMENTS
6/12	Dust Collector Tender	651	76.8	187.7	Emptied dust collectors for 16 houses
6/13	Dust Collector Tender	646	1.7	25.0	
6/14	Dust Collector Tender	695	1.4	18.2	
6/13	Hyster Operator	636	**LLD	5.9	
6/14	Hyster Operator	586	LLD	4.4	
6/12	Millman A	630	LLD	1.4	
6/13	Millman A	649	LLD	2.4	
6/14	Millman A	656	LLD	3.5	
6/12	1st Millman	646	LLD	8.8	
6/13	1st Millman	666	LLD	5.1	
6/14	1st Millman	652	LLD	6.6	
/14	2nd Millman	624	0.41	3.9	
6/13	1st Operator	702	0.43	3.0	
6/12	2nd Operator	646	LLD	7.1	
6/13	Calciner Operator	616	LLD	3.5	
6/14	Calciner Operator	628	LLD	1.9	
6/12	Laborer B	639	LLD	1.5	Shovelled zircon sand
6/12	Laborer C	597	LLD	1.8	Packaged zircon sand
6/12	Laborer E	715	0.84	3.6	Shovelled zircon sand/stacked bricks
6/12	Laborer F	702	0.57	6.1	Shovelled zircon sand/stacked bricks
6/14	Laborer A	656	0.61	8.8	Cleaned around dryer #1
6/14	Laborer C	710	LLD	1.6	Packed zircon sand
Environmental Criteria (1)			5.0	10.0	

* Does not include ST Plant.
** Lower Limit of Detection. The LLD is 20 ug per sample.
(1) ACGIH Threshold Limit Values (1979), 8-hour Time-Weighted Average.

TABLE III

ST PLANT - PERSONAL EXPOSURES TO TOTAL PARTICULATE

NL INDUSTRIES, INC.
NIAGARA FALLS, NEW YORK

June 13-14, 1979

DATE	SAMPLE DESCRIPTION	SAMPLE VOLUME LITERS	TOTAL PARTICULATE mg/M^3	COMMENTS
6/13	Mixman	647	21.9	Cleaned ribbon mixer
6/14	Mixman	657	13.6	Mixed granular rutile with soda ash
6/13	Millman	640	8.2	Screening sodium titanate
6/14	Millman	612	9.4	Screening sodium titanate
6/13	Calciner Operator	642	4.3	
6/14	Calciner Operator	665	4.2	
6/12	Laborer A	643	14.7	Packaged granular rutile
6/13	Laborer A	651	4.9	Screened sodium titanate/operated hammer mill
6/13	Laborer B	639	5.2	Screened sodium titanate
6/14	Laborer A	616	13.8	Screened sodium titanate operated hammer mill
6/14	Laborer B	629	14.1	Packaged granular rutile
Environmental Criteria(1)			10.0	

(1) ACGIH Threshold Limit Value (1979), 8-hour Time-Weighted Average.

APPENDIX C
Document 6

Optical Radiaton Levels Produced by Direct Arc Furnaces
NL Industries, Inc.
Niagara Falls, New York
June 1980

Prepared By:
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Sciences

INTRODUCTION

Three 1700 kilowatt (kW) Westinghouse* single-phase direct arc electric furnaces were surveyed by the National Institute for Occupational Safety and Health (NIOSH) to determine the associated levels of ultraviolet, visible, and infrared radiation, hereinafter denoted as optical radiation. Each furnace was approximately 2.10 meters (m) high, 1.83 m in diameter, and contained a 0.61 m diameter carbon electrode mounted vertically above the furnace chamber. The electrode was slowly lowered during furnace operation as it was consumed. The furnaces, operating at 90-92 volts direct current, were used to produce zirconium oxides by arc furnacing of zircon sand with the carbon electrode, yielding pigs of zirconium carbonitride which in turn were burned in air.

The arc furnaces were positioned as shown in Figure 1. Although the figure shows the presence of four furnaces, only the three furnaces indicated by asterisks were in operation during the survey dates. Only under unique conditions would all four furnaces ever operate simultaneously. It was also noted that normal procedure discouraged the operation of adjacent furnaces.

Due to the position of the furnaces in the facility, it was only possible to observe the reflection of optical radiaton from the furnaces. Near the end of each furnace's 20 hour run cycle, a new furnace would be fired. In this manner, only one furnace operated the majority of the time.

Approximately every ten minutes it was necessary for a furnace tender (there were two tenders per shift) to charge the furnace with zircon sand. Failure to do so at the proper time interval resulted in a poor batch of zirconium oxides and erratic furnace behavior in the immediate work area, i.e., sparks, noise, fumes, and intense optical radiation.

During the charging period (approximately four minutes) the tender stood behind a metal shield located 1 m from the furnace. Thus, in an 8 hour workday the maximum time a tender would stand 1 m from the operating furnace would be about 160 minutes. The presence of two tenders per shift normally reduces this maximum time. During the remaining shift time, when not tending the furnace, the tenders are unshielded but positioned at distances much greater than 1 m.

The tender wears goggles and clothing so that the face and neck regions are the only exposed body areas. The level of personnel exposure from optical radiation is governed by the charging cycle, since this is when workers will be closest to the furnaces. The tenders could wait for the next charge cycle either in an adjacent area, in a control room, or several meters from the furnace. The control room contained equipment which recorded the furnaces' operating wattages.

INSTRUMENTATION AND TECHNIQUES

The instruments and detectors used to measure the optical radiation levels are described below.

*Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health

An EG&G Model 555 Spectroradiometer* was used to measure the cosine corrected spectral irradiance in the wavelength region from 280 to 1150 nanometers (nm). This detector was operated in the manual mode during all measurements. The unit of measurement is watt per square centimeter per nanometer ($W \cdot cm^{-2} \cdot nm^{-1}$). The values obtained can be summed to give the total irradiance in a particular optical region in units of $W \cdot cm^{-2}$.

Luminance or brightness levels were measured with a hand-held Spectra* mini-spot photometer having a 1° field of view. The values were obtained in units of footlamberts (fL), which were converted to candelas per square centimeter ($cd \cdot cm^{-2}$).

