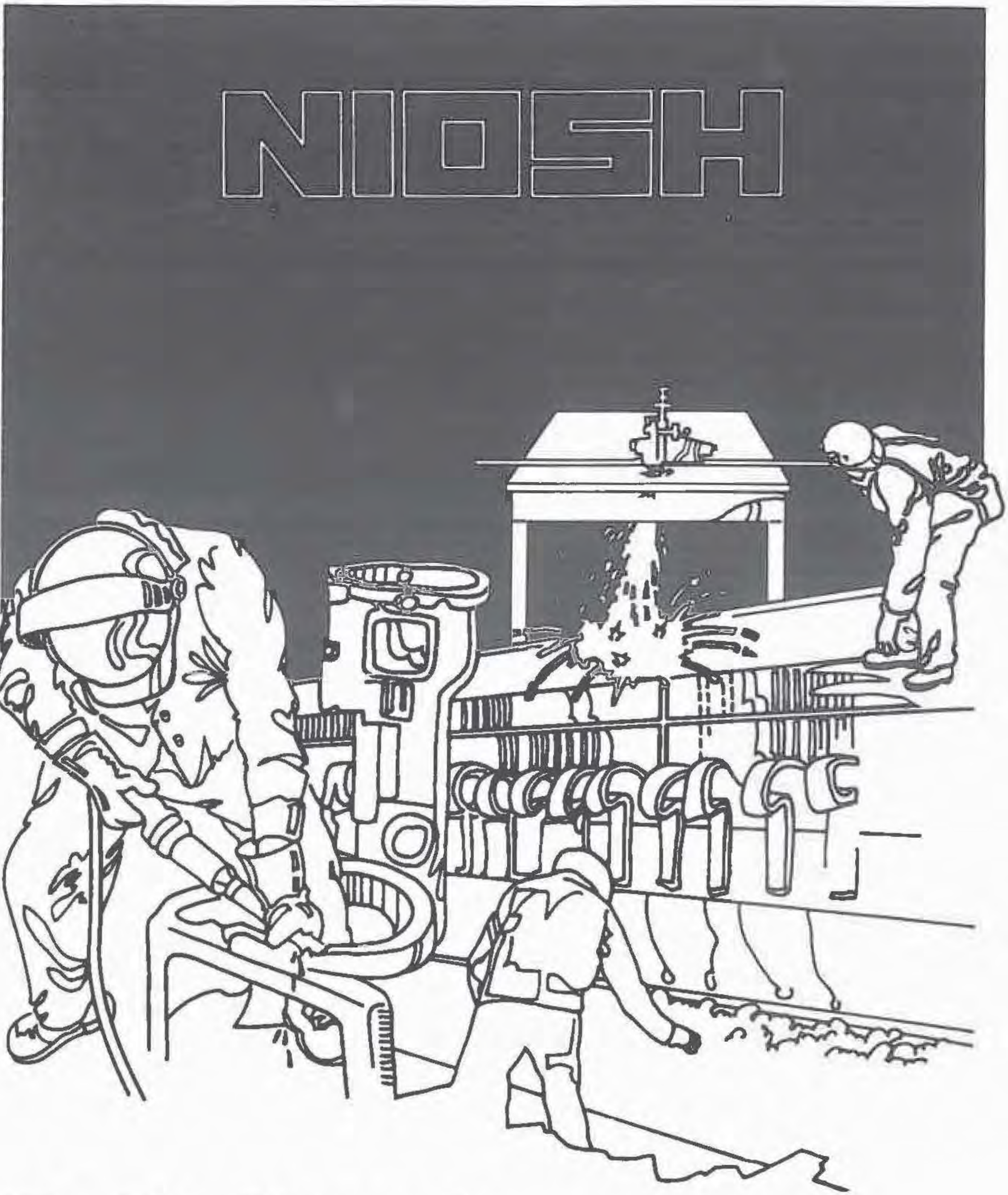
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 84-288-1847
WHEEL TRUEING TOOL COMPANY
COLUMBIA, SOUTH CAROLINA

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. 669(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.

The Hazard Evaluations and Technical Assistance Branch 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.

HETA 84-288-1847
NOVEMBER, 1987
WHEEL TRUEING TOOL COMPANY
COLUMBIA, SOUTH CAROLINA

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I. SUMMARY

In April 1984, the National Institute for Occupational Safety and Health (NIOSH) was requested to investigate potential exposures to chemicals and metal powders used in the manufacturing of diamond studded and diamond impregnated cutting tools at the Wheel Trueing Tool Company, Columbia, South Carolina. The employees submitting this request had noted a variety of health problems including gastrointestinal, neurological, cardiovascular, and respiratory complaints; a metallic taste in their mouths; and skin rash.

On June 18, 1984, NIOSH investigators conducted an initial environmental and medical survey. Based on the results of that survey, and the potential for inhalation, adsorption, and ingestion of cobalt in the tungsten carbide industries, the NIOSH investigators conducted a follow-up survey during December 1984.

A comprehensive industrial hygiene survey was performed to characterize worker exposures to airborne cobalt and nickel. Contaminated work surfaces, clothing, and other potential sources of direct skin contact with metal powders were also sampled. Out of 37 air samples collected, four samples exceeded the OSHA Permissible Exposure Limit (PEL) for cobalt (0.1 mg/m^3) and 12 samples exceeded 0.05 mg/m^3, the limit of exposure recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), and the evaluation criteria used for this investigation. The production areas and jobs having the greatest exposures to cobalt were in the OPE Powder Prep. Department where most of the loose cobalt containing powders were handled. Airborne nickel, which NIOSH has identified as a potential carcinogen, was detected in six samples. All exposures were below the OSHA PEL but three samples exceeded the NIOSH recommended exposure limit of 0.015 mg/m^3. Wipe sample results also indicated the highest concentration of cobalt and nickel in settled dust was in the OPE Powder Prep. Department. Graphite dust levels in the Carbon Room were excessive, with two of three samples detecting personal exposures above 10 mg/m^3.

An epidemiologic study was conducted of the entire plant population. NIOSH investigators administered a questionnaire to each worker and obtained both pre- and post-shift pulmonary function tests, and chest X-rays of all current employees. From the results of the chest X-rays taken of 140 Wheel Trueing employees, there was no evidence of lung changes consistent with a diagnosis of "hard metal disease" or mixed-dust pneumoconiosis. When comparing the results obtained from pulmonary function tests to high, medium, and low cobalt exposure areas

in the plant, no significant differences were observed. Nine individuals tested met the criteria for restrictive pulmonary disease with an FVC of less than 80% predicted, but all these employees worked in departments or had jobs where cobalt was not detected. However, a statistically significant decline in pulmonary function, regardless of exposure category, was observed among current smokers. There was no correlation between the results from pulmonary function tests and individuals noting respiratory symptoms. For the cobalt exposure category the general decline in FEV1/FVC was best explained by status as a current smoker ($F=5.37$, $df=2$, $p=0.02$). For the nickel exposure category the same decline in pulmonary function relative to smoking was observed ($F=6.13$, $df=2$, $p=0.01$).

Exposures to cobalt above the evaluation criteria were occurring in a number of operations where loose metal powders were handled. Workers were also potentially exposed to metals, including cobalt and nickel, through direct skin contact and through the use of contaminated tobacco products. Based on a review of the literature, it appears that long-term exposures to cobalt at concentrations above the evaluation criteria (0.05 mg/m^3) could lead to pulmonary fibrosis and "hard metal" disease. However, based on the chest X-ray and pulmonary function test findings there was no evidence of "hard metal" disease at Wheel Trueing. There was a high prevalence of smokers in this population with concomitant declines in respiratory function relative to smoking. Nine workers gave clinical histories consistent with skin sensitivities to metals. There were also excessive exposures to airborne synthetic graphite dust in the Carbon Room. Recommendations are included in this report for reducing and monitoring worker exposures to cobalt, and for establishing a medical surveillance program for all cobalt exposed workers.

