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HOEGANAES MAGNETIC MATERIALS
RANCOCAS, NEW JERSEY

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I. SUMMARY

On February 8, l988, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from employees at Hoeganaes Magnetic Materials, Rancocas, New Jersey to evaluate exposure to metal powders during the manufacture of magnetic products. This facility produces magnets containing the pyrophoric rare earth metals dysprosium and neodymium, and other materials such as boron, iron, and calcium. The potential health effects described in the request were dermatitis and gastrointestinal problems.

Seven personal breathing-zone and three general area air samples were collected for trace metals during an initial visit to the plant on June 15-16, 1988. Concentrations of iron ranged from 0.05 to 9.5 milligrams per cubic meter (mg/m^3), time-weighted average (TWA) over the period sampled. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for iron oxide is an 8-hour TWA of 10 mg/m^3. The American Conference of Governmental Industrial Hygienist (ACGIH) Threshold Limit Value (TLV*) for iron (oxide) is 5 mg/m^3, TWA.

Neodymium concentrations in personal breathing-zone air samples ranged from 0.03 to 5.0 mg/m^3, TWA. Concentrations of thallium and dysprosium, the only other metals measured in significant amounts, ranged up to 0.16 and 0.53 mg/m^3, respectively. There are no OSHA or NIOSH exposure criteria for neodymium and dysprosium; however, their properties are similar to yttrium, another compound in the rare earth group. The ACGIH TLV* for yttrium and related compounds is 1 mg/m^3, TWA. The ACGIH TLV* and OSHA PEL for thallium (soluble compounds) is 0.1 mg/m^3. Proper skin protection must also be used when handling soluble thallium compounds.

At the time of NIOSH's survey no employees reported dermatologic, gastrointestinal, or respiratory problems related to their work, but due to the short exposure time (the plant opened 2 years ago) and long latency period (10 to 15 years), the presence of work-related chronic respiratory disease in this workforce would be unlikely. However, the explosive pyrophoric nature of the rare earth powders has resulted in employee skin burns on the hands and face and continues to pose a health hazard risk to workers.

Based on these results, a potential health hazard from exposure to neodymium and iron oxide exists among employees at the Hoeganaes Magnetics plant, Rancocas, New Jersey. Concentrations of thallium, if present in soluble form, also exceed applicable exposure limits. Recommendations to reduce dust exposure in the metal powder processing room, along with changes in work practices and respiratory protection, are included in Section VIII of this report.

KEYWORDS: SIC 3499 (Fabricated Metal Products, Not Elsewhere Classified), neodymium, dysprosium, thallium, lanthanides, yttrium, rare earths, magnets, iron, dermatitis, pyrophoric metals.

II. INTRODUCTION

On February 8, 1988, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request to evaluate exposures to materials used to produce magnets at the Hoeganaes Magnetics plant in Rancocas, New Jersey. A subsidiary of the Interlake Company, Hoeganaes produces small, powerful magnets containing the lanthanides dysprosium and neodymium for use in various products, including computer disk drives and speaker coils. In addition to the lanthanides, boron, iron, and calcium are used in the production process. The potential health effects mentioned in the request were dermatitis and gastrointestinal problems. On June 15-16, 1988, NIOSH investigators conducted an initial site visit to the Rancocas plant during which environmental and medical surveys were performed. A response letter was sent to Hoeganaes Magnetics on June 24, 1988.

III. BACKGROUND

A. Process Description

The plant is located in a single story, 10,000-square-foot building in an industrial park. Limited operations began on August 18, l986, with full production occurring in October, l987. The plant produces high quality magnetic alloys from powdered metal. The alloy, composed of various combinations of iron, neodymium, dysprosium, and boron, is transported to the plant in 25-gallon containers. The nugget-sized alloy (approximately 1 cm in diameter) is crushed to a size capable of passing through a 30-mesh screen. An argon gas blanket is used to prevent spontaneous combustion of the metal. The crushed material is then blended with other crushed alloys until the desired composition is achieved. The crushing and blending processes occur in a temperature and humidity controlled room ("powder room") to prevent spontaneous combustion of the crushed metal. Adjacent to the powder room, the crushed metal is dried in a "hydrier", which also uses an argon gas medium to prevent spontaneous combustion.