An International Light Model 730A Radiometer* with specially calibrated detectors was used to evaluate the ultraviolet (UV) radiation. One detector is designed to read the actinic UV radiation region (200-315 nm), measuring in biologic effective units ($W \cdot cm^{-2}$), while the other detector measures near UV (320-400 nm) in units of $mW \cdot cm^{-2}$, with no biologic weighting function. As an additional check on the UV region, a Solar Light Company Sunburn UV Hazard Meter* was also used, which measures sunburn units per hour.

Finally, an EG&G Model 550 Radiometer* with a 5° field of view was used to measure the irradiance of the reflected radiation field from 280 to 1150 nm in units of $mW \cdot cm^{-2}$. Due to the high optical level produced by the furnace, neutral density filters had to be used with the radiometer.

All instruments were calibratd by NIOSH, or the manufacturer, within six months before these measurements were taken. Each instrument's response was checked before and after these field measurements and found to be in agreement within ± 10%.

Figure 2 shows those work areas where an unprotected worker would be at risk to optical radiation. Measurements were made in both the protected and unprotected areas. However, due to the physical impact that the various energy fields produced by the arc process had on the instruments, measurements in the unprotected areas had to be made at distances greater than 1 m.

During the measurements all detectors were pointed toward the top rim of the furnaces. Every detector was covered with protective material except at the entrance port in order to minimize surface contamination. The largest error associated with these measurements was the variation in source intensity, which could vary by orders of magnitude within a few seconds.

RESULTS

The absolute maximum values recorded for all measurements obtained from any of the three 1700 kW arc furnaces are shown in Table I. It is noted that the optical radiation levels at similar wavelengths varied in intensity by approximately 3 to 5 times from one moment to another. This fact is illustrated in Figure 3, which shows two separate scans of the same event made by different investigators using the same equipment but at different times. Each scan took two minutes to complete and the time interval between the scans was one minute. Notice that the shape of the one scan is radically different from the other.

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Spectral irradiance values were also measured and are shown in Figure 4. These values were extremely difficult to obtain in the field, as noted by the need to increase the measurement bandwidth. The radiometer and summed spectral irradiance values over the same wavelength band agree to within the 3-5 variation factor for the time of measurement. The spectral distribution data took about 5 minutes to acquire and are, of course, affected by the charging cycle. However, near the end of a furnace's run cycle the infrared contribution can be much higher.

Figure 5 shows additional information on the amount of UV radiation produced by the process. In this figure all spectral data from 280 to 340 nm acquired from readings taken on the same furnace at different times during the 20-hour run cycle are summarized by maximum, minimum, and average values.

DISCUSSION

Observations confirmed that optical radiation levels and spark generation drastically increase near the end of the 20 hour run cycle. As the furnace fills with material, the arc position moves upward. Eventually, the arc approaches the top of its travel and the radiation levels increase since the electrode is no longer submerged in the furnace. Therefore, tenders charging near the end of the cycle are more at risk to optical radiation hazards.

Those tenders who stood directly behind the metal shield at 1 m and wore appropriate safety equipment were exposed to minimal optical radiation levels. However, measurements do indicate that the optical radiation guideline values (Shown in Table II) were exceeded for certain radiation regions at relatively close unshielded distances (3 m) from the furnace. It is noted that these guideline values should be used as guides in the control of exposure to optical radiation sources and should not be regarded as a fine line between safe and dangerous levels.

The only body locations not protected were the face and neck regions. This type of furnace produces optical radiation levels that can cause skin and eye effects, i.e., erythema and retinal injuries. However, since the actual arc could not be directly viewed in this situation, then such effects may be precluded or minimized.

Since the measurements taken at 4.6 m from the furnace (in the shaded area shown in Figure 2) indicate optical radiation levels exceeding guideline values, then additional barriers or shielding should be installed at the furnace positions. Of course, the development of an automatic feed system for furnace charging could also accomplish similar reduction in personnel exposure. Conceptually, the use of closed-circuit television systems in the control room to monitor furnace operations would be another means for exposure reduction.

Most furnace personnel wore Number 4 goggles issued by the facility. These shade heat-treated goggles had leather side shields with ventilation openings, leather eye cups and nose guard. It is to be noted that a shade 4 lens would allow IR transmittance values that exceed the American Conference of

Governmental Industrial Hygienists (ACGIH) and American National Standards Institute (ANSI) guideline values, whereas a shade 6 does not (1-2). Therefore, for protection against maximum visible and IR radiation intensities at distances greater than the shielded 1 m position, it is suggested that shade 6 lens be used. It also noted that due to the high levels of IR the use of special IR reflective lenses should be required.

Workers may find it difficult to work for periods of time at unshielded distances of less than 2 m due to the presence of intense noise, heat, and sparks. Therefore all workers, especially tenders, should be trained as to the nature of damage caused by optical radiation and should be instructed never to view the operating furnace without proper eye protection due to the potential of inducing retinal injury.

CONCLUSIONS AND RECOMMENDATIONS

Because of the optical radiation levels emitted from the electric arc furnaces the following recommendations are made.

1. Instruction and training be given to tenders on hazards associated with arc furnaces such as optical radiation levels will increase radically at certain times and locations.

2. Protective barriers be installed in such a manner as to insure minimal exposure to the workers at all times to optical radiation.

3. Ensure that goggles having an appropriate shade number are available for use by all furnace personnel.

4. Appropriate signs be posted alerting personnel to the presence of optical radiation.

REFERENCES

1. American Conference of Governmental Industrial Hygienists, 1979. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment. P.O. Box 1937, Cincinnati, Ohio 45201.

2. American National Standard Practice for Occupational and Educational Eye and Face Protection. Americal National Standards Institute, 1430 Broadway, New York, New York 10018. Standard Number Z87.1-1979, 1979.

