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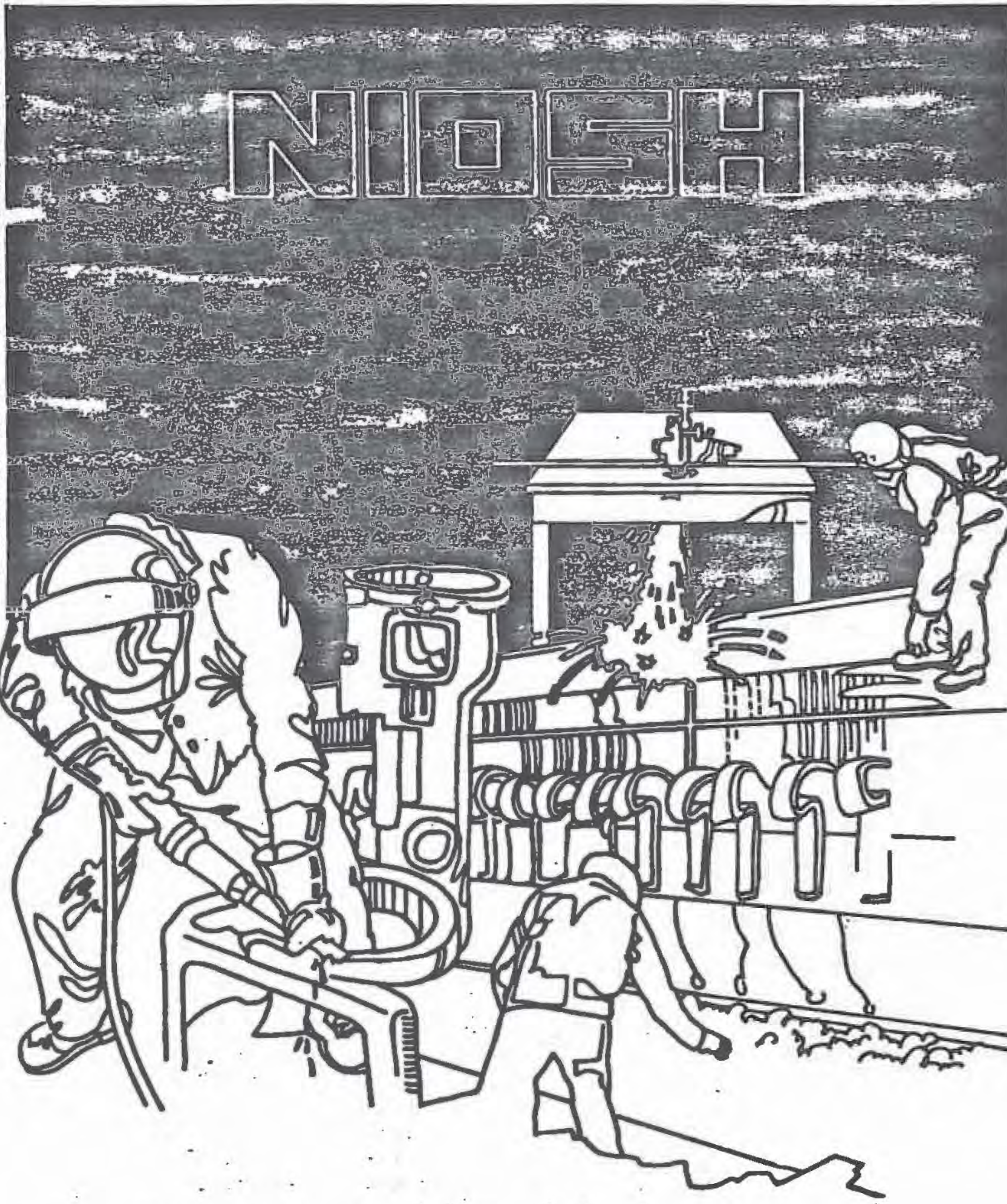

Health Hazard Evaluation Report

HETA 83-015-1809
WELLMAN DYNAMICS CORPORATION
CRESTON, IOWA

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 83-015-1809
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WELLMAN DYNAMICS CORPORATION
CRESTON, IOWA

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I. SUMMARY

On October 1, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Molders and Allied Workers Union, Local 17, to evaluate exposures to various chemical substances by workers in the welding and foundry areas at Wellman Dynamics Corporation, an aluminum magnesium castings foundry in Creston, Iowa. The employees were concerned that their symptoms of eye and upper respiratory tract irritation were associated with the chemical exposures in these two areas of the facility. Due to legal delays, NIOSH did not conduct the health hazard evaluation until December 1983.

On December 12-15, 1983, NIOSH researchers conducted an environmental - medical evaluation at the facility. Personal air samples were collected for respirable crystalline silica, formaldehyde, triethylamine (TEA), inorganic metals (aluminum, barium, magnesium and beryllium), inorganic fluorides, methylene bisphenyl isocyanate (MDI), ozone, and organic solvents (ethyl alcohol, 1,1,1-trichloroethane and perchloroethylene). A medical questionnaire was administered to employees in the foundry and welding areas; and pulmonary function test and chest x-ray records of current employees were reviewed.

Sixteen of 34 samples obtained in the breathing zone of the sand molders, sand mixers, core makers, and core knockout personnel showed crystalline silica concentrations in excess of the NIOSH Recommended Exposure Limit (REL) of 50 ug/m^3; these ranged from 52 to 238 ug/m^3 (arithmetic mean = 101 ug/m^3). The coremakers, metal pourers and core knockout personnel were being exposed to formaldehyde levels ranging from 0.11 to 0.42 mg/m^3 (arithmetic mean = 0.25 mg/m^3) that are likely primary contributors to their symptoms of eye and upper respiratory tract irritation. These sensory irritant symptoms were enhanced by the airborne presence of TEA ranging from 0.4 to 38 mg/m^3 (arithmetic mean = 12 mg/m^3). The airborne concentrations of the inorganic metals, inorganic fluorides, MDI, ozone and organic solvents were below the environmental evaluation criteria. The most commonly reported acute symptoms were nasal irritation, nasal stuffiness and shortness of breath (each 80%), followed by eye irritation (66%). In general, symptom prevalences were highest in the knockout area, but seemed high in all areas. In 1982, a chest x-ray of one employee showed findings compatable with sarcoidosis. This employee worked in an area when there was potential exposure to beryllium.

Based on the data collected during this evaluation, the NIOSH investigators concluded that the sand molders, core makers, sand mixers and core knockout personnel were being exposed to potentially toxic concentrations of respirable crystalline silica. The core makers, furnace tenders/pourers, and core knockout personnel were being exposed to potentially toxic concentrations of formaldehyde. These workers were also experiencing irritant exposures to the eyes and upper respiratory tract. Recommendations concerning environmental control measures and medical surveillance are presented in Section VII of this report.