Following drying, the material returns to the powder room and is reduced to 2.5-micron-diameter particles via a "jet mill" under a nitrogen blanket. This highly flammable metal powder is then oriented with a direct current field and isostatically pressed into various shapes and sizes. The pressed material is then sintered at 2040°F for 24 hours. After a quality control check, the magnets undergo grinding, slicing, and final finishing. A final quality control check is made, followed by a heat treatment prior to shipment. In l987, the plant produced approximately 15,000 pounds of magnets, and the projection for l988 is between 24,000 to 30,000 pounds. A plant diagram is shown in Figure 1.

B. Workforce

Since opening in l986, the plant has employed 27 full-time hourly employees, 9 salaried employees, and approximately 30 temporary employees (working at the plant less than 60 days). On June 15, 1988, the plant employed 19 full-time hourly workers, 9 full-time salaried employees, and 9 temporary hourly employees. The hourly workers are assigned to one of three major areas within the plant: the powder room, the press room, or the grinding area. Employees in the powder room rotate their job assignments and may work at crushing, blending, or milling the metal powders. The workforce had been working three 8-hour shifts until June l988, when work schedules were changed to two 10-hour shifts.

Prior to becoming a full-time employee, an applicant has a medical evaluation performed by a local industrial medical center. The evaluation consists of a medical history, physical examination, complete blood count, serum chemistries, urinalysis, urine drug screen, chest X-ray, electrocardiogram, spirometry, audiometric tests, vision tests, and spinal X-rays.

Personal protective equipment provided by the company for full-time and temporary employees includes smocks, safety glasses, gloves, single-use respirators, and hearing protection. The company provides safety shoes for full-time employees, but not temporary employees. Required equipment for all employees includes safety glasses. Hearing protection and respirators are also required for powder room employees while the crushing and jet milling machines are in operation. Safety training occurs for all employees prior to employment; however, monthly safety meetings are held only for full-time employees.

IV. EVALUATION DESIGN

A. Environmental

Ten air samples (7 personal breathing-zone, 3 general area) were collected at various plant locations on June 16, 1988 using 37-millimeter mixed cellulose ester filters (pore size 0.8 micron) and flow rates of 2.5 to 3.0 liters per minute. All samples were diluted to 25 milliliters after digestion and analyzed for trace metals by NIOSH Method No. 7300 using a Perkin-Elmer ICP Model 6500 sequential scanning inductively coupled plasma emission spectrometer controlled by a Perkin-Elmer Model 7300 laboratory computer.[1] Dysprosium and neodymium were cross-checked for interferences with one another and for interferences from calcium, iron, and aluminum.

B. Medical

All current and former full-time hourly employees were asked to participate in the medical evaluation. The current employees had a medical and occupational history taken, and a skin examination performed: the former employees had a medical and occupational history taken by telephone. To assess their knowledge of workplace health hazards, all participants were questioned about the components and potential health effects of the magnet powder. In addition, all participants were asked about use of personal protection equipment and whether they experienced skin burns from the spontaneous combustion of the metal powders.

V. EVALUATION CRITERIA

A. Environmental

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

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the 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, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH criteria documents and recommended exposure limits (RELs), 2) the American Conference of Governmental

Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs*), and 3) the U.S. Department of Labor (OSHA) permissible exposure limits (PELs). Often, the NIOSH RELs and ACGIH TLVs* are lower than their corresponding OSHA PELs. Both NIOSH RELs 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 RELs, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

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

B. Lanthanides (The Rare Earth Metals)

The lanthanides are a group of 16 elements and include lanthanum, cerium, praseodymium, neodymium, prometheum, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, and yttrium. These metals share similar chemical and toxicologic properties and are generally considered as a group in industrial exposure evaluations.[2] Although most were discovered in the 19th century, it was not until the middle of the 20th century that most of these elements were available in commercially pure form.[3] No epidemiologic studies of rare earth metal exposures have been reported.