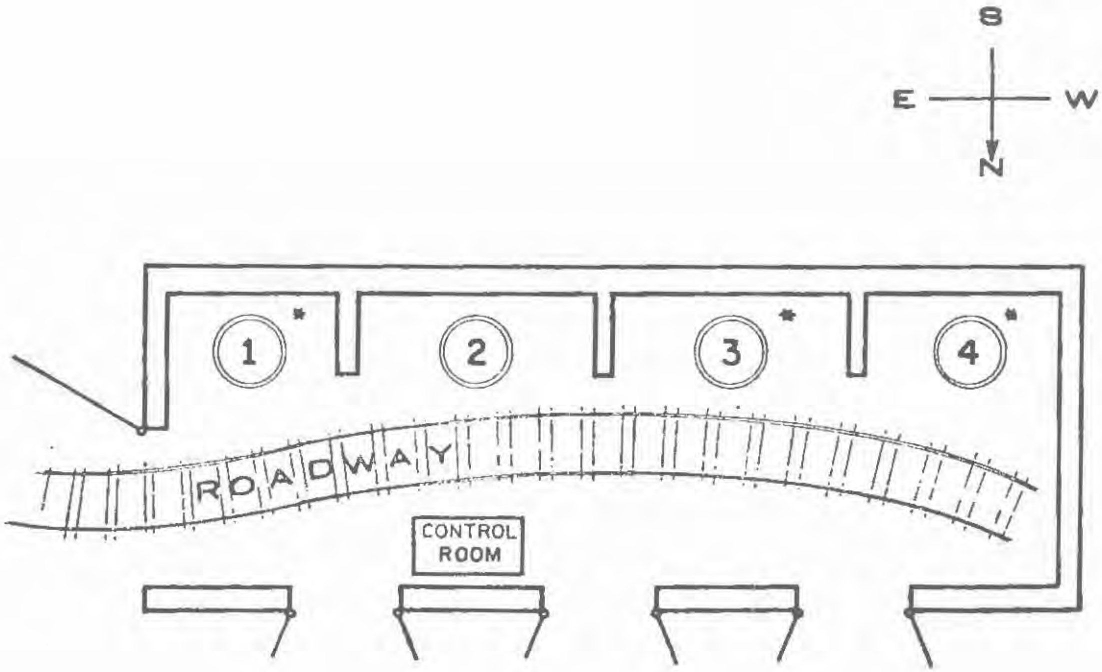

Figure 1: Layout of arc furnaces. The asterisks indicate operating furnaces during the study.

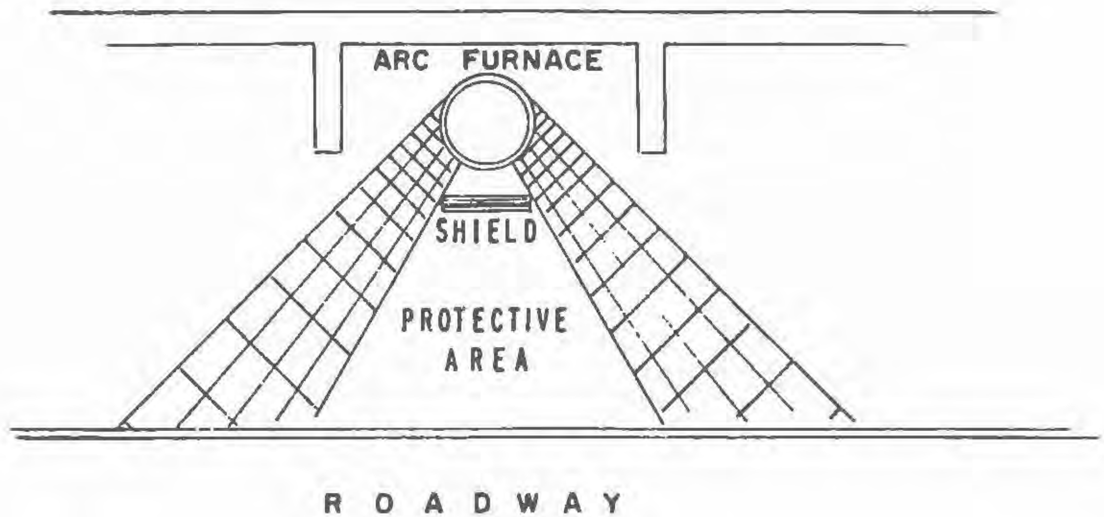

Figure 2: Schematic diagram of locations (shaded area) where optical radiation levels were measured.

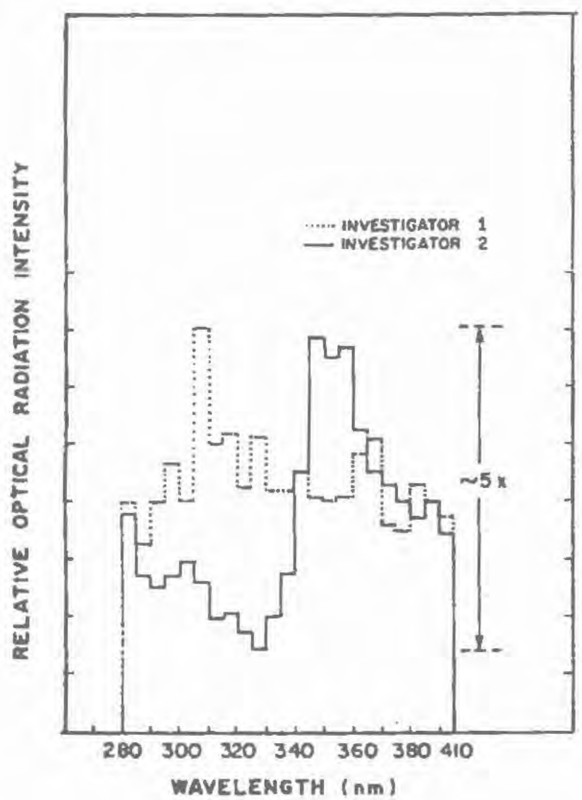

Figure 3: Variation in optical radiation levels. Two scans performed by different investigators on same arc event. The scans, requiring two minutes each to complete, were separated by a time interval of one minute.