KEYWORDS: SIC 3321 (Foundries), crystalline silica, formaldehyde, triethylamine, aluminum, magnesium, beryllium, inorganic fluorides, methylene bisphenyl isocyanate, ozone and 1,1,1-trichloroethane.

II. INTRODUCTION

On October 1, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Molders and Allied Workers Union, Local 17 at Wellman Dynamics Corporation in Creston, Iowa, to evaluate exposures to various chemical substances by workers in the welding and foundry areas. The employees were concerned that a variety of acute health effects, including eye, upper respiratory, and skin irritation, were associated with chemical exposures in these two areas of the facility .

On December 7, 1982, the management of the facility refused to voluntarily admit NIOSH representatives seeking to perform the health hazard evaluation. On November 15, 1983, the same management protested execution of a warrant for inspection by NIOSH representatives; the warrant was returned to the U.S. Magistrate unexecuted. Subsequent discussions between NIOSH and Wellman Dynamics resulted in a site-walk of the facility on November 17, 1983, by NIOSH investigators to identify the specific areas that NIOSH intended to evaluate. On November 18, 1983, NIOSH informed Wellman Dynamics of the specific areas to be evaluated in accordance with the warrant. The areas included Departments 10, 13, 14, 19, 24, 31 and 38.

On December 12-15, 1983, NIOSH investigators conducted an environmental-medical evaluation at the Wellman Dynamics facility. On January 11, 1985 a letter was sent to the plant physician advising him that several of the employee's pulmonary function tests appeared to be too low due to technical factors and should be repeated. That letter also advised that the consulting pulmonary physician who was following an employee with sarcoidosis should be informed that that employee had occupational exposure to beryllium. The letter also recommended that that employee be transferred to a job without potential beryllium exposure if the consultant thought that beryllium exposure could be the cause of the employee's sarcoid-like condition. NIOSH distributed Interium Report No. 1 in September 1984 which presented the results of the medical investigation.

III. BACKGROUND

Wellman Dynamics Corporation is a light-alloy foundry engaged in the production of high-integrity aluminum and magnesium castings for aircraft, missile and aerospace industries. The NIOSH health hazard evaluation involved Department 38 (Welding and Weld Cleaning) and six other departments in the foundry. Included are Department 10, Coremaking and Dry Sand Mixing; Department 13, Dry Sand Molding; Department 19, Green Sand Molding; Department 19, Green Sand Molding and Sand Mixing; Department 14, Chill Room; Department 24, Metal Pouring and Furnace Tending; and Department 21, Core Knockout.

A description of the processes and corresponding exposure control systems for these departments follows:

The furnaces consists of a cylindrical metal shell, lined with refractory brick; a crucible, cup-shaped container that holds the metal is placed in the furnace. The refractory crucible containing the molten metal is lifted from the furnace by an overhead crane and positioned in a bruggy ladle, which is supported on a wheeled carriage, and transported to pouring area. The ladles are managed by a crane, and a geared mechanism tilts them for pouring. The metal is poured into sand molds on an open pouring floor without any mechanical exhaust ventilation. General ventilation serves as the control mechanism for both pouring and cooling processes.

Fluxes composed of chlorides or fluorides of the alkaline earth metals are used to flux the molten magnesium and aluminum alloys, respectively. In addition to the fluxing procedure, the aluminum alloys are de-gassed by the addition of hexachloroethane tablets to the molten metal.

7. Department 21 Knockout: When the molten metal in a mold has solidified, the casing is separated from the mold, and the core is removed from the casting in an operation known as knockout. An automated or manual abrasive blasting process is used for mold and core separation. The automated process, termed "new knockout", involves a rotary table blasting machine. The sand mold is placed on a table that carries it through a chamber where an air blast or centrifugal wheel projects a metallic abrasive against the mold with resultant removal of the sand. The manual process, termed "old knockout", involves the manual sand blasting of the casting by a worker. The sandblaster wears a standard air-line supplied abrasive blasting helmet.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

The potential chemical exposures evaluated by work department are presented in Table 1. The sampling and analytical methods [1] for these chemical substances, including the collection device, air flowrate and referenced analytical procedures, are presented in Table 2.

Multiple personal air samples were obtained within the same job classification on multiple days to characterize the range of exposure concentrations to a particular chemical substance(s). The air samples were collected for a 7- to 8-hour period to define an 8-hour time weighted average exposure concentration. The one exception was the sampling for ozone, which consisted of sequential 45-minute samples collected over a 7- to 8-hour period.

In job classifications where there were exposures to multiple substances believed to have the same toxicologic effect, their combined effect, rather than that of either substance individually, was given primary consideration in evaluating the exposure. The following formula was used to evaluate such an exposure [18]:

$$Em = C_1/T_1 + C_2/T_2 = \ldots Cn/Tn$$

Where: Em = the equivalent exposure for the mixture.
C = the observed airborne concentration of a particular contaminant.
T = the exposure evaluation criterion.

If the sum of the fractions exceed one, then the exposure criterion for the multiple exposure is considered as being exceeded.

To supplement the NIOSH environmental data copies of the reports of environmental sampling conducted at this facility previous to the NIOSH Health Hazard Evaluation were obtained from Wellman Dynamics management. These reports covered a five year period between 1977 and 1983.

B. Medical Evaluation

The NIOSH investigators administered a medical questionnaire to the employees in the seven departments. The questionnaire was intended to compare the various work areas for any differences in prevalence health effect. Since exposures are different between work areas, differences in health effects between work areas might be attributable to differences in exposures. Initially, a random sample of employees to be interviewed was selected from each work area, but because of a poor participation rate (over 50% refusal), all remaining employees were also invited to be interviewed.

The pulmonary function test and chest x-ray records for the employees who were presently working in the foundry areas were reviewed. Chest x-rays and pulmonary function tests were done in 1978, 1980, 1982 and 1983 at a local hospital. Foundry workers in the job catagories of furnace tender/metal pourer, core knockout, welder, sandmixer or shakeout were examined; no tests were done for coremakers or molders.

V. EVALUATION CRITERIA

A. Environmental Criteria

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 criteria. 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 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 (TLV's); 3) the U.S. Department of Labor (OSHA) occupational health standards; and 4) the American Industrial Hygiene Association's Hygiene Guide Series. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's 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 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 a OSHA standard.

A time 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. The environmental evaluation criteria for the chemical substances evaluated are presented in Table 3.