The industrially important lanthanides (yttrium, cerium, and lanthanum) are used as alloys for electronic devices, jet engine components, ceramics, carbon arc cores for light and theater projectors, semiconductors, and refractory oxides.[3] In addition to producing magnetic alloys, neodymium is also used in coloring glass and doping glass lasers. Neodymium, and several other rare earths, have been tried as anticoagulants.[4] Dysprosium, a non-corroding metal, is used in reactor fuels and reactor control labs, mercury arc lamps, measuring neutron flux, and as a fluorescence activator in phosphors.[5]

Compared to the other lanthanides, yttrium produces the most pronounced pulmonary changes (diffuse sclerosis),[6,7] and has been associated with mild irritation of the eyes, upper respiratory tract, and skin.[8] Other lanthanides have been associated with eye problems, specifically conjunctivitis, and cornea damage.[9] Neither OSHA, ACGIH, nor NIOSH has exposure criteria for neodymium and dysprosium. However, OSHA and ACGIH have exposure criteria for yttrium. OSHA's PEL and ACGIH's TLV* for all forms of yttrium are 1 mg/m^3, TWA.[10,11] Since the lanthanides share similar chemical properties and health effects, the yttrium limit is used to set exposure criteria for neodymium and dysprosium.

C. Thallium

Thallium, a soft, easily fusible heavy metal, has acute and chronic toxicities.[2] Acute intoxication can result in hair loss, gastrointestinal symptoms, and symptoms of the central nervous system.[12] Chronic poisoning can cause paralysis, endocrine disorders, and psychoses.[6] Little data exists from which to derive an exposure limit for thallium despite the fact that studies have shown thallium, especially soluble thallic compounds, are extremely toxic.[13,14] OSHA's PEL and ACGIH's TLV* for soluble thallium are 0.1 mg/m^3 TWA.[10,11] This exposure limit is based primarily on analogy with other highly toxic heavy metals and is intented to protect against overt systemic toxicity.

D. Iron

Inhalation of iron oxide fume or dust is associated with an asymptomatic pulmonary disorder, siderosis. Siderosis can produce chest X-rays indistinguishable from fibrotic pneumoconiosis; however, studies fail to demonstrate a reduction in pulmonary function.[12] ACGIH recommends an 8-hour TLV* of 5.0 mg/m^3 for iron oxide.[11] The OSHA PEL for iron oxide is an 8-hour TWA of 10 mg/m^3.[10]

VI. RESULTS

A. Environmental

Ten air samples (seven personal breathing-zone and three general area samples) were collected for trace metals on June 15 and 16, 1988. Concentrations of iron in personal samples ranged from 0.05 to 9.5 mg/m^3, TWA, over the period sampled (Table 1). The highest personal sample, 9.5 mg/m^3, was collected from a powder room worker. This exceeds the ACGIH TLV* of 5.0 mg/m^3 for iron oxide and is just below the OSHA PEL of 10 mg/m^3 for this compound.

Neodymium concentrations ranged from 0.03 to 5.0 mg/m^3, TWA, with the highest levels occurring in the powder processing room where the magnetic powders are crushed, blended, and milled. These neodymium air concentrations exceed the OSHA PEL and ACGIH TLV* for yttrium (and related compounds) of 1.0 mg/m^3. Concentration of dysprosium, the only other rare earth measured in significant amounts, ranged from 0.002 to 0.53 mg/m^3 (Table 1). It should be noted that dysprosium is present in very small amounts in the magnetic powder formulation.
Concentrations of thallium metal (no determination on solubility) ranged from 0.02 to 0.16 mg/m^3. Thallium oxide, the probable chemical form present in the metal ore used at Hoeganaes is, however, relatively insoluble.[4] Lead was detected in three samples in concentrations ranging from 0.002 to 0.013 mg/m^3, TWA, well below the OSHA PEL of 0.05 mg/m^3 for this substance.