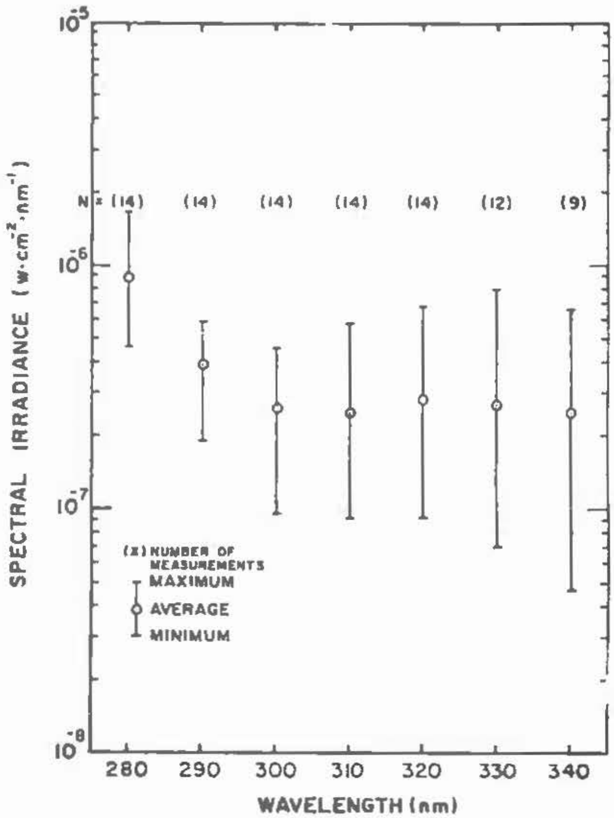

Figure 4: Spectral irradiance values (cosine corrected) of 1700 kW electric arc furnace 5 hours after start-up. Measured total spectral irradiance from 280-1100 nm is 5.5 $mW \cdot cm^{-2}$ at 4.6 m. Note bandwidth changes. Furnace temperature approximately 1900°C.

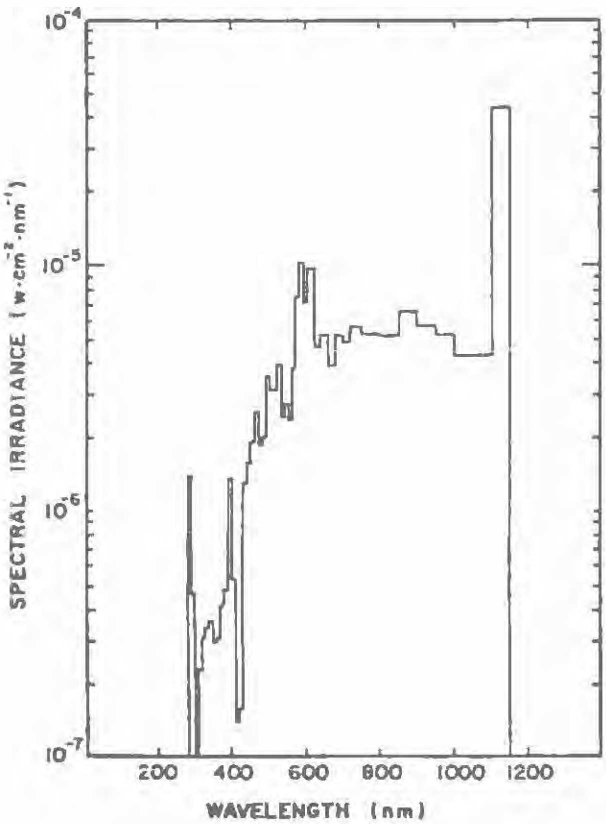

Figure 5: Maximum, minimum, and average variation in spectral irradiance at selected UV wavelengths.

TABLE I

Summary of Maximum Results Obtained
from All Measurements on Arc Furnaces

Quantity	Maximum Values	Location
Luminance	200 $cd \cdot cm^{-2}$	4.6 m from furnace (shaded area)
Sunburn Meter (285-320 nm)	1.5 sunburn units/hour 0.1 sunburn units/hour	Outside - Sun Measurement Inside - Top of Operating Furnace (0.5 m)
Near UV (320-400 nm)	220 $\mu W \cdot cm^{-2}$	4.6 m from furnace (shaded area)
Actinic UV (200-315 nm)	17.4 $\mu W \cdot cm^{-2}$ (effective)	3.1 m from furnace (shaded area)
Total Irradiance (280-1100 nm)	>200 $mW \cdot cm^{-2}$	4.6 m from furnace (shaded area)

TABLE II

Comparison of Measured Processes at Given Distance with American Conference of Governmental Hygienists (ACGIH) TLV Values

Optical Region	Distance from Source	Maximum Measured Value	Guideline Value
Actinic UV (200-315 nm)	3.1 m	17.4 $\mu W \cdot cm^{-2}$	0.1 $\mu W \cdot cm^{-2}$ in 8 hour day
Near UV (320-400 nm)	4.6 m	0.22 $mW \cdot cm^{-2}$	1.0 $mW \cdot cm^{-2}$ for time periods greater than 16 minutes
Luminance (400-760 nm)	4.6 m	200 $cd \cdot cm^{-2}$	1.0 $cd \cdot cm^{-2}$ in 8 hour day
Infrared (760-1100 nm)	4.6 m	>200 $mW \cdot cm^{-2}$	10.0 $mW \cdot cm^{-2}$ in 8 hour day

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

INTERIM REPORT
HEALTH HAZARD EVALUATION PROJECT NO.
HE 79-69

NIAGARA STEEL FINISHING COMPANY
NIAGARA FALLS, NEW YORK

September 7, 1979

I. INTRODUCTION

This Interim Report presents the available results of the environmental sampling conducted by the National Institute for Occupational Safety and Health (NIOSH) at Niagara Steel Finishing Company during June 26-28, 1979. This survey was conducted as part of NIOSH's involvement in the multiple agency effort to assess the health and environmental impacts of the Hyde Park Landfill Chemical Disposal Site in Niagara Falls, New York. Interim Report No. 1 (May 7, 1979) detailed background information and plans for the NIOSH investigation. Interim Report No. 2 (July 31, 1979) provided a summary of NIOSH's progress and future plans.