KEYWORDS: SIC 353x (Construction, Mining, and Materials Handling Machinery and Equipment), cobalt, nickel, graphite, hard metal disease, tungsten carbide industry.

II. INTRODUCTION

In April, 1984 the National Institute for Occupational Safety and Health (NIOSH) received a request for a NIOSH Health Hazard Evaluation, from employees of the Wheel Trueing Tool Company, Columbia, South Carolina. Their request noted the following problems:

1. gastrointestinal symptoms including acidity, gas, nausea, and a metallic taste in their mouths;

2. neurologic symptoms including irritability, dizziness, and depression;

3. cardiovascular symptoms including heart flutters and irregular heartbeats;

4. dermatologic symptoms including rashes and sores on the tongue; and

5. respiratory symptoms including shortness of breath, chest tightness, and burning.

On June 18-19, 1984, NIOSH investigators conducted an initial survey at the plant. During this visit an opening conference was held with management and employee representatives to discuss the health complaints noted above. After the opening conference, a walk-through survey was conducted to study the manufacturing processes and to observe work practices. The NIOSH industrial hygienist collected air samples to characterize potential exposures to metal dusts and acid gases. The NIOSH medical officer conducted confidential interviews with various production workers from each department of the plant. An interim report discussing the NIOSH investigator's preliminary findings and recommendations was submitted to Wheel Trueing employer and employee representatives on November 15, 1987.

Based on the variety of complaints voiced by employees which were consistent with the toxic effects of cobalt exposure, and the preliminary air sampling results indicating some employees were exposed to airborne cobalt dust above the Permissible Exposure Limit (PEL), set by the Occupational Safety and Health Administration (OSHA), the NIOSH investigators decided to conduct a comprehensive medical and environmental survey at the plant.

On December 4-5, 1984, an industrial hygiene survey was completed to monitor employee exposures to airborne cobalt and nickel. Potential sources of direct skin contact with these metals were also located by collecting and analyzing dust samples from work surfaces, clothing, or other items directly handled by production workers. An interim report summarizing these findings was sent to employer and employee representatives on February 19, 1985.

An epidemiologic and medical study was conducted of the entire plant population on December 10-12, 1984. A team of NIOSH investigators administered a questionnaire, and obtained both pre- and post-shift pulmonary function tests, and chest X-rays of all current employees. A preliminary report summarizing the results of the medical survey was forwarded to employer and employee representatives on February 26, 1986.

III. BACKGROUND

A. Process Description

The Wheel Trueing Tool Company at Columbia, South Carolina has been in operation since 1977. The company manufactures hard metal cutting and grinding tools impregnated or studded with industrial diamonds. The diamonds are mixed or set in molds and combined under heat and pressure with powdered metals, generally tungsten, tungsten carbide, and cobalt to form various sized cutting and grinding surfaces used on rock cutting drill bits and saw blade segments. Other metal powders used in some formulations include, nickel, aluminum, copper, iron, and zinc. Other products manufactured include grinding wheels dressing tools, and metal or resin bonded grinding wheels used in glass edging and lens grinding. Production areas include the Setting Room, the OPE Department, Resin Grinding Wheel Department, Masonry and Mining Departments, Rotary Department, Small Tools, Plating, Takeout Laboratory, Quality Control, Carbon Room, Tool Room, Machine Assembly, Shipping, and Maintenance. Handling of loose metal powders occurs mostly in the Powder Prep. and Cold Press areas of the OPE Department, and in the Powder Prep. room of the Resin Grinding Wheel Dept. Small amounts of metal powder are also used in the Setting Room.

1. Setting Room

Most of the health complaints originated from a group of employees working in the Diamond Setting Department. Health complaints from this area had twice prompted the company to request industrial hygiene surveys from the state OSHA consultation program, once in 1982 and again in 1984. No excess exposures to metals or solvents (above the OSHA Permissible Exposure Limits) were found in this area during either survey. Here 10-15 diamond setters place diamonds by hand into bowl-shaped carbon molds. To hold the diamonds in place, the molds are coated inside with a heat setting epoxy adhesive or a special solvent based glue. After the diamonds are set, the mold core is packed with powdered metal containing mostly tungsten and cobalt. The molds are later furnaced to shrink the metal around the diamonds and the mold is removed exposing a diamond studded cutting surface that is later brazed into position on tools manufactured in the Masonry, Mining, and Rotary Departments.

2. OPE Department

Two to three employees working in the Powder Prep. room formulate all the diamond/metal mixtures used throughout the plant. other than a laboratory hood used for storing small amounts of solvents or solvent based adhesives, local exhaust systems were not available. In the mixing room where large batches of metal powders (mostly cobalt) are mixed once per week, an exhaust vented enclosure had recently been installed over the floor mixer.

In the Cold Press room, diamond/metal powders formulated in the Powder Prep room are weighed and placed in individual packets by the Weighout Operator. The Cold Press Operators dump the pre-measured packets of powder into a cold press machine which forms a rectangular shaped saw blade segment. Three cold press machines, one manually operated and two electrically operated, were located in this area. One operator is required for each press, but all three presses were not always running. Segments coming from the cold presses are hand filed to remove the rough edges. No local exhaust systems were available in this area.

Segments are sent from the Cold Press room to the Hot Press area where they are pressed and heated to 850-900° C. The finished segments are then sent to another department where they are deburred and brazed onto drill bits or saw blades. Exposure to metal dust in the Hot Press area is mostly through direct skin contact with the segments or from metal contaminated surfaces.

3. Resin Grinding Wheel Department

Another powder prep. room is located in the Resin Grinding Wheel Department. Metal powders used in this area are mostly aluminum combined with bronze, iron, and silicon carbide. The powders formulated in this area are used for making grinding wheel bodies and resins which are used for mounting diamond cutting surfaces on grinding wheel rims.

4. Takeout Room

In the Takeout room, defective segments are dissolved in nitric acid to recover the diamonds. This is done under an exhaust ventilated enclosure to capture nitrogen dioxide (NO2) gas generated from the acid digestion. Exhaust systems keep this room under a slight negative pressure relative to other areas of the plant. Iron, cobalt and other liquid waste metals were also recovered and reused by the plant.

5. Carbon Room

In this room, graphite stock is turned and cut to make carbon molds. The lathes were equipped with plane opening, flexible exhaust ducts, but some exhaust ducts were not positioned to properly capture the graphite dust released. The concrete floor had been groved to prevent slipping on the graphite dust that accumulated on the floor.

6. Quality Control Laboratory

Tests for density, hardness, and diamond content were performed in this area. Testing requires destruction or etching to remove material from around the diamonds. Some grinding was also necessary. Nitric acid was used, but all procedures were performed under a laboratory hood.

IV. EVALUATION DESIGN AND METHODS

A. Initial Survey

During the initial survey in June 1984, NIOSH investigators conducted a walk-through survey of all production areas including Diamond Setting, Powder Prep, Cold Press, Hot Press, Quality Control Lab, Plating, Takeout, and Carbon Room. After the walk-through, the NIOSH Industrial Hygienist photographed various production processes and collected air samples for acid gases released during digestion of hard metal segments with nitric acid. Personal and area air samples were collected using silica gel tubes and battery powered air sampling pumps. A known volume of air was pulled through the silica gel tubes at a flow rate of 200 cubic centimeters of air per minute (cc/min). The NIOSH laboratory analyzed the samples by ion chromatography using NIOSH Method No. 7903.[1] Bulk dust and airborne dust samples were collected for quantitative and qualitative trace element analyses. The samples were collected using 0.8 micron cellulose ester membrane filters, mounted in 3-piece plastic cassettes, connected to battery powered air sampling pumps operated at a flow rate of two (2) liters of air per minute (2 Lpm). The samples were analyzed by inductively coupled argon plasma, atomic emission spectroscopy method (NIOSH Method 7300).[1]

The NIOSH Medical Officer interviewed 21 employees, mostly those who worked in the Setting Room and Powder Prep. areas. The Medical Officer also reviewed the OSHA 200 logs from 1978 through 1983.