B. Health Effects

a. Crystalline Silica

Silica is silicon dioxide that occurs both in a crystalline form, in which molecules are arranged in a fixed pattern, and in an amorphous form where molecules are randomly arranged. The silica dust in foundries is composed primarily of crystalline silica. The three most common crystalline forms of silica are quartz, tridymite, and cristobalite; with quartz being the most common of the three forms.

The principle adverse health effect of crystalline silica is a respiratory disease known as silicosis [2]. Silicosis is a form of diffuse interstitial pulmonary fibrosis resulting from the deposition of respirable crystalline silica in the lung. Conditions of exposure may affect both the occurrence and severity of silicosis. Although it usually occurs after 15 or more years of exposure, latent periods of only a few years are well-recognized and are associated with intense exposures to respirable dust high in free silica. Early, simple silicosis usually produces no symptoms. However, both acute and complicated silicosis (progressive massive fibrosis, PMF) are associated with shortness of breath, intolerance for exercise, and a marked reduction in measured pulmonary function. Diagnosis is most often based on a history of occupational exposure to free silica and the characteristic appearance of a chest radiograph. Respiratory failure and premature death may occur in advanced forms of the disease. Individuals with silicosis are also at increased risk of contracting tuberculosis. No specific treatment is available, and the disease may progress even after a worker is no longer exposed to silica.

NIOSH, in its recommendations for a free silica standard, has proposed that exposures to all forms of free silica be controlled so that no worker is exposed to respirable airborne concentrations greater than a TWA of 0.05 mg/m^3 (50 ug/m^3), for up to a 10-hour working day. This recommendation was designed to protect workers from silicosis. Exposures to free silica greater than one-half the recommended standard, or "action level", should initiate adherence to the environmental, medical, labeling, record keeping, and worker protention guidelines contained in the NIOSH criteria document, "Occupational Exposure to Crystalline Silica"[2].

b. Formaldehyde

Formaldehyde and other volatile aldehydes are strong irritants and potential sensitizers to the skin, eyes, and respiratory tract. Short-term exposure to high concentrations may produce pulmonary edema and bronchitis. Contact dermatitis and allergic sensitization may also develop [3]. Formaldehyde is considered a potential human carcinogen by NIOSH [4].

c. Triethylamine

Triethylamine is an irritant of the eyes and mucous membranes [5]. Amines with similar chemical structures cause skin irritation and, although not documented, the same effect is expected with triethylamine.

d. 1,1,1-Trichloroethane

The primary adverse health effects associated with exposure to 1,1,1-trichloroethane by inhalation, skin absorption, or ingestion may include headache, dizziness, incoordination, lightheadedness, drowsiness, generalized weakness, fatigue, nausea, vomiting, diarrhea, hypotension, bradycardia, cardiac arrhythmias, skin dryness and irritation, mucous membrane irritation, and liver function abnormalities [6]. Because of the chemical similarity of 1,1,1-trichloroethane to four other chloroethanes considered as potential carcinogens, NIOSH recommends prudence in the use of this substance [7].

e. Perchloroethylene

Exposure to perchloroethylene vapor can cause degrees of anesthesia, with minimal levels causing headaches, and greater exposure causing light-headedness, "drunkeness" and even unconsciousness. The National Cancer Institute (NCI), in a long term animal study, has demonstrated that perchloroethylene, administered by gavage, causes heptocellular carcinoma (liver cancer) in laboratory mice of both sexes [8]. The 50 ppm (339 mg/m^3) exposure criterion recommended by NIOSH in 1976 [9], and the current 100 ppm (678 mg/m^3) OSHA PEL [10], were both established before the NCI study was done. Perchloroethylene is considered as a potential human carcinogen by NIOSH [11].

f. Methylene Bisphenyl Isocyanate (MDI)

MDI is a strong irritant to the eyes, respiratory tract and skin [12]. Asthmatic reactions due to pulmonary sensitization can occur [12].

g. Ozone

Ozone is extremely irritating to the upper and lower respiratory tract [13]. The characteristic odor is readily detectable at low concentrations (approximately 0.01 to 0.05 mg/m^3). Ozone produces local irritation of the eyes and mucous membranes and may cause pulmonary edema at high exposure concentrations. A partial tolerance appears to develop with repeated exposures. Although most health effects are acute, the possibility of chronic lung impairment should be considered, based upon animal experimentation.

h. Beryllium

The main route of exposure of beryllium and beryllium compounds is through the lung. Local contact has produced a granulomatous and scarring skin reaction and can produce a systematic sensitization, aggravating the effects of inhalation [14-15].

Under current conditions of exposure in the United States, skin reactions are no longer seen. The most serious effect of beryllium exposure is a sarcoidosis-like granulomatous lung disease, which can produce symptoms of shortness of breath, weight loss, anorexia, and cough. The disease is associated with alterations in immunity. There is an acute form of beryllium disease, a chemical pneumonitis, which was common before industrial regulations. There have been no reported cases of the acute disease in the United States in more than 20 years.

A recent study [16] has demonstrated chronic beryllium disease in workers exposed to concentrations of airborne beryllium below the OSHA Permissible Exposure Limit [10].

i. Magnesium Oxide

Magnesium oxide may cause irritation of the eyes and nose [17]. The effects of long-term exposure are not known [18].

j. Aluminum Oxide

Aluminum oxide is considered to be a nuisance dust [18]. Nuisance dusts are believed to have little adverse effects on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control [18].

k. Barium

Soluble barium compounds may cause local irritation of the eyes, nose, throat and skin; inhalation of high concentrations of barium oxide may cause a benign pneumoconiosis termed baritosis [17].

l. Inorganic Fluorides

Airborne exposure to inorganic fluorides can cause irritation of the eyes and respiratory tract [19]. Absorption of excessive amounts of fluorides over a long period of time results in increased radiographic density of bone, which may cause crippling fluorosis (osteosclerosis); now an exceedingly rare phenomenen [20].

m. Ethyl Alcohol

Ethyl alcohol is an irritant of the eyes and mucous membranes, and can cause light-headedness and headaches [21].

VI. RESULTS AND DISCUSSION

A. Environmental

a. Respirable Crystalline Silica

Personal breathing zone concentrations of respirable crystalline silica were measured in the sand molding, core making, sand mixing, and core knockout areas. Quartz was the only polymorph of crystalline silica present above the limit of quantitation (LOQ). The results, therefore, are reported as micrograms of quartz per cubic meter of air sampled (ug/m^3). The LOQ was 30 ug per sample, or 150 ug per sample when the primary quartz value had an interference requiring that the second most intense value be used.