B. Medical

Twenty-two full-time hourly workers (19 currently working) had been employeed prior to NIOSH's evaluation on June 15-16, 1988. Two current workers refused participation, and one worker (a secretary) was excluded due to no involvement in the magnet production process. Thus, 19 full-time employees (16 current, 3 former) participated in NIOSH's study. The mean age of the study population was 33 years: there were 13 men (68%), and 6 women (32%). Fifteen of the 19 study participants were white (79%), 3 were black (16%), and one was Asian (5%). The mean length of employment was three months, with a range of 3 days to 19 months. All medical diagnoses had been made prior to employment at the plant (Table 2). Nine workers reported a variety of symptoms (Table 3). Three workers felt their symptoms were work-related (heartburn, acne, and headache), but none were symptomatic at the time of NIOSH's survey.

All 16 participating current employees had their skin examined; none had evidence of dermatitis or acne.

Only one of the 19 workers (5%) could name at least one of the components of the alloy. No worker could name any of the potential health problems presented by the magnet powder.

All workers stated they used their personal protection equipment when required. This was corroborated by NIOSH's observations during the two day evaluation; however, employees in the powder room did not have a tight respirator face mask to face seal and one temporary employee in the powder room was observed wearing a handkerchief beneath his half-mask air-purifying respirator, a practice which disrupts the face mask to face seal.

During the preceeding year (June 1987 to June 1988), 3 workers required medical treatment for burns suffered on the hands and/or face. One of the burns required three days off work, while the other two did not result in lost work time. All of these burns occurred as a result of the spontaneous combustion of the fine powder containing the pyrophoric rare earth metals. One of these was recorded on the OSHA 200 Log.

VII. DISCUSSION AND CONCLUSIONS

Given the distribution and type of medical conditions found among this workforce, there does not appear to be an elevated or unexpected prevalence of disease. At the time of NIOSH's survey no employees reported symptoms of dermatologic or gastrointestinal problems related to their work. No workers had respiratory symptoms; however, the restrictive lung disorder due to rare earth exposure takes 10 to 15 years to develop.[6] Therefore, chronic respiratory problems due to rare earth exposure detectible now would be unlikely, but could eventually occur in powder room employees.

Engineering controls or personal protection equipment can reduce personal exposures to the magnetic powder. The disposable respirators used at the time of the survey (3M model 8710) were not effective because employees reported a black nasal discharge, or distinct metallic taste, while working in the powder room. The failure of this respirator to provide protection could be due to poor face seals (as noted during NIOSH's evaluation), and/or the respirator's inability to filter the dust due to its small particle size (2.5 to 5 microns). In addition, these respirators provide inadequate protection from metal fumes generated during the spontaneous combustion of the magnetic powder. Employees stated that these small "fires" occurred approximately once per week.

The plant should be commended for its commitment to the monthly safety meetings regarding injury prevention. These meetings, however, should also include temporary employees and provide information on the composition and health effects associated with the magnetic dust exposure. At the time of the NIOSH survey only one of 19 full-time hourly employees could name one component of the metal alloy. No workers were aware of the potential health problems from exposure to these components.

NIOSH's investigation focused on the potential health effects of the magnetic dust powder. Equally important is the injury potential from the explosive, combustible nature of the powder. Three employees have received medical treatment for burns caused by the powder, one resulting in three days off work. In addition, the alloy nuggets and subsequent powder is manually lifted and transported in 100- to 200-pound containers within the powder room. The powder room is not ergonomically designed, and transporting these containers could result in back and foot injuries.

The potential for exposure to and potential health effects from magnetic fields was not addressed in this evaluation.

VIII. RECOMMENDATIONS

1. Reduce personal exposures to neodymium, iron, and thallium in the powder room by developing engineering controls utilizing local exhaust ventilation at the crushing, blending, and jet millingoperations. Based on good industrial hygiene practice, recirculating industrial exhaust air is not generally recommended.

   The feasibility of a recirculating air system depends on industrial hygiene and engineering factors, as well as insuring the protection of the workers from any toxic agents in the airstream. All local and state regulations regarding recirculation must be reviewed to determine restrictions or prohibitions. Industrial recirculating systems must incorporate a monitoring system which provides a warning or signal and is capable of process shutdown before harmful concentrations of the recirculated agents build up in the work area. A suitable air cleaner, such as high-efficiency particulate air (HEPA) filters, must also be used.