B. Follow-up Environmental Survey

Based on the findings from the initial survey indicating possible excess exposures to cobalt and nickel dust, the NIOSH industrial hygiene investigator returned in December 1984 to conduct a follow-up environmental monitoring survey of worker exposure to cobalt and nickel dust. Because the lathe machine ventilation systems appeared inadequate during the initial survey; during the follow-up survey personal exposures to graphite dust were monitored for workers assigned to the Carbon Room. A solvent based glue used in the Setting Room and OPE Powder Prep. area (trade name Bedacryl) was analyzed to determine its solvent components. The glue was imported from Belgium and no material safety data sheet was available.

During the two-day survey, 40 personal or area air samples were collected to measure airborne concentrations of cobalt and nickel throughout the plant. The departments or areas sampled included OPE Powder Prep., Cold Press, OPE Hot Press, Resin Powder Prep., Diamond Setting, Quality Control Laboratory, Rotary, Small Tools, Tool Room, Engineering, Breakroom, Carbon Room, Resin and Mining, Hot Press, and the plant's personnel office. The air samples were collected with battery powered air sampling pumps attached via plastic tubing to plastic cassettes containing a 0.8 micron cellulose ester membrane filter. A measured volume of air was pulled through the filters at a flow rate of 2 Lpm. Personal samples were obtained by having the worker wear the sampling pump with the filter cassettes attached to the worker's shirt collar. All sampling pumps were pre- and post-calibrated to accurately measure their flow rates. After sampling, the filter cassettes were sent to the NIOSH laboratory for analysis. In the laboratory the filters were removed from the cassettes and ashed with nitric and perchloric acids using procedures outlined in NIOSH Method No. 7300[1]. The resulting solution was then diluted and analyzed for cobalt and nickel by atomic adsorption spectroscopy according to NIOSH Method No. P&CAM 173.[2]

Dust ladened working surfaces, tools, and other settled dust was collected by wiping the area with Whatman Smear Tabs. The smear tabs were ashed and analyzed for cobalt and nickel by the NIOSH laboratory using the same methods as previously described for the air sample analysis.

The filters used for collecting graphite dust in the Carbon Room were pre-weighed by the NIOSH laboratory. After sampling the filters were returned to the laboratory. The total amount of dust collected on the filters was determined by weighing the sample plus the filter on an electrobalance and subtracting the previously determined weight of the filter. All weighings were done in duplicate for each sample.

The bulk sample of glue (Bedacryl) submitted to the NIOSH laboratory for qualitative analysis was extracted with carbon disulfide and the extract was screened by gas chromatography using an HP 5880 GC equipped with a flame ionization detector and a 30-meter DB-1 fused silica capillary column. The extract was then analyzed by gas chromatography/mass spectrometry (GC/MS) for chemical identification of predominant components.

3. Follow-up Medical Survey

Interviews conducted with 21 employees in June, during the initial survey, identified employees with complaints consistent with symptoms reported from workplace exposures to metals. Work practices, such as smoking by employees whose hands were blackened with cobalt/tungsten dust, concerned the NIOSH investigators, and indicated that potential excess exposures to these metals were possible. To evaluate these concerns, 143 employees of the Wheel Trueing Tool Company participated in a plant-wide medical survey from December 10-12, 1984.

A self-administered questionnaire, focusing primarily on respiratory and dermatologic symptoms, was completed by 142 current hourly and salaried employees. This number represented 117 (89%) of the 131 hourly employees and 25 (33%) of the 75 salaried employees. Health symptoms related to work were classified into five broad categories: (1) respiratory (cough, wheezing, chest pain, shortness of breath), (2) gastrointestinal (nausea, diarrhea), (3) neurologic (headache, confusion, fainting, light-headedness, dizziness, etc.), (4) irritant (watery eyes, runny nose, cough), and (5) skin rash or blistering. Symptoms were considered significant if an individual noted that they usually or always occurred at work.

Based on the follow-up environmental survey results, departments were classified by the likelihood of exposure to an excess of either cobalt or nickel. Symptoms were then classified by exposure category. For the purposes of analysis of the questionnaire, the following exposure categories were used:

Cobalt or Nickel Exposure category	Departments
High	OPE powder prep mixing, OPE weigh out operator, OPE manual and automatic cold press, OPE filing segments, rotary, grinding wheel/resin, masonry, mining.
Medium	Tool room/crib, diamond setting, blades, stone, carbon room, furnace, maintenance, lab.
Low	Accounting, shipping, planning/facilities, purchasing, production control, management, sales, office.

Chest X-rays (CXRs) were performed on 140 employees. All films were read independently by two B-readers, radiologists trained in recognizing occupational pneumoconioses. Where disagreements occurred between the radiologists in the interpretation of a given CXR, the films were resubmitted to the two radiologists for a consensus reading.

Pulmonary function tests (PFT) were performed on 140 employees. Each employee completed at least three forced expirations in order to produce two efforts with maximal lung volumes within 5% of each other. Based on the PFT a forced vital capacity (FVC) and a forced expiratory volume at one second (FEV1) were determined. The measured values were corrected for ambient room temperature and pressure, and a percent predicted was calculated for each individual based on his or her age, race, sex, and height.

An individual was considered to have restrictive lung disease if their FVC was less than 80% of their predicted value. A diagnosis of obstructive lung disease was based on a reduction of the ratio of FEV1/FVC below 0.80. An obstructive pattern is most commonly observed among smokers. A restrictive pattern may be seen in lung conditions resulting from exposures to a variety of occupational dusts including hard metals.

Upon completion of the interpretation of the CXRs and PFTs, each employee was sent a copy of his personal results in August, 1985, with an interpretation of the findings and recommendations for further follow-up, where appropriate, by the employee's personal physician.

Exposure categories by department, as defined below, were used to compare the results of the PFTs. These categories differed slightly from the ones used in analyzing the questionnaire survey examining exclusively the possible effects of overexposure to either cobalt or nickel. Each category was stratified by smoking status. For the purposes of analysis, only those individuals who gave the history of currently smoking (present) or having never smoked (never) were included.

Cobalt Exposure Category	Departments
High	OPE powder prep mixing, OPE weigh out operator, OPE manual and automatic cold press, OPE filing segments.
Medium	Rotary, tool room/crib, diamond setting, resin, masonry, blades, stone, setting room, carbon room, mining, furnace, maintenance, lab.
Low	Accounting, shipping, planning/facilities, purchasing, production control, management, sales, office.

Nickel Exposure Category	Departments
High	OPE powder prep mixing, OPE weigh out operator, OPE manual and automatic cold press, OPE filing segments, rotary, grinding wheel/resin, masonry , mining.
Medium	Tool room/crib, diamond setting, blades, stone, carbon room, furnace, maintenance, lab.
Low	Accounting, shipping, planning/facilities, purchasing, production control, management, sales, office.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff use environmental evaluation criteria for assessment of many chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. However, not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes which could potentially increase the total exposure. Lastly, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH criteria documents and recommendations, (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs),[3] and (3) the U.S. Department of Labor (OSHA) occupational safety and health standards.[4] Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, employers should note they are legally required to meet those levels specified by an OSHA standard.

The exposure limits recommended by NIOSH, ACGIH, or permitted by OSHA, for the substances monitored during this health hazard evaluation, are presented in the following table. For the purposes of this evaluation, the NIOSH investigators have selected the most stringent exposure limits as the evaluation criteria.

1. Cobalt

NIOSH	Recommended exposure limit	none published
ACGIH	Threshold limit value	0.05 mg/m^3 TWA
OSHA	Permissible exposure limit	0.1 mg/m^3 TWA

2. Nickel

NIOSH	Recommended exposure limit[5]	0.015 mg/m^3 TWA
ACGIH	Threshold limit value (metal)	1.0 mg/m^3 TWA
OSHA	Permissible exposure limit	1.0 mg/m^3 TWA

3. Graphite Dust (synthetic)

NIOSH	Recommended exposure limit	None published
ACGIH	Threshold limit value	10 mg/m^3 TWA
OSHA	Permissible exposure limit	15 mg/m^3 TWA

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8 to 10-hour workday.