Table 4 presents the crystalline silica concentrations measured in the sand molding area. Seven of the 17 samples showed concentrations above the NIOSH Recommended Exposure Limit (REL) of 50 ug/m^3; these 7 ranged from 52 - 105 mg/m^3. These seven samples are distributed over the three types of sand molders evaluated.

Table 5 presents the crystalline silica concentrations measured in the core making areas. Three (containing 53, 53, amd 188 ug/m^3) of the seven samples showed concentrations above the NIOSH REL. These three samples each come from a different core-making area.

Table 6 presents the crystalline silica concentrations measured in the new and old core knockout areas. The two samples collected in the new core knockout, and the one in the old knockout, all showed concentrations (100 and 144 ug/m^3, and 70 ug/m^3, respectively) above the NIOSH REL.

Table 7 presents the crystalline silica concentrations measured among the sand mixers. Three of the six samples showed concentrations (147, 157, and 238 ug/m^3) above the NIOSH REL.

b. Formaldehyde and Triethylamine

Table 8 presents the personal breathing zone concentrations of formaldehyde and triethylamine measured at the five coremaking areas. Formaldehyde was present in 17 of 17 samples, at concentrations ranging from 0.11 to 0.42 mg/m^3 (arithmetic mean = 0.26 mg/m^3); four field blanks did not show the presence of formaldehyde at a detection limit of 0.04 mg/m^3. Exposure concentrations of formaldehyde between 0.16 mg/m^3 and 0.55 mg/m^3 have been shown to promote eye irritation and lachrymation [23]. Triethylamine was present in 15 of 15 samples, at concentrations ranging from 0.4 to 38 mg/m^3 (arithmetic mean = 12 mg/m^3), which are below the ACGIH Threshold Limit Value of 40 mg/m^3. The five field blanks did not show detectable levels of triethylamine at a detection limit of 0.4 mg/m^3. Because formaldehyde and triethylamine have similar acute health effects (strong irritants of eyes and mucous membranes), their combined exposure potential was also evaluated. (See Part IV, Section A for formula). The calculated combined exposures ranged from 0.14 to 1.14 (arithmetic mean = 0.5), where one of the 10 combined exposures exceeded 1.0, the equivalent exposure limit for the mixture. This sample was taken on a worker operating the Osborne core machine. The formaldehyde and triethylamine concentrations for the Osborne coremakers were generally higher than those measured for the other coremakers.

Table 9 presents the concentrations of formaldehyde measured in the breathing zone of the furnace tenders and new core knockout operator. Formaldehyde was present in four of four samples at concentrations ranging from 0.19 to 0.23 mg/m^3.

c. Methylene Bisphenyl Isocyanate (MDI)

Table 10 presents the personal breathing zone concentrations of MDI. A total of nine samples were collected; 13 on core makers, two on furnace tenders during pouring, and one on the new core knockout operator. All of the samples showed non-detectable levels of MDI at an average detection limit of 0.59 mg/m^3. These data, however, may not be representative of the actual exposure concentrations. A latter investigation by NIOSH [22] suggested that the method of sample collection (impregnated glass fiber filter) is likely an ineffective sample collection media. Thus, the measured concentration was probably lower than the actual concentration.

d. 1,1,1-Trichloroethane and Ethyl Alcohol

Table 11 presents the personal breathing zone concentrations of 1,1,1-Trichloroethane (TCE) and ethyl alcohol. The TCE concentrations ranged from 4 to 51 mg/m^3 (arithmetic mean = 18 mg/m^3, n = 10), all of which were below the NIOSH REL of 1900 mg/m^3. The ethyl alcohol concentrations ranged from none detected (2.1 mg/m^3) to 18 mg/m^3 (arithmetic mean = 9 mg/m^3). Because TCE and ethyl alcohol have similar acute health effects (central nervous system depression), their combined exposure potential was also evaluated. The ten calculated combined exposures ranged from 0.01 to 0.03, all significantly less 1.0, the equivalent exposure for the mixture.

e. Inorganic Fluorides

Table 12 presents the airborne concentrations of inorganic fluorides. Three samples obtained in the breathing zone of the furnace tenders ranged from 0.02 to 0.03 mg/m^3, and area concentrations measured in the magnesium melting area ranged from 0.04 to 0.05 mg/m^3. All concentrations were below the NIOSH REL of 2.5 mg/m^3.

f. Inorganic Metals

Table 13 presents the concentrations of aluminum, barium, magnesium, and beryllium measured in the breathing zone of the furnace tenders. Aluminum, barium, and magnesium were consistently present in the samples, with the maximum concentrations measured representing 0.4%, 7.4% and 3.9%, respectively, of the environmental evaluation criteria.

Although none of the samples showed detectable concentrations of beryllium, the analytical limit of detection (approximately 1.0 ug/m^3) was not sufficiently low enough to adequately evaluate the presence of airborne beryllium: the reported detection limit was approximately twice the NIOSH REL of 0.5 ug/m^3. Previous sampling conducted by a consultant for Wellman Dynamics showed airborne beryllium concentrations of 0.2 ug/m^3 in the breathing zone of a metal pourer. Furthermore, it is not known whether a magnesium-beryllium alloy was being produced at the time of the NIOSH health hazard evaluation.

Table 14 presents the airborne concentrations of aluminum, magnesium, and beryllium measured in the breathing zone of the welders and weld cleaners. Aluminum and magnesium were consistently present in the sample, with the maximum concentrations measured representing 0.08% and 0.43%, respectively, of the environmental evaluation criteria. Beryllium was not detected in any of the samples. However, as previously noted, the limit of detection was not sufficiently low enough to adequately evaluate exposure to airborne beryllium. Previous sampling conducted by a consultant for Wellman Dynamics showed concentrations of 1.1 to 1.4 ug/m^3 in the breathing zone of a weld cleaner working on a casting containing approximately 0.03% by weight beryllium. It is not known whether a beryllium containing casting was being processed during the NIOSH sampling periods.

g. Ozone

Table 15 presents the concentrations of ozone measured in the breathing zone of a welder on consecutive days. The 8-hour time weighted average, (TWA) concentrations, based on 45-minute sequential samples, are 79.5 and 80.5 ug/m^3 for the consecutive sampling days. Both 8-hour TWA exposure concentrations are below the OSHA PEL of 200 ug/m^3.

h. 1,1,1-Trichloroethane and Perchloroethylene

Table 16 presents the airborne concentrations of 1,1,1-trichloroethane and perchloroethylene measured in the Welding Department. The 1,1,1-trichloroethane (TCE) is used by the weld cleaner to spot clean castings. The measured exposure concentration (175 mg/m^3) was below the NIOSH REL of 1900 mg/m^3. The area samples for perchloroethylene were taken to evaluate the extent of vapor transfer from a parts degreaser in an adjacent department. Although the measured air concentrations (range 0.58 to 1.1 mg/m^3) are significantly below the NIOSH REL (339 mg/m^3), they do demonstrate that vapor transfer is occurring. This creates a potential risk of photodegradation of the perchloroethylene by ultraviolet radiation from the welding operation, resulting in the formation of a highly toxic gas, phosgene. Measurements made by Wellman Dynamics in the welding shop on one occasion showed levels of phosgene ranging between 0.15 to 0.18 parts per million (ppm). The levels exceed the NIOSH REL of 0.1 ppm.