II. METHODS

Personal breathing zone air sampling was conducted to evaluate the workers' exposures to welding fumes and associated particulates generated during repair and/or assembly of various metal products. The air measurements were made inside the welder's helmet. Copper and iron-in-air samples were collected and analyzed in accordance with the NIOSH recommended methods (P&CAM 173) using calibrated personal sampling pumps operating at 1.5 liters per minute and 0.8 um DM-800 membrane filters in 2-piece, closed face cassettes. The filters were digested with nitric acid and analyzed using atomic absorption spectrophotometry. The total particulate on each filter was determined gravimetrically by weight gain.

III. FINDINGS AND DISCUSSION

Table I presents the personal exposures to copper and iron oxide fumes, and associated total particulate to Class A welders. The exposures were determined during the metal inert gas (MIG) welding of copper cathode to steel tanks. The average copper fume concentration of 0.74 mg/m^3 (S.D.$\pm$ 0.26, range 0.47 to 1.11 mg/m^3) for five samples exceeded the 0.20 mg/m^3 American Conference of Governmental Industrial Hygienist (ACGIH) Threshold Limit Value (TLV). The maximum iron oxide (0.51 mg/m^3) and total particulate (3.47 mg/m^3) levels did not exceed the respective ACGIH TLV's of 5.0 mg/m^3 and 10.0 mg/m^3.

Each of the work stations involving copper-to-steel welding were equipped with a local exhaust ventilation system. This consisted of either a portable (Widdervac) exhaust system with a slot type hood (1¼ X 8½ inches), or a slot type hood (2 X 19½ inches) which branched off the main exhaust duct via a flexible duct. The face velocities of the hoods were 900-1000 linear feet per minute (lfpm) and 1200-1400 lfpm, respectively. By comparison, the ACGIH Ventilation Committee recommends a face velocity of 1500 lfpm (1). In addition to insufficient face velocities, one other practical problem involving the slot hoods was noted with the exhaust ventilation system. The steel construction and relatively large size of the slot hoods made them difficult to use in certain operations such as welding of corners and angular shapes.

Table II presents the personal exposures to copper, iron oxide, and total particulate to Class B and C welders during the welding (shielded metal arc and MIG) and grinding of various steel materials. The levels of exposure to these contaminants were less than the referenced occupational health criteria.

Table III presents the personal exposures to iron oxide and total particulates to Helpers, Fitter Mechanics, and Layout personnel during oxyacetylene cutting, shielded arc welding, and grinding of various steel materials. The maximum iron oxide (1.20 mg/m^3) and total particulate (4.09 mg/m^3) exposures were less than the 10.0 mg/m^3 ACGIH TLV.

IV. RECOMMENDATIONS

The Class A welders were exposed to potentially toxic concentrations of copper fume generated in welding copper-containing metals. Inhalation of copper fume can cause irritation of the upper respiratory tract and metal fume fever. Typical metal fume fever, a 24 to 40-hour illness, is characterized by chills, fever, aching muscles, dryness in mouth and throat, metallic or sweet taste, and headache. The following recommendations are provided to reduce the levels of exposure to copper fume below the TLV.

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(1) Industrial Ventilation: A Manual of Recommended Practice. 14th Edition. Committee on Industrial Ventilation, American Conference of Governmental Industrial Hygienists, Lansig, Michigan (1976).

APPENDIX C
Document 8

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

INTERIM REPORT
HEALTH HAZARD EVALUATION PROJECT NO.
HHE 79-70

GREIF BROTHERS CORPORATION
NIAGARA FALLS, NEW YORK

October 1, 1979

I. INTRODUCTION

This Interim Report presents the available results of the environmental sampling conducted by the National Institute for Occupational Safety and Health (NIOSH) at Greif Brothers Corporation during June 26-28, 1979. This survey was conducted as part of NIOSH's involvement in the multiple agency effort to assess health and environmental impacts of the Hyde Park Landfill Chemical Disposal Site in Niagara Falls, New York. Interim Report No. 1 (May 7, 1979) detailed background information and plans for the NIOSH investigation. Interim Report No. 2 (July 31, 1979) provided a summary of NIOSH's progress and future plans.

II. METHODS

Personal breathing zone sampling was conducted on three consecutive days to evaluate the workers' exposures to organic contaminants during the spray painting of steel drums and associated lids. The organics were collected and analyzed in accordance with NIOSH method P&CAM 127 using calibrated personal sampling pumps operating at 0.2 liters per minute and 150 mg of activated charcoal packed into 7 cm long 4 mm I.D. glass tubes. The analytes were desorbed from the activated charcoal with carbon disulfide and analyzed using a gas chromatograph.

III. FINDINGS AND DISCUSSION

Table I presents the personal breathing zone exposures to xylene. The maximum exposure measured (4.8 ppm) was less than 5% of the NIOSH recommended standard (100 ppm).

TABLE III

Iron Oxide and Total Particulate Concentrations in the Breathing Zone of Helper's, Fitters and Layout Personnel

Niagara Steel Finishing Company
Niagara Falls, New York

June 26-28, 1979

Date	Sample Description: Job Classification	Sample Description: Work Location	Sample Volume Liters	Airborne Concentration - mg/m3: Iron Oxide	Airborne Concentration - mg/m3: Total Particulate	Comments
6/26	Fitter Mechanic B	Bay 3/Column 2	660	1.20	4.09	
6/27	Fitter Mechanic B	Bay 3/Column 2	667	0.28	1.39	
6/27	Fitter Mechanic C	Bay 3/Column 7	627	0.15	1.45	
6/27	Layout C	Bay 3/Column 3	670	0.15	1.94	
6/27	Layout C	Bay 3/Column 3	690	0.12	1.61	
6/27	Layout C	Bay 3/Column 3	679	0.27	0.84	
6/28	Layout C	Bay 3/Column 3	675	0.24	2.12	
6/28	Layout C	Bay 3/Column 3	544	0.12	0.83	
6/26	Helper	Bay 3/Column 3	645	0.14	1.16	Assist in welding screens.
6/26	Helper	Bay 3/Column 3	640	0.22	2.56	Assist in welding screens.
6/27	Helper	Bay 3/Column 7	601	0.20	2.06	Assist Fitter Mechanic C.
Environmental Criteria[1]				10.0	10.0	

[1] ACGIH TLV's (1979), 8-hour Time-Weighted Average.