2. As an interim measure, until engineering controls can be implemented, employees working in the powder-processing room should wear NIOSH-approved half-mask respirators equipped with HEPA filters. The HEPA filters are recommended in consideration of the small diameter particles that the workers handle during the milling and blending operations.

3. A respirator program consistent with the guidelines found in DHHS (NIOSH) Publication No. 87-116, "A NIOSH Guide to Industrial Respiratory Protection," and the requirements of the General Industry Occupational Safety and Health Standards (29 CFR 1910.134) should be implemented. As a minimum, the written standard operating procedures for the respirator program should contain the following:

   a. Guidance for selecting approved respirators for protection against particular hazard(s). In this evaluation the hazards would inculde respirable size metal dust and fumes (when the pyrophoric metals ignite).

   b. Detailed instructions for employee training in proper use of the respirators, including fit testing. A written record should be maintained of respirator training and fit-testing.

   c. Detailed maintenance procedures for cleaning and disinfecting the respirators; inspection, repair and replacement of defective parts; and respirator storage in uncontaminated areas.

   d. Administrative procedures for purchasing and issuance of approved respirators, surveillance of respirator use, and continued evaluation of the respirator program's effectiveness.

   e. Instructions for respirator use during emergencies, including fire.

   f. Guidelines for medical surveillance of workers to eliminate those employees physically or psychologically unfit to wear respirators.

4. Periodic environmental sampling in the powder room for neodymium, dysprosium, thallium, and iron is recommended.

5. Improved communication from management to the employees about the contents, and potential health problems, posed by the alloy powder should be implemented to meet the requirements of the OSHA Hazard Communication Standard 29 CFR Part 1910.1200.

6. Hydraulic or mechanical devices to lift and transport the 100- to 200-pound containers of alloy nuggets and powder located in the powder room should be utilized . Until the hydraulic or mechanical lifting devices are in

use, employees should handle smaller loads and be instructed in proper lifting techniques.

7. Warning signs requiring the use of hearing protection should be posted outside the powder processing room. It was company policy that hearing protection be worn by employees in this room when powder processing equipment was operating, but no warning signs had been posted.

8. The emergency eye wash stations in the powder processing and isostatic pressing areas were not capable of supplying at least 15 minutes of continuous, flushing water to the eyes. They should be replaced with emergency eye wash/shower stations capable of providing copius amounts of water.

9. The company should provide safety shoes to all workers, including temporary employees. These temporary workers should also be included in the monthly safety meetings.

10. It is recommended that all work-related injuries and/or illness requiring medical treatment be recorded, regardless of lost work time.

It should be noted that many of these recommendations were implemented by management during the interval between NIOSH's site visit and the issuance of this final report.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 3. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1984. (DHHS (NIOSH) publication no. 84-100.

2. Patty FA. Patty's industrial hygiene and toxicology. Vol II--toxicology, 3rd revised ed. New York: John Wiley & Sons, 1981.

3. Knight AL. The rare earths in occupational medicine. Ed. by Carl Zenz. Chicago: Year Book Medical Publishers, Inc. 1975.

4. Doull J, Klaassen C, and Amdur M. Casarett and Doull's Toxicology--the basic science of poisons. 2nd Edition. New York: Macmillan Publishing Co., Inc., 1980.

5. Hawley, GG. The condensed chemical dictionary. New York: Van Nostrand Reinhold Company, 1987.

6. Israelson ZI., Ed. Toxicology of rare metals. Moscow, 195-208, 1963.

7. Ruettner JR, Spycher MA, Vogt P. Lung fibrosis with rare earth exposure. Presented at the VII International Conference on the Pneumoconioses Aug 23-26, 1988 Pittsburgh, PA USA.

8. Tebrock HE, Machle W. Journal of Occupational Medicine, 10:682, 1968.

9. National Institute for Occupational Safety and Health. Occupational respiratory diseases. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1986. (DHHS (NIOSH) publication no. 86-102).

10. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.1000. Occupational Safety and Health Administration, revised 1986.