B. Health Effects of Exposure to Hard Metals

The manufacture of the "hard metal" bases or cemented carbides originated in Germany shortly after World War I. Tungsten carbide in combination with other metals, notably cobalt, possesses a high degree of hardness, low coefficient of thermal expansion, and high compressive strength. These extremely hard products have a variety of industrial uses.

1. Cobalt

"Hard metal disease", also known as tungsten carbide pneumoconiosis or mixed dust pneumoconiosis, consists of a reticulonodular interstitial pulmonary fibrosis. The CXR findings may be be accompanied by a hypersensitivity bronchitis with PFT decrements over a workshift or a fixed restrictive ventilatory impairment.

Experimental evidence in animals indicates that cobalt is the probable etiologic agent for both the acute and chronic lung diseases observed in workers of the cemented tungsten-carbide industry. Miniature swine exposed to 0.1 and 1 mg/m^3 for six hours a day for three months experienced pulmonary disease at the 0.1 mg/m^3 exposure level. The animals showed signs of hypersensitivity as evidenced by wheezing observed during the fourth week of exposure following a one-week sensitizing dose.[6]

The interstitial lung disease in humans thought to be associated with the manufacture and grinding of tungsten carbide has been described in numerous case reports, medical examinations, and industry-wide studies. A common pattern of the illness has been described. First, the worker develops a cough, followed by labored breathing on exertion. The person may lose a substantial amount of weight and develop a progressive interstitial pulmonary fibrosis. The final stages of this fibrotic process may lead to cor pulmonale (heart disease due to pulmonary hypertension secondary to disease of the blood vessels of the lungs) and cardiorespiratory collapse. Chest radiographs reveal increased linear striations and diffuse nodular opacities in the middle and lower zones of the lung. The degree of abnormality evident in the radiographs becomes greater as the stage of the disease becomes more severe. In some cases, the disease has been reversible or has not progressed if it was detected at an early stage and the worker received no further exposure to cobalt.[7]

Transient pulmonary function decrement during the working week, with improvement on the weekend, have been described in workers exposed at cobalt concentrations of 0.005-0.01 mg/m^3, with smokers more affected than nonsmokers.[8] Rhinitis and rhinopharyngitis have been described at air cobalt concentrations of 0.4-2.9 mg/m^3. The toxic effects in hard metal workers at relatively low and constant concentrations of cobalt have not been thoroughly studied. Early signs of restrictive ventilatory impairment without CXR changes in grinding machine operators exposed to a mean TWA concentration of cobalt of 0.18 mg/m^3 (range, 0.03-0.43) have been reported.[9]

It appears that hard metal workers can develop fibrosis or prefibrotic changes with exposure to cobalt in the range of 0.1-0.2 mg/m^3. The Swedish studies[9] suggest possible chronic lung obstruction at average concentrations of 0.06 mg/m^3.

Experimental studies in animals indicate that some cobalt compounds cause pulmonary fibrosis. However, the information is insufficient to determine what effect, if any, exposure to other substances often present in cemented tungsten carbide may have on the development of hard metal disease. The possibility that adverse effects in workers exposed to cobalt in the 0.06-0.2 mg/m^3 range, were aggravated by exposure to mixtures, must be considered. However, the degree of worker exposure to cobalt is clearly related to the number of signs and symptoms observed in workers. Thus, decreasing exposure to cobalt should reduce the risk of adverse health effects. For cobalt metal, the adverse lung effects observed at or below the OSHA PEL (0.1 mg/m^3) suggests that the current OSHA limit may not be adequate.[5] Because of findings of Kerfoot et al [7] that pulmonary disease could be produced after only 3 months exposure to cobalt at the current OSHA PEL of 0.1 mg/m^3, the ACGIH has adopted a TLV of 0.05 mg/m^3 for cobalt dust and fume[10].

a. Effects on the Skin

The incidence of skin sensitivity to cobalt in the general population appears to be low, probably between 0.8-1.8% of the population. For workers with exposure to cobalt with occupational dermatitis or eczema, approximately 5% of those studied have been cobalt-sensitive with 82% of these having combined metal sensitivities, particularly to nickel and chromium. All three metals are prevalent in the general environment, which suggests that individuals with cobalt sensitivity also have had contact with nickel and chromium making the possibility of independent sensitization reactions likely.[5]

b. Effects on Other Organ Systems

Cobalt-containing compounds have been shown or implicated as a causative agent in certain types of cardiac diseases, blood conditions, and thyroid problems. Most of these effects have occurred in special situations (contamination, therapeutic use of cobalt compounds), usually at levels of exposure to cobalt far in excess of those occurring in most industrial situations. Information on cobalt is inadequate to conclude that cobalt is a carcinogen. However, the information is also inadequate to conclude that cobalt is noncarcinogenic. Evidence concerning the effects of cobalt on reproduction is conflicting and insufficient to draw definite conclusions.[5]

Cobalt metal and salts, and probably cobalt oxides, can damage the kidneys.[11] These effects are thought to occur only at levels that also produce other toxic effects.

2. Nickel

Even though the available evidence indicates an association between human exposure to inorganic nickel and the development of cancer, the mixed exposures, both to different nickel compounds and to other elements frequently occurring in the workplace, have prevented complete differentiation of the effects of individual compounds. Nickel accumulates in the kidney of test animals and can cause nephrotoxicity given sufficiently high concentrations.[6] NIOSH has identified nickel as a suspect carcinogen because workers in the nickel industry have experienced excess lung and nasal cancers. The NIOSH policy on workplace exposures to carcinogens recommends reducing exposures to the lowest feasible level. The NIOSH exposure limits for carcinogens are therefore based on the limits of detection by the current NIOSH sampling and analytical method, which, for nickel, is currently 0.015 mg/m^3.[6] The ACGIH has taken the position that not all forms of nickel are carcinogens and continues to recommend a TLV of 1.0 mg/m^3 for metallic nickel.[10]

3. Synthetic Graphite

Synthetic graphite is a crystalline form of carbon made from high temperature treatment of coal or petroleum products. Synthetic graphite has the same physical and chemical properties as natural graphite. On the basis of experimental evidence, the ACGIH has concluded that pure synthetic graphite can be treated as a "nuisance dust." Accordingly, a TLV of 10 mg/m^3 (8-hour TWA) is recommended.[6] The OSHA PEL for nuisance dust is currently 15 mg/m^3.

VI. RESULTS AND DISCUSSION

A. Initial Survey Results

1. Acid Gasses

Initial concerns that acid gasses were contaminating the air inside the plant during the nitric acid digestion of metal segments in the Takeout room were not confirmed by air samples collected during the initial NIOSH survey. Airborne concentrations of hydrochloric, nitric, hydrobromic, sulfuric, and phosphoric acids were below the detectable limits of the sampling method used for samples collected in the following locations:

QC Laboratory - segment digestion under laboratory hood (personal sample)

Takeout Room - segment digestion under local exhaust hood (personal sample)

Takeout Room - segment digestion near exhaust hood (air sample)

Roof-top air-conditioner - outside air intake vent

This sample was taken to check for possible reintrainment of NO2 released from the Takeout Room exhaust system.

2. Dust Sample Analyses

The NIOSH laboratory analyzed bulk and airborne dust samples collected during the initial survey for trace elements to identify what metals were most likely to represent exposure risks for Wheel Trueing workers. Based on the concentrations detected and the recommended exposure limits of the metals identified, cobalt and nickel were chosen as the best indicator of exposure for any follow-up surveys. The results obtained from the initial environmental survey are summarized in Tables 1 and 2.

3. Medical findings

At the time of the NIOSH survey, Wheel Trueing employed 118 hourly workers (70% male) on a one-shift per day schedule from 6:00 a.m. to 4:30 p.m. Of the 21 employees interviewed, seven reported no work related health problems. Of the 14 workers who reported symptoms, the complaints included dermatologic, respiratory, gastrointestinal, neurologic, and cardiac symptoms. The table below summarizes the types and nature of their complaints and the numbers of individuals involved.