1. A thorough inspection of the entire ventilation system should be conducted to insure that conditions such as obstructions, leaking duct connections, torn flexible ducts, fan belt slippages, etc., are not preventing the attainment of maximum efficiency.

2. The geometry of the local exhaust hoods should be redesigned to permit maximum adaptability to the space requirements of the various materials requiring welding. (A minimum face velocity of 1500 lfpm is recommended for slot hoods.) Fume collection in small confined areas may be achieved using commercially available low volume, high velocity fume extraction welding guns. The concept is quite unique because the extraction device is mounted on the gun, thus giving the welder a higher degree of accessibility and mobility than is afforded by the conventional local exhaust hood.

3. The exhaust hoods should be constructed of a lightweight material to allow the welder greater ease in handling the hoods.

4. The duct once used to exhaust the fumes from the plasma arc burning station should be closed-off where it branches from the main collection system. This will result in a increased air flow to the other exhaust hoods.

5. Until the levels of copper fume are reduced below the referenced occupational health criteria the welders should wear a respirator approved by NIOSH under the procedures of Federal regulations 30 CFR 11 should be used. Various types of respirators specially designed for welders are commercially available. Refer to <u>NIOSH Certified Equipment List as of July 1, 1978</u>* for a listing of NIOSH-approved respirators. Refer to NIOSH's <u>A Guide to Industrial Respiratory Protection</u>** for guidelines on appropriate respiratory protection programs.

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* NIOSH publication #79-107, no charge. Available from:
Publications Dissemination, DTS
NIOSH
4676 Columbia Parkway
Cincinnati, Ohio 45226

** GPO publication #017-033-00153-7, $2.30. Available from:
Superintendent of Documents
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INTERIM REPORT NO. 2
HEALTH HAZARD EVALUATION REPORT NO.
HE 79-70

GREIF BROTHERS CORPORATION
NIAGARA FALLS, NEW YORK

April 1980

I. INTRODUCTION

This Interim Report presents the results of the environmental sampling conducted by the National Institute for Occupational Safety and Health (NIOSH) at Greif Brothers Corporation on November 10 and December 27, 1979. This sampling was conducted as part of NIOSH's involvement in the multiple agency effort to determine the health and environmental impacts of the Hyde Park Landfill Chemical Disposal Site.

II. SAMPLE DESCRIPTION

Testing was conducted of the environment within the manhole located adjacent to Production Line No. 2 on November 10, 1979. This manhole provides access to a 24-inch I.D. conduit located beneath the Greif Brothers manufacturing facility. Drainage water and chemical leachate from the landfill flows through the conduit. Prior to the December 1978 sealing of the manhole, the production workers complained of noxious odors emanating from the manhole. The manhole environment was tested for airborne 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), mirex, lindane, and other identifiable organic chemicals. Samples of bottom sediment were collected to determine the presence of TCDD's, mirex, and lindane.

Samples of settled dust were collected from the rafters and from the ventilation system's make-up air diffuser unit on December 27, 1979. A sediment sample was collected from the swampy area between the building's east end and the east parking lot the same day. These samples were analyzed for the presence of mirex, lindane, and polychlorinated biphenyl's (PCB's).

III. RESULTS AND DISCUSSION

The atmosphere within the manhole contained less than (<) 2 ppb 2,3,7,8-TCDD, <1 ppb mirex and <2 ppb lindane. A corresponding sample of bottom sediment contained 480 ppb 2,3,7,8-TCDD and 320 ppb of an unidentified TCDD isomer, 23,000 ppb mirex, and <3 ppb lindane. Although these chemical compounds are present in the sediment, the data indicates that the flow of water is serving as an effective buffer to prevent or minimize their ability to become airborne.

The other airborne organic chemicals identified were all fluorinated and chlorinated compounds including carbon tetrachloride, perchloroethylene, and numerous chlorobenzenes, chlorotoluenes, and chlorofluorotoluenes (Table I). Since so many different compounds and isomers (total of 17) were detected, quantitative data is given only for the seven largest components of the air sample (Table I). These data show that the manhole atmosphere contains many organic chemicals most probably originating from the landfill. Although these chemicals are considered toxic, exposure to the workers is minimal, if at all. The aerometric testing conducted by the U.S. Department of Labor - OSHA - during March 1979 (by positioning their instrumentation on the face of the sealed manhole) supports this conclusion. Thus, the data do not represent an inhalation hazard (by current occupational health criteria) to the workers potentially exposed. The NIOSH data, however, do provide qualitative information on possible exposures which could have occurred prior to sealing of the manhole in December 1978.

A sample of settled dust collected from the rafters contained parts-per-billion quantities of mirex, lindane, and PCB's. These compounds were not detected in a sample collected from the make-up air diffuser unit or in a sediment sample collected from a swampy area located east of the building (Table II).

IV. CONCLUSIONS AND RECOMMENDATIONS

A sample of settled dust collected from the rafters suggest that airborne exposures to mirex, lindane and PCB's have occurred in the past. No definitive assessment of the hazard to the workers potentially exposed to this settled dust can be made. However, because these chemicals are known or suspected of causing cancer, and because they may become re-entrained into the workplace atmosphere, maximum protection of human health must be effected. Therefore, it is recommended that the Greif Brothers Corporation remove the contaminated dust. Vacuum procedures or other methods which would minimize re-entrainment of the particulate should be used. NIOSH personnel are available to offer recommendations concerning the use of personal protective equipment by the workers involved in the clean-up.

The manhole located along Production Line No. 2 is not presenting an inhalation hazard to the plant employees.

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Acknowledgment: Special appreciation and thanks are offered to Ms. Ardith Grote (Measurements Support Branch, NIOSH) for the GC/MS analysis of the solid sorbent tubes.