11. American Conference of Governmental Industrial Hygienists. Threshold limit values and biological exposure indices for 1988-89. Cincinnati, Ohio: ACGIH, 1988.

12. American Conference of Governmental Industrial Hygienists. Documentation of the threshold limit values and biological exposure indices. 5th ed. Cincinnati, Ohio: ACGIH, 1986.

13. Truhaut R. Recherches sur la Toxicologie du Thallium. Inst. Nat. Soc. Pour Prevent. des Accidents du Travail, Paris, 1959.

14. Downs WL, Scott JK, Steadman LT and Maynard EA. Am. Industrial Hygiene Association Journal Vol. 21:399, 1960.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Hoeganaes Magnetics, Rancocas, New Jersey.
2. The National Institute for Occupational Safety and Health (NIOSH) Region I.
3. The Occupational Safety and Health Administration (OSHA) Region III.
4. Confidential Requestors.

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
TRACE METAL ANALYSIS
PERSONAL AND AREA AIR SAMPLES
HOEGANAES MAGNETICS COMPANY
RANCOCAS, NEW JERSEY
HETA 88-166

Sample Location	Sample Type[b]	Sample Volume (L)	Concentration, mg/m^3 [a] Neodymium	Dysprosium	Thallium	Iron	Lead
Powder Room	BZ	700	5.0	0.53	0.16	9.5	0.01
Powder Room	BZ	1023	1.0	0.09	0.02	0.98	c
Powder Room	BZ	628	3.0	0.29	0.09	5.3	0.01
Grinder No. 740-3	BZ	738	0.03	c	ND[d]	0.05	ND
Grinder No. 740-2	BZ	853	0.14	0.01	ND	0.28	ND
Grinder No. 740-1	GA	903	0.03	c	ND	0.05	ND
At Hammermill	GA	945	0.32	0.02	0.02	0.43	ND
Near Glove Box	GA	918	0.3	c	ND	0.05	ND
Powder Room	BZ	115	0.5	0.04	ND	0.83	ND
Powder Room	BZ	115	0.5	0.04	ND	0.78	ND
LOD (ug/sample)[e]			5.0	1.0	10	1.0	2.0
Evaluation Criteria:[f]							
ACGIH			NE[g]	NE	0.1[h]	5	0.15
OSHA			NE	NE	0.1[h]	10	0.05

a Concentrations of specified metals expressed in milligrams per cubic meter, time-weighted average.
b BZ = Breathing zone; GA = General Area.
c Concentration less than 0.01 mg/m^3.
d Not Detectable.
e Limit of detection for this sample set, expressed in micrograms per sample.
f All evaluation criteria are expressed in mg/m^3, time weighted averages for 8 to 10 hours. The exposure limits for thallium (soluble forms) also has a skin notation, meaning that proper protection must be used to prevent skin absorption.
g NE, none established. The ACGIH TLV for Yttrium of 1.0 mg/m^3 is used for the rare earths.
h ACGIH TLV for soluble thallium compounds. While the solubility of thallium in these air samples was not measured, it was probably present as an oxide, a relatively insoluble form of thallium.

TABLE 2

LIST OF MEDICAL DIAGNOSES AMONG FULL-TIME EMPLOYEES

HOEGANAES MAGNETIC CO.
RANCOCAS, NEW JERSEY
HETA 88-166

CONDITION	# EMPLOYEES
Hypertension	2
Upper Respiratory Infections	2
Allergic Rhinitis	1
Crohn's Disease	1
Gastritis	1
Tuberculosis	1
Sinusitis	1

TABLE 3

SYMPTOMS REPORTED BY FULL-TIME EMPLOYEES

HOEGANAES MAGNETIC CO.
RANCOCAS, NEW JERSEY
HETA 88-166

SYMPTOMS	# EMPLOYEES
Heartburn	3
Acne	2
Allergies	2
Headache	2
Knee Pain	1
Sinus Pain	1
Shortness of Breath	1

FIGURE 1
Plant diagram
Hoeganaes Magnetics, Rancocas, NJ
HETA 88-166