SYMPTOMS	NUMBER OF INDIVIDUALS
Skin Rash	5
Respiratory	
sinus problems	4
throat/nose irritation	3
chest tightness/difficulty breathing	3
Gastrointestinal	
burning/bloating/gas	4
nausea	7
metallic taste	2
Neurologic	
dizziness	6
headache	3
fatigue	2
Cardiac	
retention of fluid/swelling	4
heart palpitations	2
No symptoms	7

Four reports of dermatitis were identified on the OSHA 200 logs. All these complaints are consistent with symptoms reported from workplace exposures to metals.

B. Follow-up Survey Results

1. Environmental

Out of 37 air samples collected for cobalt, four samples exceeded the current OSHA Permissible Exposure Limit (PEL) of 0.1 mg/m^3 (see Table 3). However, when compared to the ACGIH TLV of 0.05 mg/m^3, 12 samples were above the evaluation criteria. As expected, the areas and jobs which had the greatest exposures were in the OPE Department where most of the loose cobalt dust was handled.

Airborne nickel was detected in six samples. All exposures were below the OSHA PEL. However, because NIOSH recommends exposures to all forms of airborne nickel not exceed 0.015 mg/m^3; three "above-limit" exposures were detected in the samples.

Results from wipe samples are presented in Table 4. Again, the highest concentrations of settled cobalt and nickel dusts were found in the OPE Department. Trace amounts of cobalt and nickel were detected in dust accumulation taken from an air-conditioning supply vent in the Setting Room.

Graphite dust exposures in the Carbon Room were excessive (see Table 5), with two of three samples detecting personal exposures above 10 mg/m^3, the ACGIH and NIOSH recommended exposure limit for nuisance dusts. These exposures also exceeded the OSHA PEL of 15 mg/m^3.

The GC/MS analysis of the Bedacryl adhesive identified the primary solvent components as xylene isomers. Other peaks detected were toluene, n-butyl methacrylate, n-propylbenzene and other aromatics such as trimethylbenzenes, or methylethylbenzenes (see Figure 1).

2. Medical

From the self-administered questionnaire completed by 142 hourly and salaried employees at Wheel Trueing, the demographic characteristics of the survey population were determined (see Table 6). The smoking status of the population is summarized in Table 7. It was noteworthy that 50% of the workforce were current smokers.

There was no statistically significant difference in the prevalence of any symptom by exposure category, as previously identified in Section IV. A similar analysis by department revealed no excess of complaints for any one department. Of the 15 individuals with complaints of job related skin rashes, nine (67%) gave histories of skin reactions to other metals. Six of the nine noted reactions to metal watch bands, costume jewelry, or "cheap jewelry", all of which contain varying quantities of nickel and chromium metals, frequently implicated in skin sensitization. Two individuals noted skin reactions to gold. All nine individuals worked in departments with potential exposures to cobalt and nickel. In addition to metal reactions, machinists using cutting oils may develop irritant-type reactions to components or contaminants of the oils. Five individuals with complaints of skin rashes worked in the grinding wheel or rotary departments with presumed exposures to cutting oils. The prevalence of significant symptoms is noted in Table 8 for all employees who completed the questionnaire. The prevalence of symptoms by exposure category, as previously defined in section IV, is presented in Table 9.

From the chest X-rays performed on 140 Wheel Trueing employees, no chest film contained evidence of changes in the lung consistent with the diagnosis of "hard-metal disease" or mixed-dust pneumoconiosis.

Tables 10 and 11 show the results of the pulmonary function tests for the cobalt and nickel exposure categories, respectively. The departments included in the high, medium, and low exposure categories are noted on the tables and were based on exposure data from the industrial hygiene portion of this evaluation. An analysis of variance (ANOVA), using the Statistical Analysis System (SAS) general linear model for unbalanced data, was performed for each exposure category and PFT variable stratifying for smoking status.

A decline in the forced vital capacity (FVC) was used to indicate restrictive pulmonary disease. No differences in FVC that could be accounted for by exposure category were observed for either cobalt or nickel. This absence of a difference was observed both for smokers and nonsmokers.

Tables 12 and 13 redefine exposure categories using job titles with high, medium, and low exposures to cobalt and nickel, respectively. Again, the categories were based on the results of area and personal exposure sampling. As for the exposure categories based on department, no differences in FVC by job exposure category were observed for either cobalt or nickel. Nine individuals tested met the criteria for restrictive pulmonary disease, with an FVC less than 80% predicted. All individuals, however, worked in departments or had job titles for which cobalt was not detected. Previous jobs, both at Wheel Trueing and prior to employment at Wheel Trueing, also did not explain the presence of restrictive disease except in one instance of prior exposure to silica in a rock quarry.

For the PFT variable used to indicate obstructive disease (FEV1/FVC), no differences that could be accounted for by exposure category were observed for either cobalt or nickel. However, a statistically significant decline in pulmonary function, regardless of exposure category, was observed among those currently smoking. For the cobalt exposure category, Table 10, the general decline in FEV1/FVC was best explained by status as a current smoker ($F=5.37$, $df=2$, $p=0.02$). For the nickel exposure category, Table 11, the same decline in pulmonary function relative to smoking was observed ($F=6.13$, $df=2$, $p=0.01$).

For the exposure categories based on job title, no differences in FEV1/FVC could be explained by degree of exposure to either cobalt or nickel. However, declines in pulmonary function were again observed relative to smoking status ($F=6.38$, $df=2$, $p=0.01$ for jobs with cobalt exposure, $F=5.42$, $df=2$, $p=0.02$ for nickel exposure).

There was no correlation between the results of the pulmonary function tests and individuals noting respiratory symptoms (shortness of breath, cough, wheezing) as occurring usually or always at work.

Given that 50% of the employee population smoked at the time of the evaluation, it is not surprising to find evidence of increased pulmonary obstructive disease relative to smoking in all categories of exposure to cobalt and nickel.

Analysis of the pulmonary function data by exposure to cobalt did not provide evidence of the existence of restrictive disease consistent with the cumulative effect of hard metal exposure in this population.

VII. CONCLUSIONS

1. There was no evidence of "hard metal" disease at the time of testing based on the chest X-ray and pulmonary function test findings.

2. Overexposures to cobalt were occurring in a number of operations where loose metal powders were handled. A review of the literature indicates that long term exposures to cobalt at concentrations above the evaluation criteria (0.05 mg/m^3) may lead to pulmonary fibrosis and "hard metal" disease.

3. There is a high prevalence of smokers in this population with concomitant declines in respiratory function relative to smoking. Inhalation of cigarette smoke on the job has the potential for increasing the amount of metal dusts deposited in the lungs through handling smoking materials with contaminated hands and the deeper inhalations accompanying the act of smoking a cigarette.

4. Nine workers gave clinical histories consistent with skin sensitivities to metals. In addition, six workers experiencing skin rashes work with cutting oils.

5. Local exhaust ventilation systems in the Carbon Room are not effective in controlling exposure to airborne synthetic graphite dust.

VIII. RECOMMENDATIONS

1. At the time of the NIOSH evaluation, workers were allowed to smoke on the job throughout the plant. Considering the potential for cobalt and nickel exposure through contaminated smoking materials, this practice should be prohibited. Wheel Trueing should prohibit eating, food handling, food storage, or the carrying of tobacco products within the production areas. After working with metal powders or materials contaminated with metal powders, workers should thoroughly wash their hands and face before drinking, eating, or smoking. Showers should be available to workers who have had substantial contact with metal powders. These workers should be encouraged to wash or shower after each workshift.