B. Medical

1. Questionnaire Analysis

a. Participation

Thirty-six employees participated in the questionnaire survey: in core, 15 of 30 (50%); green sand molding, one of 13 (7%); dry sand molding, nine of 15 (60%); furnace, two of 11 (18%); welding, four of six (67%); knockout, four of four (100%); and shakeout, one of two (50%). Because of the small number of participants from the shakeout, furnace, and green sand milding areas, these areas were excluded from department-specific statistical calculations in this report.

b. Demographic Data (Table 17)

The 36 interviewed employees had a mean age of 34 years and a range of 23 to 60 years. Their length of employment ranged from three years to 19, with an average of 9.5 years. They were all white males except for one white female. On the average, core and knockout employees were slightly older (39 and 36 years, respectively), than molding and welding area employees (29 and 32 years, respectively), and core employees had been employeed slightly longer (11 years) than those in the other areas (nine years in welding and knockout, seven in molding). All four of the knockout employees, none of the four welders, and half of the workers in the other departments smoked.

c. Reported Symptoms (Table 18)

Overall, the most commonly reported acute symptoms (occurring in the past six months) were nasal irritation, nasal stuffiness, and shortness of breath (each 80%), followed by eye irritation (66%). In general, symptom prevalences were the highest in the knockout area, but seemed high in all areas. Overall, workers attributed a high proportion of symptoms to the following exposures: sand binder fumes, smoke from pouring metals and the amine gas used to catalyze hardening of the sand binders in the core area; excessive smoke and dust from knocking out castings when they are still hot, in knockout; and chill spray and metal pour smoke in the molding area. Other health complaints mentioned by the interviewed employees included chest tightness and wheezing in the welding area, associated with a sweet odor of undetermined origin, and rashes in the core department.

All four knockout employees reported having chronic (lasting two or more years) cough and phlegm, and two reported chronic shortness of breath. The proportion of employees in the core and molding areas reporting chronic respiratory symptoms ranged from 10-29% (Table 19). A substantially higher proportion of employees in the knockout area were smokers (100%) compared to the other areas (50%).

2. Medical Record Review

The pulmonary function records contained insufficient data for workers in the years 1978 and 1980, so only the 1982 and 1983 pulmonary function test results were analyzed. Eight men showed marked decrements in pulmonary function on their 1983 pulmonary function tracings. Data for several of these men suggested that technical test factors rather than actual impaired lung function may have produced the low values for pulmonary function measured in these men in November 1983. Five of these eight men underwent repeat pulmonary function testing, and all five showed marked improvement from their first 1983 tests. These retest results were used for subsequent analyses.

The pulmonary function results are summarized in Table 20, which shows the average FEV_1, FVC, and FEV_1/FVC ratio for the men in the specified job categories.

In the June 1982 testing, the group of furnace tender/metal pourers and the group of core knockout men had mean values for FEV_1 and FVC that ranged from 91 to 95% of the values predicted by Kory et. al. (Amer. J. Med. 30: 243-258, 1961). In these two groups only one furnace tender had values of FEV_1 and FVC below the lower limit of "normal" (80% of the predicted value). In the 1983 testing, one knockout man (not of the predicted value), one knockout man (not retested) and one furnace tender (not retested) showed markedly decreased values compared to their 1982 results, and the mean FEV_1 and FVC for these two groups were somewhat lower.

In 1982, the group of four welders and the group of two sandmixers had mean values for FEV_1 and FVC that ranged from 74 to 83 percent of the predicted value. Two welders and one man in the sandmixer or shakeout group had FEV_1 and/or FVC below the limit of normal. In the 1983 testing, three welders had improved, and one welder had unchanged lung function, compared to their 1982 results, and the mean pulmonary function values for the four welders improved somewhat. In 1983, two additional sandmixers were tested, and while the mean values for this group did not change greatly, two of the four tested showed FEV_1, and all four showed FVC values that were below 80% of their predicted values.

The X-rays and X-ray reports of 19 workers (four knockout men, three sand mixers/shakeout men, eight furnace tender/metal pourers, and four welders) were reviewed. The chest X-rays were of generally good quality. In only one employee was a potentially occupationally related condition noted by the hospital radiologist. The 1982 X-ray of this employee was reported to show findings compatible with sarcoidosis. This employee worked in an area where there was potential exposure to beryllium fume; beryllium exposure can produce a disease very similar to sarcoidosis.

VII. CONCLUSION

1. The sand molders, core makers, sand mixers and core knockout personnel were exposed to concentrations of airborne respirable crystalline silica above the NIOSH REL.

2. The coremakers, metal pourers and core knockout personnel were, exposed to airborne formaldehyde that could be contributing to the eye and upper respiratory tract irritation that were frequently reported by these workers. The coremakers also were exposed to another strong irritant (triethylamine), which can also cause the irritant effects reported by these workers.

3. The furnace tenders/pourers and welders were not being exposed to concentrations of aluminum or magnesium in excess of the OSHA PELs. Although none of the samples collected by NIOSH to evaluate the potential exposure to beryllium contained detectable amounts, the analytical limit of quantitation (approximately 1 ug/m^3) was not low enough to adequately evaluate the presence of airborne beryllium; the reported limit of quantitation was approximately twice the NIOSH REL of 0.5 ug/m^3.

4. The furnace tenders were not exposed to concentrations of airborne inorganic fluorides or barium in excess of the NIOSH REL and OSHA PEL, respectively.

5. Airborne concentrations of methylene bisphenyl isocyanate (MDI) were not detected in the breathing zone samples obtained on core makers, furnace tenders, or core knockout personnel. These data, however, may not have been representative of the actual exposure concentrations since the method of sample collection used may not have sufficiently collected MDI under the conditions of use.

6. The sand molders and chill room personnel, during the spraying of chills and sand molds/cores, were not exposed to 1,1,1-trichloroethane or ethyl alcohol in excess of the NIOSH REL or OSHA PEL, respectively.