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TABLE I

AIRBORNE ORGANIC CHEMICALS IDENTIFIED IN THE MANHOLE
ALONG PRODUCTION LINE NO. 2

GREIF BROTHERS CORPORATION
NIAGARA FALLS, NEW YORK

November 1980

SUBSTANCES	AIRBORNE CONCENTRATION - mg/M^3	HEALTH CRITERIA - mg/M^3
Alkanes*		
Carbon Tetrachloride	1.15	12.6** 60-minute ceiling
Chlorobenzotrifluorides	0.50	None available
Chlorotoluenes	1.02	250*** 8-hour TWA
Dichlorobenzotrifluorides		
Dichlorotoluenes	0.54	None available
Hexachlorobutadiene		
Hexachloroethane		
Perchloroethylene	0.73	339** 8-hour TWA
Tetrachlorobenzenes		
Tetrachlorobenzotrifluorides		
Toluene	0.29	375** 8-hour TWA
Trichlorobenzenes		
Trichlorobenzotrifluoride		
Trichlorotoluene		
Trifluorotoluene	0.27	None available
Xylene Isomers		

* Aliphatic hydrocarbons characterized by a straight chain.
***ACGIH Threshold Limit Value.

** NIOSH recommended occupational exposure criteria.

Table I

Metallic Fume and Total Particulate Concentrations in Welder's Breathing Zone

Niagara Steel Finishing Company
Niagara Falls, New York

June 26-28, 1979

	Sample Description		Sample Volume	Airborne Concentration - mg/M^3			
Date	Job Classification	Work Location	Liters	Copper*	Iron Oxide*	Total Particulate	Comments
6/26	Welder A	Bay 3/Column 6	541	0.47	0.51	3.57	MIG: Copper-to-steel weld
6/26	Welder A	Bay 3/Column 6	465	0.82	0.20	1.78	MIG: Copper-to-steel weld
6/27	Welder A	Bay 3/Column 6	652	0.77	0.11	1.27	MIG: Copper-to-steel weld
6/28	Welder A	Bay 3/Column 6	631	1.11	0.18	2.55	MIG: Copper-to-steel weld
6/28	Welder A	Bay 3/Column 6	645	0.51	0.17	1.05	MIG: Copper-to-steel weld
Environmental Criteria[1]				0.20	5.0	10.0	

*Excluding wire brushing of the freshly prepared weld, no abrasive grinding was observed. Therefore, these results are reported as metallic fumes - solid particles condensing in varying sizes after the volatilization of the melted substance.

[1]ACGIH TLV's (1978), 8-hour Time-Weighted Average.

TABLE II

Metallic and Total Particulate Concentrations in Welder's Breathing Zone

Niagara Steel Finishing Company
Niagara Falls, New York

June 26-28, 1979

Date	Sample Description		Sample Volume	Airborne Concentration - mg/m³			Comments
	Job Classification	Work Location	Liters	Copper	Iron Oxide	Total Particulate	
6/26	Welder B	Crane Yard	574	-	1.39	5.63	Welding and grinding tanks.
6/26	Welder B	Crane Yard	592	-	0.46	3.13	Welding and grinding tanks.
6/28	Welder B	Crane Yard	520	-	1.50	6.38	Welding and grinding tanks.
6/28	Welder B	Crane Yard	516	-	0.64	1.12	Welding and grinding tanks.
6/26	Welder C	Bay 3/Column 2	582	0.62	0.40	2.90	Welding and grinding copper plate.
6/26	Welder C	Bay 3/Column 2	652	-	1.69	4.33	
6/26	Welder C	Bay 3/Column 4	619	0.04	0.87	4.17	
6/27	Welder C	Bay 3/Column 4	680	0.01	0.53	4.96	
6/27	Welder C	Bay 3/Column 2	420	0.05	2.26	5.38	
6/28	Welder C	Bay 3/Column 2	636	-	0.85	2.91	
6/28	Welder C	Bay 3/Column 4-5	674	0.02	0.13	3.71	
6/28	Welder C	Bay ?/Column 3	636	0.05	2.70	5.38	
Environmental Criteria[1]				1.0	10.0	10.0	

Dash (-) indicates that analysis was not performed.
[1]ACGIH TLV's (1978), 8-hour Time-Weighted Average.

TABLE II

MIREX, LINDANE AND POLYCHLORINATED BIPHENYL (PCB) SAMPLE ANALYSIS

GREIF BROTHERS CORPORATION
NIAGARA FALLS, NEW YORK

December 27, 1979

SAMPLE NO.	SAMPLE TYPE/DESCRIPTION		CONCENTRATION - ppb MIREX	LINDANE	PCB*
K-01	Settled dust:	Ventilation make-up air diffuser located at the east side of plant.	<6	<1	<40
K-02	Settled dust:	Channel steel rafter adjacent to windows-south wall east corner of plant.	13	31	400
K-03	Sediment:	Swampy area between east end of building and east parking lot.	<8	<1	<30

* Reported as Arochlor 1254, 54% chlorination.

TABLE III

Personal Breathing Zone Exposures to Organic Vapors

Greif Brothers Corporation
Niagara Falls, New York

June 26-28, 1979

Date	Sample Description	Sample Volume Liters	Airborne Concentration - ppm						Combined[1] Exposure
			Methyl Ethyl Ketone	n-Butyl Alcohol	Methyl Cellosolve Acetate	Xylene	Toluene	Ethanol	
6/26	Painter: Auto-Line, 1st Interior Booth	48	6.9	3.1	2.2	2.4	0.89	2.7	0.21
6/26	Painter: Press Dept., High Bake	38	3.8	1.9	1.6	3.3	0.49	7.7	0.16
6/27	Painter: Small Parts Booth	42	0.24	0.24	0.04	3.5	0.13	0.38	0.04
6/27	Painter: Line 1, 1st Interior Booth	43	5.6	1.3	0.73	2.3	1.6	1.5	0.13
6/28	Painter: Press Dept., High Bake	91	6.5	-	1.6	-	-	1.1	0.09
Environmental Criteria: 8-hour Time-Weighted Average			200[2]	50[2]	25[2]	100[3]	100[4]	1000[2]	1

Dash (-) indicates that analysis was not performed.

(1) Denotes the workers combined daily exposure to multiple contaminants with similar toxicologic effects calculated as $C_1/T_1 + C_2/T_2 + C_3/T_3 + \ldots Cn/Tn$ (see text of this report).