2. At the time of the initial site visit, material safety data sheets describing the physical, chemical, and toxicologic properties of the many products and metal powders used by Wheel Trueing were not available. Lacking toxicity information on materials handled, workers may get the impression that special precautions to prevent or reduce exposures are unnecessary. As required by the new OSHA Hazard Communications Standard (29 CFR 1910.1200), all workers should have access to and be familiar with each material safety data sheet corresponding to the materials they use or handle. All material used in the

workplace must also be labeled to show their chemical identity and appropriate hazard warnings.

3. Workers should be instructed in the safe handling of cobalt and nickel. Instructions concerning proper handling methods, cleanup procedures, personal protective equipment, and emergency procedures should be part of Wheel Trueing's hazard communications program.

4. General plant maintenance should be conducted regularly to prevent cobalt containing dusts from accumulating in work areas. Cleaning should be performed with vacuum pickup or wet mopping to minimize the amount of dust dispersed into the air. Spills of metal powders should be promptly cleaned up to minimize inhalation or dermal contact.

5. Additional local exhaust systems or modifications to existing systems are needed to further reduce cobalt exposures, especially in the OPE Department. Where exposures exceed 0.05 mg/m^3, a NIOSH approved respirator should be worn (respirator selection based on exposure concentration) until exposures are reduced to below 0.05 mg/m^3 through improved engineering controls or work practices. Single use respirators for protection from cobalt dust exposures are not recommended by NIOSH[7].

6. Industrial hygiene surveys to evaluate cobalt exposures should be performed at least once every three years throughout the plant. Tasks involving potential exposures to loose cobalt powders including maintenance activities, should be monitored annually or as soon as possible after any process change which might modify the potential for exposure.

7. NIOSH encourages the provision of medical surveillance programs for workers. These programs should ideally include preplacement examinations and periodic reevaluations that will allow detection of absorption before onset of perceptible damage.

   The most dramatic effect of cobalt is on the lungs. A medical history is important to determine the presence of factors that would argue against placement in a job requiring exposure to cobalt. The physical examination should give special attention to the chest and lungs. NIOSH recommends that pulmonary function studies, sensitive indicators of early changes in lung tissues, be conducted yearly. The PFTs should include a measurement of forced expiratory volume in one second (FEV1) and forced vital capacity (FVC). Chest X-rays are less able to detect early changes as compared to pulmonary function tests. A suitable timing for chest X-rays might be every three years.

   The skin should receive attention because cobalt and nickel compounds can cause allergic responses and sensitization. Once sensitized, a worker can probably not tolerate any additional exposure. As a result, any worker with a previous history of allergic skin disease should be carefully counselled and schooled in techniques that will minimize contact with cobalt and nickel. In addition, skin protection should be stressed in the workplace to keep the number of new cases of skin sensitization at a minimum.

In addition, the medical examination might include testing for urinary protein, palpation of the thyroid, and determination of certain hematologic parameters such as a complete blood count. The medical surveillance program should be reevaluated frequently and changed to reflect current working conditions and knowledge of health effects. Medical records should be kept for 30 years after the worker's last exposure to cobalt or nickel.

8. Workers currently with skin rashes should be patch tested by a dermatologist or allergist to determine metal sensitivity. If metal sensitivity exists, and a reduction/elimination of symptoms does not occur with engineering controls and personal protective clothing to control exposures, then a job transfer should be considered.

9. The local exhaust systems used on the lathe machines in the Carbon Room need improving. Installing taper or cone hoods in the openings of the flexible exhaust ducts and positioning these hoods as close to the dust release points as possible will improve the capture effectiveness of the existing system.

10. Use of barriers creams, such as the frequent application of petroleum jelly and hand washing, plus the use of gloves, will help to ameliorate the irritant dermatitis from cutting oils.

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XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati, Ohio address.

Copies of this report have been sent to:

1. Wheel Trueing Tool Company, Columbia, South Carolina
2. Employee representatives (confidential request)
3. U.S. Department of Labor, OSHA Region IV
4. NIOSH Regional Office, Atlanta, Georgia
5. Appropriate agencies for the State of South Carolina

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

TABLE 1
BULK SAMPLE RESULTS

WHEEL TRUEING TOOL COMPANY
COLUMBIA, SOUTH CAROLINA
HETA 84-288

Bulk Sample B1 -- a mixture of three mold fill powders used in Setting Room (M-41, T-30, and powder with no I.D.)

Note: According to manufacturers' information, M-41 is 99.9% pure tungsten; and T-30 is 40-50% tungsten carbide, 18-25% iron, 10-18% nickel, and about 10% copper.

Bulk Sample B2 -- unidentified mold filling powder

Bulk Sample B3 -- grinding wheel dust from leaking dust collector

Note: NIOSH also analyzed this sample for free silica by X-ray powder diffraction. The sample contained less than 1% quartz. No cristobalite or tridymite was detected.

ELEMENTS	SAMPLE B1 (%)	SAMPLE B2 (%)	SAMPLE B3 (%)
Silver	<0.005	<0.005	0.299
Aluminum	<0.005	0.012	0.212
Calcium	<0.005	<0.005	0.072
Cobalt	0.033	0.023	8.97
Chromium	<0.005	<0.005	<0.005
Copper	5.22	<0.005	4.67
Iron	13.2	0.177	0.356
Magnesium	<0.005	<0.005	0.023
Manganese	0.361	0.005	<0.005
Sodium	<0.005	<0.005	0.091
Nickel	>14.5	0.017	0.063
Phosphorus	0.348	<0.005	0.209
Lead	0.005	<0.005	0.006
Tin	<0.005	<0.005	0.009
Titanium	<0.005	<0.005	0.008
Tungsten*	0.173	0.086	<0.005
Zinc	0.009	<0.005	0.022

Elements not detected (less than 0.005%) were: arsenic, barium, beryllium, cadmium, lanthanum, lithium, molybdenum, platinum, antimony, selenium, strontium, tellurium, thallium, vanadium, yttrium, and zirconium.

* The values listed for tungsten only indicate its presence in the sample because NIOSH method 7300 cannot accurately quantitate tungsten. Based on further analysis of samples B2 and B3 by atomic absorption spectroscopy (NIOSH Method 7074), sample B2 contained 95% tungsten and sample B3 contained 0.7% tungsten.

< = less than
> = greater than

TABLE 2

AIR SAMPLE RESULTS

WHEEL TRUEING TOOL COMPANY
COLUMBIA, SOUTH CAROLINA
HETA 84-288

Air Sample A1 -- Personal exposure, Grinding Wheel Powder Prep.
Air Sample A2 -- Personal exposure, Setting Room
Air Sample A3 -- Personal exposure, OPE Powder Prep.

ELEMENTS	SAMPLE A1	SAMPLE A2	SAMPLE A3	Exposure Limits
	(mg/m^3)	(mg/m^3)	(mg/m^3)	
(mg/M^3)				
Aluminum	0.38	0.004	0.002	10.0
Calcium	0.1	0.004	0.007	2.0
Cadmium	0.001	0.002	<0.001	0.04**
Cobalt	0.001	0.003	1.05	0.05***
Copper	0.02	0.001	<0.001	1.0
Iron	0.003	0.47	0.012	5.0
Sodium	0.003	0.003	0.004	--
Nickel	<0.001	0.004	0.002	0.015**
Phosphorus	0.002	<0.001	<0.001	0.1
Tungsten*	<0.001	0.002	0.02	5.0**
Zinc	0.009	0.02	0.01	5.0**

Elements not detected include: silver, arsenic, barium, beryllium, chromium, lanthanum, lithium, magnesium, manganese, molybdenum, lead, platinum, antimony, selenium, strontium, tellurium, thallium, titanium, vanadium, yttrium, and zirconium.

* The values listed for tungsten only indicate its presence in the sample since NIOSH method 7300 can not accurately quantitate tungsten. NIOSH could not analyze these samples for tungsten by atomic absorption, Because all samples were consumed during the first analyses.