7. The welders were not being exposed to airborne concentrations of ozone above the OSHA PEL.

VIII. RECOMMENDATIONS

A. Respirable Crystalline Silica

1. An effective medical and environmental monitoring program to detect cases of pneumoconiosis (silicosis) should be instituted. The components of this program are described in the NIOSH criteria document, a Recommended Standard for Occupational Exposure to Crystalline Silica [2], and should include the following:

a. Exposure to crystalline silica should be controlled so that no worker is exposed to a time-weighted average (TWA) concentration of respirable free silica greater than 50 ug/m^3 of air as determined by a full-shift sample of up to a 10-hour workday, 40-hour workweek. Exposure should be determined by a personal (breathing zone) sample. Procedures for sampling, calibration and analyses of environmental samples are specified in Appendixes in the NIOSH Criteria Document for Occupational Exposure to Crystalline Silica.

b. Engineering controls should be used to maintain free silica dust exposure within the NIOSH recommended standard. Periodic air sampling for silica is necessary in order to determine the extent of the potential silica problem and the effectiveness of engineering controls and work areas where more frequent monitoring or examination of workers is necessary. Preferably, this should be done at least once every six months. Proper respiratory equipment should be available, evaluated and maintained when its use becomes necessary.

c. A medical examination should be made available to all workers subject to "exposure to free silica" at preplacement. The examination should include (1) a medical and occupational history to elicit data on worker exposure to silica and other fibrogenic dusts, other significant occupational exposures, significant past medical illness, smoking history, and symptoms and signs of respiratory disease; (2) a baseline chest roentgenogram (14" x 17" posteroanterior x-ray), interpreted according to the ILO/UC International Classification of Radiographs of Pneumoconiosis; and (3) pulmonary function testing, including FVC, FEV_1 and FEV_1/FVC ratio, to provide a baseline for evaluation of pulmonary function and to determine the advisability of workers using negative- or positive-pressure respirators. Standardized procedures for calibrating the spirometer, performing the tests, calculating the results, interpreting the observed spirograms, and using accepted normal values are available and should be utilized.

d. A periodic medical examination should be performed at least once every three years and should include the three elements described above. Results of pulmonary function should be compared to the previous best test. A 10% reduction in FEV_1 or FVC over a 2-3 year period should be considered a significant change.

2. Chest x-rays performed should be of adequate quality. Chest x-rays should be interpreted by trained "B readers".

3. Medical records should be of such a form that information is easily accessible and retrievable, so that comparisons can be made from one examination to the next and should be maintained for at least 30 years following the employee's termination of employment.

4. Medical management of any employee, with or without x-ray evidence of silicosis, who has significant respiratory symptoms or signs of silicosis, or who has significant respiratory symptoms or signs or significant abnormalities on pulmonary function testing should be fully evaluated by a physician (preferably by a chest physician) qualified to advise the employee whether he should continue working in a dusty trade. Employees with definite or suspected silicosis should be promptly evaluated by a chest physician.

5. Any workers with simple or complicated silicosis should be notified of this finding and warned of the hazards of further exposure. They should be removed from further "exposure" to silica dust. If no pulmonary function impairment is noted, this may be accomplished by combination of environmental dust control, reduced exposure time, and adequate respiratory protective equipment (if the silica dust level meets the NIOSH recommended standard).

B. Beryllium

1. Any Wellman workers with potential occupational beryllium exposure who develop a condition compatible with sarcoidosis should be evaluated for possible berylliosis. If medical evaluations of such workers indicate that beryllium exposure could possibly be causing their sarcoid-like condition, they should transfer to an area of the plant where there is no exposure to beryllium dust or fume.

C. Respiratory Protection Program

1. Plant management should implement a respirator program consistent with the guidelines found in DHEW (NIOSH) Publication No. 76-189, "A Guide to Industrial Respiratory Protection," and the requirements of the General Industry Occupational Safety and Health Standards (29CFR 1910 134). Any respirators used, including the approved components and replacement parts should have NIOSH/MSHA approval.

2. If non-certified or substituted respirator components are used, the NIOSH/MSHA approval of the entire respirator assembly is voided, and the protection offered by the respirator may be compromised. Providing respiratory protection for individuals wearing glasses is problem. A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of the full facepiece. Systems have been developed for mounting corrective lenses inside full facepieces. When a worker must wear corrective lenses as part of the facepiece, the facepiece and lenses should be fitted by qualified individuals to provide good vision, comfort, and a good tight seal.

3. Beards should be prohibited on employees who are required to use respirators. Similar to the glasses problem, respirators cannot provide sufficient protection if facial hair interferes with a proper facepiece-to-face seal.

4. To ensure that workers wearing respirators are afforded an adequate fit and a reasonable protection factor, fit testing procedures (preferably quantitative, but qualitative as a minimum) should be conducted.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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 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. President, Local 17, International Molders and Allied Workers Union, Creston, Iowa.

2. Health and Safety Department, International Molders and Allied Workers Union, Cincinnati, Ohio.

3. Director of Industrial Relations, Wellman Dynamics Corporation, Creston, Iowa.

4. U.S. Department of Labor - OSHA Region VII.

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

Chemical Exposure Evaluated By Department

Wellman-Dynamics Corporation
Creston, Iowa

December 1983

	Chemical Substances Evaluated									
Department	Crystalline Silica	Formaldehyde	Inorganic Metals	Triethyl-amine	Inorganic Fluorides	Ozone	MDI*	Ethanol	1,1,1-TCE**	Perchloro-ethylene
38: Welding-Weld Cleaning			X			X			X	X
10: Coremaking Sand Mixing	X	X		X			X	X	X	
13: Dry Sand Molding	X							X	X	
19: Green Sand Molding	X									
14: Chill Room								X	X	
24: Metal Pouring-Furnace Tenders		X	X	X	X		X			
21: Core-Knockout	X	X		X			X			

*MDI = Methylene Bisophenyl Isocyanate
**1,1,1,-TCE = 1,1,1-Trichloroethane

Table 2

Sampling and Analytical Methodology [1]

Wellman Dynamics Corporation
Creston, Iowa

December 1983

Substance	Collection Media	Flow Rate Lt./min.	Duration hours	Analysis	Detection Limit ug per sample	NIOSH Anal. Method reference
Crystalline Silica	PVC Filter; 10-mm cyclone	1.7	6.5-8	X-ray diffraction	30	P&CAM 259
Ethanol	Charcoal sorbent	0.05	6.5-8	Gas chromatography	50	P&CAM 127
Formaldehyde	ORBO-22 sorbent	0.05	6.5-8	Gas chromatography	1	P&CAM 354
Inorganic Fluorides	MCEF filter/impregnated pad	2.0	6.5-8	Specific ion electrode	5	P&CAM 212
MDI	Glass Fiber Filter	1.0	6.5-8	HPLC*	0.2	P&CAM 347
Metals	MCE Filter	2.0	7-8	ICP-AES**	1	P&CAM 351
Ozone	Alkaline potassium iodide	1.0	0.5	Colorimetric	0.2	P&CAM S-8
Perchloroethylene	Charcoal sorbent	0.05	7-8	Gas chromatography	10	P&CAM S-335
1,1,1-Trichloroethane	Charcoal sorbent	0.05	6.5-8	Gas chromatography	10	P&CAM 127
Triethylamine	Silica gel sorbent	0.05	6.5-8	Gas chromatography	10	P&CAM 221

*High pressure liquid chromatography
**Inductively coupled plasma atomic emission spectroscopy.