(2) Denotes American Conference of Governmental Industrial Hygienists Threshold Limit Values (1979).
(3) Denotes NIOSH recommended occupational health standard (1973).
(4) Denotes NIOSH recommended occupational health standard (1975).

TABLE IV

Personal Breathing Zone Exposures to Organic Vapors

Greif Brothers Corporation
Niagara Falls, New York

June 28, 1979

Sample Description	Sample Volume Liters	Airborne Concentration - ppm Isopropanol	Xylene	Toluene	Combined[1] Exposure
Painter: 1st Interior Booth	31	2.4	0.67	1.2	0.03
Painter: 1st Interior Booth	45	4.9	0.82	2.2	0.04
Environmental Criteria: 8-hour Time-Weighted Average		400[2]	100[3]	100[4]	1

(1) Denotes the workers combined daily exposure to multiple contaminants with similar toxicologic effects calculated as

$$C_1/T_1 + C_2/T_2 + C_3/T_3 \ldots Cn/Tn$$ (see text of this report).

(2) Denotes NIOSH recommended occupational health standard (1976).
(3) Denotes NIOSH recommended occupational health standard (1973).
(4) Denotes NIOSH recommended occupational health standard (1975).

TABLE I

Personal Breathing Zone Exposures to Xylene

Greif Brothers Corporation
Niagara Falls, New York

June 26-28, 1979

Date	Sample Description	Sample Volume Liters	Air Concentration - ppm
6/26	Painter: Auto-Line, 3rd Booth, Exterior Painting	48	4.8
6/26	Painter: Hand Line, Drums	18	2.1
6/26	Painter: Small Parts Paint Booth	89	2.9
6/27	Painter: Auto-Line, 3rd Booth, Exterior Painting	91	1.4
6/28	Painter: Hand Line, Drums	46	1.8
6/28	Painter: Small Parts Paint Booth	98	0.94
6/28	Painter: Auto-Line, 3rd Booth, Exterior Painting	9	0.26
Environmental Criteria: 8-hour Time-Weighted Average			100(1)

(1) Denotes NIOSH recommended occupational health standard (1975).

TABLE II

Personal Breathing Zone Exposures to Organic Vapors

Greif Brothers Corporation
Niagara Falls, New York

June 26-27, 1979

Date	Sample Description	Sample Volume Liters	Airborne Concentration - ppm: Xylene	Toluene	Methyl Ethyl Ketone	n-Butyl Acetate	Methyl Cellosolve Acetate	Combined Exposure[1]
6/26	Painter: 1st Interior Booth	91	2.3	0.62	5.7	<0.01	0.64	0.08
6/27	Painter: 1st Interior Booth	41	3.4	0.18	1.6	<0.01	0.91	0.08
6/27	Painter: Hand Line, Drums	104	8.6	0.28	1.0	<0.01	0.33	0.11
6/27	Painter: Press Dept., High Bake	70	2.8	0.77	5.6	<0.01	0.36	0.08
Environmental Criteria: 8-hour Time-Weighted Average			100[2]	100[3]	200[4]	150[4]	25[4]	1

(1) Denotes the workers combined daily exposure to multiple contaminants with similar toxicologic effects calculated as $C_1/T_1 + C_2/T_2 + C_3/T_3 + \ldots Cn/Tn$ (see text of this report).

(2) Denotes NIOSH recommended occupational health standard (1973).
(3) Denotes NIOSH recommended occupational health standard (1975).
(4) Denotes American Conference of Governmental Industrial Hygienists Threshold Limit Values (1979).

Table II presents the concomitant exposures to xylene, toluene, methyl ethyl ketone, n-butyl acetate and methyl cellosolve acetate. None of the measured concentrations exceeded the respective individual criteria for the substances evaluated. The maximum concentration measured (xylene 8.6 ppm) was less than 9% of the NIOSH recommended standard (100 ppm). Because two or more chemical compounds are present that have similar toxicologic effects, their combined effects, rather than that of either individually, must be considered. That is, if the sum of the following fractions,

$$C_1/T_1 + C_2/T_2 + C_3/T_3 + \ldots\ldots Cn/Tn$$

exceeds 1, then the "standard of the mixture" should be considered as being exceeded. C_1 indicates the measured air level, and T_1 the corresponding environmental criteria. None of the calculated mixtures exceeded the "standard of the mixture".

Tables III and IV presents the concomitant exposures to other organic vapors. None of the measured concentrations exceeded the respective individual criteria for the substances evaluated, nor the calculated "standard of the mixture".

IV. FUTURE ACTIONS

1. Analysis of the air samples collected in the manhole located approximately 75 feet south of the manhole located along production line No. 2 have not been completed. The sewer atmosphere was sampled for dioxins and other identifiable organic compounds. Analysis of a sediment and water sample collected in the sampled manhole for dioxins, lindane, and Mirex also has not been completed.

2. Analysis of a sediment sample collected at the effluent end of the conduit (which runs beneath the Greif Brothers Corporation) for dioxins, lindane, and Mirex has not been completed.

3. Authorized representatives and members of Local Union No. 12256, USWA, requested that NIOSH evaluate the atmosphere in the manhole located next to production line No. 2. In a July 5, 1979 letter, the Greif Brothers Corporation opposed this evaluation for the following reasons:

   a. The workers' concern that they could have been exposed to toxic chemicals prior to the sealing of the manhole is insufficient justification.

   b. Estimating past employee exposures is beyond NIOSH's mandate.

c. There is no assurance that NIOSH would protect the Company from financial loss in the event that plant contamination occurred as a result of opening the manhole during testing.

d. Industrial hygiene testing conducted by the U.S. Department of Labor - OSHA (outside of the manhole) failed to determine, according to compliance standards, that a hazardous condition existed in the workplace.

In a September 13, 1979, letter to the attorney representing Greif Brothers Corporation, NIOSH responded to these concerns and outlined the technical procedures which would be used to conduct the testing. This letter was forwarded by Greif Brothers Corporation to an Industrial Hygiene consultant for review and comment. To date, NIOSH has not received their response.

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