** NIOSH recommended limit

*** Current threshold limit value recommended by the American Conference of Governmental Industrial Hygienists (ACGIH)

TABLE 3
AIR SAMPLING RESULTS FOR COBALT AND NICKEL
WHEEL TRUEING TOOL COMPANY
COLUMBIA, SOUTH CAROLINA
NIOSH HEALTH HAZARD EVALUATION
HETA 84-288

Job Classification	Sample No.	Sample Start - Stop	Duration minutes	Flow Rate Lpm	Cobalt Conct mg/M^3	Nickel Conct mg/M^3
Collected Dec 4, 84						
OPE powder prep mixing	A2	0715 - 1508	473	2.00	[0.07]	0.004
OPE powder prep mixing	A5	0713 - 1510	477	2.05	[0.18]	0.004
OPE weigh out operator	A7	0739 - 1431	412	2.00	[0.07]	0.005
OPE manual cold press	A1	0720 - 1431	431	2.00	[0.06]	0.005
OPE automatic cold press	A3	0727 - 1431	424	2.00	[0.07]	0.005
OPE filing segments	A16	0752 - 1431	399	2.00	[0.15]	0.011
OPE hot press operator	A15	0756 - 1431	395	2.20	0.02	0.005
OPE filing seg/mch assy	A4	0737 - 1518	461	2.00	0.01	0.004
Resin powder prep	A9	0815 - 1513	418	2.00	0.00	0.005
Resin powder prep, micron	A6	0812 - 1314	302	2.00	ND	0.007
Setting, Diamond setter	A11	0831 - 1425	354	2.00	ND	0.006
Setting, Diamond setter	A14	0834 - 1523	409	2.08	ND	0.005
Setting, Mining setter	A13	0840 - 1520	400	2.05	ND	0.005
Setting, Masonry/mining	A12	0847 - 1521	394	2.05	ND	[0.028]
Lab, grinding/testing	A10	0743 - 1431	408	2.00	0.01	0.005
Rotary, grinding wheels	A8*	0904 - 1400	296	2.00	ND	[0.051]
Small Tools, lapping	A18	0917 - 1505	348	2.00	ND	0.006
Tool Room, Machinist	A20	0909 - 1415	306	2.00	0.01	0.008
Engineering Clerk	A19	0926 - 1535	369	2.00	ND	0.005
Breakroom, change machine	A17	0929 - 1535	366	2.05	ND	0.005
Collected Dec 5, 84						
OPE powder prep mixer	A22	0750 - 1505	435	1.95	[0.10]	0.005
OPE powder prep mixer	A34	0753 - 1505	432	2.00	0.05	0.005
OPE powder prep mixer	A32	0755 - 1505	430	2.00	[0.08]	0.005
OPE powder mixer area	A35	0834 - 0857	23	2.00	[0.11]	[0.087]
OPE manual cold press opr	A38	0809 - 1427	378	2.00	[0.08]	0.005
OPE auto cold press opr	A33	0800 - 1427	387	2.00	[0.17]	0.005
OPE auto cold press opr	A27	0805 - 1427	382	2.00	[0.14]	0.005
OPE hot press operator	A28	0817 - 1427	370	2.00	ND	0.005
Setting mining table	A39	0930 - 1423	293	1.95	ND	0.007
Setting rotary table	A23	0926 - 1525	359	1.95	ND	0.006
Setting rotary table	A29	0923 - 1528	365	2.00	ND	0.005
Resin hot press operator	A24	0823 - 1512	409	1.95	ND	0.005
Resin powder prep	A30	0828 - 1514	406	1.95	ND	0.005
Resin powder prep	A40	0829 - 1517	408	2.00	ND	0.005
Mining hot press operator	A21	0912 - 1521	369	1.95	ND	0.006
Rotary wheel grinder	A25	0938 - 1531	353	2.00	ND	0.035
Personnel office area	A37	0942 - 1534	352	2.00	ND	0.006
Evaluation Criteria (NIOSH Recommended Exposure Limits)					0.05	0.015
Current OSHA Permissible Exposure Limits					0.1	1.0

[indicates exposure above the NIOSH evaluation criteria]

Limits of Detection = 3.0 micrograms per sample for cobalt
= 4.0 micrograms per sample for nickel

ND = None Detected

TABLE 4

WIPE SAMPLE RESULTS FOR COBALT AND NICKEL

WHEEL TRUEING TOOL COMPANY
COLUMBIA, SOUTH CAROLINA
NIOSH HEALTH HAZARD EVALUATION
HETA 84-288

December 4-5, 1984

Sample No.	Surface Location Sampled	Cobalt	Nickel
		(ug/100 sq cm)*	
1	Setting - rotary setting table	ND	ND
2.	Setting - mining setting table	ND	ND
3	Setting - mining weigh-out area	ND	ND
4.	Water fountain outside Setting room	29	8
5.	Telephone hand set in Powder Prep room	7	ND
6.	OPE Powder Prep - top of safe	1100	68
7.	OPE Powder Prep - manual cold press table	180	6
8.	Floor in front of hot press machines	500	160
9.	Resin Powder Prep - work table	4	17
10	Resin Powder Prep - top of safe	3	ND
11	Resin Powder Prep - table near mixing area	ND	ND
12	Resin P. Prep - top of small exhaust hood	110	11
13	Rotary - Top of Jones & Lamson insp machine	260	390
14	Tool Room - work bench near telephone	37	100
15	Setting - airconditioner supply vent	290	42
Limit of Detection =		3	3

* Surface area wiped (100 square centimeters) was estimated and results are reported as micrograms per 100 cubic centimeters of surface area

TABLE 5

AIR SAMPLING RESULTS FOR GRAPHITE DUST IN CARBON ROOM
(as total dust)

WHEEL TRUEING TOOL COMPANY
COLUMBIA, SOUTH CAROLINA
NIOSH HEALTH HAZARD EVALUATION
HETA 84-288

Substance Measured Wheel Trueing Tool Co. Job Classification	Start	Stop	minutes	Flow Rate Lpm	Sample Vol liters	Carbon Dust mg/M^3
Collected Dec 4, 84						
Carbon Room, Machinist	0857	- 1527	390	1.95	760.50	3.26
Carbon Room, Machinist	0857	- 1420	323	2.00	646.00	19.95
Collected Dec 4, 84						
Carbon room, machinist	0934	- 1526	352	1.60	563.20	33.50
Evaluation Criteria (NIOSH Recommended Exposure Limit) =						10.0
Current OSHA Permissible Exposure Limit =						15.0

TABLE 6

DEMOGRAPHICS
WHEEL TRUEING TOOL CO.
HETA 84-288

December 1984

Age

Mean - 32.6 years ± 8.9 (Range 18-60)
Median - 30.5 years

Sex

Male 105 (74%)
Female 37 (26%)

Race

White	97 (68%)
Black	37 (26%)
Asian	5 (4%)
Hispanic	3 (2%)

Length of employment

Mean - 4.3 years ± 3.2 (Range, 1 month - 13.4 years)
Median - 4.8 years

TABLE 7

SMOKING STATUS
WHEEL TRUEING TOOL CO.
HETA 84-288

December 1984

Smoking status

Current smokers - 71/142 (50%)

Past smokers - 17/142 (12%)

Never smoked - 54/142 (38%)

Smoking status by number of pack-years* smoked (current smokers only)

Pack-years	Number of employees
70-79	1
60-69	0
50-59	3
40-49	2
30-39	4
20-29	13
10-19	22
<10	25
N/A	1
	71

* - one pack-year equals the consumption of one pack of cigarettes per day for one year, or the equivalent (eg. smoking one-half pack per day for two years equals one pack-year).

TABLE 8

PREVALENCE OF SYMPTOMS
WHEEL TRUEING TOOL CO.
HETA 84-288

December 1984

Symptom*	# (%)
Runny, stuffy nose	33 (23%)
Headache	20 (14%)
Watery, burning, pink or itchy eyes	20 (14%)
Skin rash or blisters	15 (11%)
Cough	13 (9%)
Difficulty breathing or shortness of breath	10 (7%)
Light-headedness	9 (6%)
Muscle cramping	9 (6%)
Chest pain	8 (6%)
Fainting or dizziness	7 (5%)
Weakness	7 (5%)
Wheezing	7 (5%)
Chills	6 (5%)
Diarrhea	6 (5%)
Slurred speech	6 (5%)
Nausea or vomiting	5 (4%)
Confusion or disorientation	2 (1%)

* - symptoms experienced during the workshift noted during the one month prior to the survey, and reported as occurring always or more than half the time.