Table 3

Environmental

Wellman-Dynamics Corporation
Creston, Iowa

December 1983

Substance	Exposure Limits*	Source	OSHA Standard
Aluminum	10 mg/m^3	ACGIH	15 mg/m^3
Barium	0.5 mg/m^3	OSHA	0.5 mg/m^3
Beryllium	0.5 ug/m^3	NIOSH	2.0 ug/m^3
Crystalline Silica	50 ug/m^3	NIOSH	10 mg/m^3 / % Quartz + 2
Ethyl Alcohol	1900 mg/m^3	OSHA	1900 mg/m^3
Fluorides, Inorganic	2.5 mg/m^3	NIOSH	2.5 mg/m^3
Formaldehyde	CA	NIOSH	3.6 mg/m^3
Magnesium	10 mg/m^3	ACGIH	15 mg/m^3
Methylene bisphenyl isocyanate	50 ug/m^3	NIOSH	200 ug/m^3 (ceilings)
Ozone	200 ug/m^3	OSHA	200 ug/m^3
Perchloroethylene	CA	NIOSH	678 mg/m^3
1,1,1-trichloroethane	1900 mg/m^3	NIOSH	1910 mg/m^3
Triethylamine	40 mg/m^3	ACGIH	100 mg/m^3

*The environmental exposure limits used for this evaluation are work-shift time-weighted average (TWA) levels except where noted otherwise, eg. ceiling limits.

CA: Substance is a suspect carcinogen. Exposure should be reduced to the lowest feasible levels by the use of the best control technology available.

mg/m^3: Milligram (mg) or microgram (ug) of substance per cubic meter of air sampled.

Table 4

Personal Breathing Zone Concentrations of Respirable Crystalline Silica (as Quartz*) and Total Respirable Particulate - Sand Molding

Wellman-Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration - ug/m^3 Quartz	Respirable Dust
12-13	Dry sand molder - leadman	0626-1419	728	<41.2**	230
12-13	Dry sand molder	0601-1416	765	<39.2	327
12-13	Dry sand molder	0602-1417	765	<39.2	157
12-13	Dry sand molder	0604-1418	763	<39.3	380
12-13	Dry sand molder	0606-1420	758	66.0	871
12-14	Dry sand molder	0602-1420	770	<19.5***	571
12-14	Dry sand molder	0603-1421	773	51.7	724
12-14	Dry sand molder	0608-1420	762	<39.4	1325
12-14	Dry sand molder	0601-1415	712	<42.1	530
12-14	Dry sand molder	0604-1416	760	<39.7	1040
12-14	Dry sand molder - heavy lift	0611-1425	772	64.8	648
12-15	Dry sand molder - heavy lift	0608-1420	774	64.6	620
12-15	Dry sand molder - heavy lift	0608-1422	779	<38.5	400
12-13	Green sand molder	0610-1423	762	105	827
12-13	Green sand molder	0614-1424	755	53.0	1589
12-14	Green sand molder	0614-1422	751	53.3	1171
12-15	Green sand molder	0613-1421	753	<39.8	956
Environmental Criteria				50	

*Quartz was the only polymorph of crystalline silica detected. Cristobalite was not present at a limit of quantitation (LOQ) of 30 ug per sample.
**Denotes the volume adjusted LOQ. The LOQ for quartz is 30 ug per sample.
***This sample had an interference with the primary quartz value. Therefore, the second most intense value was used for reporting. The LOQ is 150 ug per sample.

Table 5

Personal Breathing Zone Concentrations of Respirable Crystalline Silica (as Quartz*) and Total Respirable Particulate - Core Making

Wellman-Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration - ug/m³ Quartz	Respirable Dust
12-13	Bench area: core maker	0608-1419	762	52.5	538
12-14	WDC area: core maker	0637-1421	714	<42.0**	434
12-15	WDC area: core maker	0608-1422	765	<39.2	458
12-13	North area: core maker	0621-1425	745	53.1	577
12-14	North area: core maker	0636-1423	729	<41.2	412
12-13	Carver area: core maker	0615-1420	706	42.5	807
12-13	Carver area: core maker	0624-1420	744	188	860
12-14	Carver area: core maker	0622-1420	734	<40.9	599
Environmental Criteria				50	

*Quartz was the only polymorph of crystalline silica detected. Cristobalite was not present at a limit of quantitation (LOQ) of 30 ug per sample.

**Denotes the volume adjusted LOQ. The LOQ for quartz is 30 ug per sample.

Table 6

Personal Breathing Zone Concentrations of Respirable Crystalline Silica (as Quartz*) and Total Respirable Particulate - Core Knockout

Wellman-Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration - ug/m^3 Quartz	Concentration - ug/m^3 Respirable Dust
12-13	Operator: New core knockout	0600-1415	763	144	931
12-15	Operator: New core knockout	0602-1424	802	99.8	800
12-15	Operator: Old core knockout	0701-1523	853	70.3**	540
Environmental Criteria				50	

*Quartz was the only polymorph of crystalline silica detected. Cristobalite was not present at a limit of quantitation (LOQ) of 30 ug per sample.

**The sample was positioned underneath the helments shroud during use of the pneumatic tools.

Table 7

Personal Breathing Zone Concentrations of Respirable Crystalline Silica (as Quartz*) and Total Respirable Particulate - Sand Mixing

Wellman-Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration - ug/m^3 Quartz	Respirable Dust
12-13	Department 10: core-sand-mixer	0638-1355	680	147	559
12-14	Department 10: core-sand-mixer	0626-1417	731	<205**	602
12-15	Department 10: core-sand-mixer	0601-1356	724	<207	900
12-13	Department 19: green-sand-mixer	0625-1425	757	238	380
12-14	Department 19: green-sand-mixer	0616-1422	755	<199	1815
12-15	Department 19: green-sand mixer	0612-1420	763	157	1190
Environmental Criteria				50	

*Quartz was the polymorph of crystalline silica detected. Cristobalite was not present at a limit of quantitation (LOQ) of 150 ug per sample.