TABLE 9

PREVALENCE OF SYMPTOMS
BY EXPOSURE CATEGORY
WHEEL TRUEING TOOL CO.
HETA 84-288
December 1984

Symptom*	Exposure category		
	High[1] (N=77)	Medium[2] (N=44)	Low[3] (N=21)
1. Respiratory			
Cough	8 (10%)	5 (11%)	2 (10%)
Wheezing	3 (4%)	3 (7%)	2 (10%)
Difficulty breathing or shortness of breath	6 (8%)	2 (5%)	3 (14%)
Chest pain	6 (8%)	2 (5%)	1 (5%)
2. Gastrointestinal			
Diarrhea	4 (5%)	1 (2%)	2 (10%)
Nausea or vomiting	3 (4%)	2 (5%)	1 (5%)
3. Neurologic			
Light-headedness	5 (6%)	4 (9%)	1 (5%)
Muscle cramping	7 (9%)	3 (7%)	0
Fainting or dizziness	5 (6%)	1 (2%)	1 (5%)
Weakness	4 (5%)	3 (7%)	1 (5%)
Slurred speech	6 (8%)	1 (2%)	0
Confusion or disorientation	3 (4%)	2 (5%)	1 (5%)
4. Irritant			
Runny, stuffy nose	20 (26%)	11 (25%)	4 (19%)
Watery, burning, pink or itchy eyes	10 (13%)	9 (20%)	6 (29%)
5. Skin			
Skin rash or blisters	9 (12%)	6 (14%)	1 (5%)

* - symptoms experienced during the workshift noted during the one month prior to the survey, and reported as occurring always or more than half the time.

1 - Departments - OPE powder prep mixing, OPE weigh out operator, OPE manual and automatic cold press, OPE filing segments, rotary, grinding wheel/resin, masonary, mining.

2 - Departments - Tool room/crib, diamond setting, blades, stone, carbon room, furnace, maintanence, lab.

3 - Departments - Accounting, shipping, planning/facilities, purchasing, production control, management, sales, office.

TABLE 10

PULMONARY FUNCTION BY
EXPOSURE TO COBALT
WHEEL TRUEING TOOL CO.
HETA 84-288

December 1984

Exposure category (cobalt) / Smoking status		Restrictive FVC (%pred) Present	Never
High[1]	N	9	3
	Mean	97.7	107.3
	SD	8.2	4.9
Medium[2]	N	51	41
	Mean	98.1	99.3
	SD	12.0	11.9
Low[3]	N	10	9
	Mean	100.2	101.2
	SD	12.0	10.1

Exposure category (cobalt) / Smoking status		Obstructive FEV_1/FVC Present	Never
High[1]	N	9	3
	Mean	80.0	76.3
	SD	9.9	11.7
Medium[2]	N	51	41
	Mean	81.0	83.7
	SD	7.1	5.3
Low[3]	N	10	9
	Mean	77.0	84.1
	SD	6.7	6.2

1 - Departments - OPE powder prep mixing, OPE weigh out operator, OPE manual and automatic cold press, OPE filing segments.

2 - Departments - Rotary, tool room/crib, diamond setting, resin, masonary, blades, stone, setting room, carbon room, mining, furnace, maintanence, lab.

3 - Departments - Accounting, shipping, planning/facilities, purchasing, production control, management, sales, office.

TABLE 11

PULMONARY FUNCTION BY
EXPOSURE TO NICKEL
WHEEL TRUEING TOOL CO.
HETA 84-288

December 1984

Exposure category (nickel) / Smoking status		Restrictive FVC (%pred) Present	Never
High[1]	N	36	28
	Mean	98.5	98.6
	SD	11.5	11.3
Medium[2]	N	24	16
	Mean	97.3	101.9
	SD	11.6	12.6
Low[3]	N	10	9
	Mean	100.2	101.2
	SD	12.0	10.1

Exposure category (nickel) / Smoking status		Obstructive FEV_1/FVC Present	Never
High[1]	N	36	28
	Mean	81.0	82.6
	SD	6.9	6.3
Medium[2]	N	24	16
	Mean	80.7	84.4
	SD	8.4	5.4
Low[3]	N	10	9
	Mean	77.0	84.1
	SD	6.7	6.2

1 - Departments - OPE powder prep mixing, OPE weigh out operator, OPE manual and automatic cold press, OPE filing segments, rotary, grinding wheel/resin, masonary, mining.

2 - Departments - Tool room/crib, diamond setting, blades, stone, carbon room, furnace, maintanence, lab.

3 - Departments - Accounting, shipping, planning/facilities, purchasing, production control, management, sales, office.

TABLE 12

PULMONARY FUNCTION BY
EXPOSURE TO COBALT
WHEEL TRUEING TOOL CO.
HETA 84-288

December 1984

Exposure category (cobalt) Smoking status		Restrictive FVC (%pred) Present	Never
High[4]	N	8	6
	Mean	93.1	100.8
	SD	7.8	17.4
Medium[5]	N	54	33
	Mean	99.4	100.5
	SD	12.1	10.8
Low[6]	N	8	14
	Mean	96.4	98.8
	SD	9.1	10.8

Exposure category (cobalt) Smoking status		Obstructive FEV_1/FVC Present	Never
High[4]	N	8	6
	Mean	81.1	78.5
	SD	9.4	7.8
Medium[5]	N	54	33
	Mean	80.7	83.9
	SD	7.3	5.7
Low[6]	N	8	14
	Mean	76.8	84.3
	SD	6.6	5.2

4 - Job titles - press operator, finish fileman, deburring, hot press, cold press, automatic press, powder packing.

5 - Job titles - utility worker, production foreman, diamond sorter/setter, tool grinder/brazer, machine operator, quality control, supervisor, large blade tech, welding/exposing, diamond laper, thermosetter, mechanic, maintanence, hammersmith, tool crib attendant.

6 - Job titles - accountant, planner, inspector, shipping & receiving clerk, secretary, employee relations, expeditor, inventory, purchasing agent, programmer, clerk.

TABLE 13

PULMONARY FUNCTION BY
EXPOSURE TO NICKEL
WHEEL TRUEING TOOL CO.
HETA 84-288
December 1984

Exposure category (nickel) / Smoking status		Restrictive FVC (%pred) Present	Never
High[4]	N	10	10
	Mean	101.4	96.8
	SD	9.5	11.9
Medium[5]	N	52	29
	Mean	98.0	101.8
	SD	12.2	11.6
Low[6]	N	8	14
	Mean	96.4	98.8
	SD	9.1	10.8

Exposure category (nickel) / Smoking status		Obstructive FEV_1/FVC Present	Never
High[4]	N	10	10
	Mean	83.6	84.7
	SD	2.6	5.4
Medium[5]	N	52	29
	Mean	80.3	82.5
	SD	8.0	6.5
Low[6]	N	8	14
	Mean	76.8	84.3
	SD	6.6	5.2

4 - Job titles - Lathe machine operator, tool grinder/brazer, weigher.

5 - Job titles - press operator, finish fileman, deburring, hot press, cold press, automatic press, powder packing, utility worker, production foreman, diamond sorter/setter, machine operator, quality control, supervisor, large blade tech, welding/exposing, diamond laper, thermosetter, mechanic, maintanence, hammersmith, tool crib attendant.

6 - Job titles - accountant, planner, inspector, shipping & receiving clerk, secretary, employee relations, expeditor, inventory, purchasing agent, programmer, clerk.

FIGURE 1

GC/MS RESULTS FOR BEDACRYL ADHESIVE
WHEEL TRUEING TOOL COMPANY
HETA 84-288