**Denotes the volume adjusted LOQ. These samples had an interference with the primary quartz value. Therefore, the second most intense value was used for reporting. The LOQ is 150 ug per sample.

Table 8

Personal Breathing Zone Concentrations of Airborne 1,1,1-Trichloroethane (1,1,1-TCE) and Ethanol

Wellman-Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sample Description	Sampling Period	Sample Value Liters	Concentration - mg/m³ Formaldehyde	TEA	Combined Exposure
12-13	Bench area: oper. large core blower	0559-1415 (0559-1415)*	23.2 (24.2)	0.30	5.0	0.33
12-14	Bench area: oper. large core blower	0608-1416 (0608-1416)	22.3 (22.9)	0.13	2.6	0.16
12-15	Bench area: oper. large core blower	0602-1419 (0602-1419)	23.2 (25.2)	0.20	0.40	0.14
12-13	Bench area: core maker	0603-1416 (0603-1416)	22.1 (24.2)	0.27	7.9	0.38
12-13	Bench area: core maker	0608-1417 (0701-1417)	22.5 (20.6)	0.22	9.7	0.39
12-14	Bench area: core maker	- (0617-1419)	- (23.6)	-	3.4	-
12-14	Bench area: core maker	0619-1420 -	22.5 -	0.17	-	-
12-15	Bench area: core maker	0604-1421 (0604-1421)	24.1 (25.2)	0.22	14.7	0.52
12-13	North area: core maker-osborne	0613-1421 (0613-1421)	22.6 (22.7)	0.30	25.1	0.84
12-13	North area: core maker-osborne	0615-1423 (0616-1423	22.6 (22.5)	0.11	18.2	0.53
12-14	North area: core maker-osborne	- (0628-1425)	- (23.5)	-	28.1	-
12-14	North area: core maker-osborne	0631-1427 -	22.9 -	0.24	-	-
12-15	North area: core maker-osborne	0611-1425 (0611-1425)	25.5 (23.5	0.28	37.9	1.14
12-15	North area: core maker-osborne	0613-1426 -	23.2 -	0.30	-	-
12-13	North area: core maker - west wall	0620-1426 (0620-1426)	23.7 (20.5)	0.29	14.2	0.55
12-14	North area: core maker - west wall	- (0634-1423)	- (23.1)	-	9.5	-
12-15	North area: core maker - west wall	0615-1424 -	22.0 -	0.27	-	-
12-13	Carver area: core maker	0624-1404 -	17.4 -	0.42	-	-
12-14	Carver area: core maker	- (0606-1417)	- (25.2)	-	0.79	-
12-14	Carver area: core maker	0604-1408 -	21.4 -	0.35	-	-
12-15	Carver area: core maker	- (0618-1419)	- (23.6)	-	0.85	-
12-15	Carver area: core maker	0620-1403 -	22.2 -	0.35	-	-
12-14	Sand-mixer	0626-1417 -	21.2 -	0.27	-	-
12-15	Sand-mixer	- (0601-1356)	- (22.7)	-	3.5	-
Environmental Criteria				CA**	40	1

*Values in parenthesis apply to the TEA samples.

**Substance is a suspect carcinogen; exposure should be reduced to the lowest feasible levels. The ACGIH TLV of 15. mg/m³ was used to calculate the combined exposure concentration for irritant effects with TEA.

Table 9

Personal Breathing Zone Concentrations of Airborne Formaldehyde

Wellman Dynamics Corporation
Creston, Iowa

December 14-15, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration mg/m^3
12-14	Furnace tender	0728-1556	24.0	0.23
12-15	Furnace tender	0721-1600	24.2	0.22
12-14	Core knock-out operator	0623-1417	23.7	0.19
12-15	Core knock-out operator	0600-1424	23.0	0.20
Environmental Criteria				CA*

*Substance is a suspect carcinogen; exposure should be reduced to the lowest feasible levels.

Table 10

Personal Breathing Zone Concentrations of Methylene Bisphenyl Isocyanate (MDI)

Wellman Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration ug/m^3
12-14	Core knock-out operator	0605-1417	462	<0.43*
12-14	Furnace tender	0728-1550	473	<0.42
12-15	Furnace tender	0716-1550	484	<0.41
12-14	Bench area: core maker	0617-1419	434	<0.46
12-14	Bench area: core maker	0619-1420	429	<0.47
12-15	Bench area: core maker	0607-1420	457	<0.44
12-14	North area: core maker - osborne	0628-1425	438	<0.46
12-14	North area: core maker - osborne	0631-1427	441	<0.45
12-14	North area: core maker - osborne	0613-1426	448	<0.45
12-14	North area: core maker - west wall	0634-1423	429	<0.47
12-15	North area: core maker - west wall	0615-1424	444	<0.45
12-14	Carver area: core maker	0639-1417	413	<0.48
12-14	Carver area: core maker	0641-1408	406	<0.49
12-15	Carver area: core maker	0618-1419	436	<0.46
12-15	Carver area: core maker	0753-1403	337	<0.59
Environmental Criteria	50			

*Denotes the volume adjusted limit of detection based on the samples air volume and analytical limit of detection (0.2 ug per sample).

Table 11

Personal Breathing Zone Concentrations of Airborne 1,1,1-Trichloroethane (1,1,1-TCE) and Ethanol

Wellman-Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration - mg/m^3 1,1,-TCE	Ethanol	Combined Exposure
12-13	Sprayer - chill room	0632-1429	26.1	31.4	4.2	0.02
12-13	Sprayer - chill room	0633-1429	23.3	24.9	9.8	0.01
12-14	Sprayer - chill room	0629-1415	21.6	50.9	7.4	0.03
12-14	Dry sand molder	0605-1420	23.2	3.7	16.4	0.01
12-14	Dry sand molder	0607-1422	21.1	17.1	<2.4*	0.01
12-15	Dry sand molder	0605-1417	23.7	18.6	<2.1	0.01
12-15	Dry sand molder	0603-1415	20.3	9.9	15.4	0.01
12-14	Dry sand-heavy lift	0611-1425	23.3	7.3	10.3	0.01
12-15	Dry sand-heavy lift	0609-1422	23.4	7.3	2.6	0.0
12-15	Dry sand-heavy lift	0608-1420	23.3	12.5	18.0	0.01
Environmental Criteria				1900	1900	1

*Denotes the volume adjusted limit of quantitation (LOQ). The LOQ for ethanol is 0.5 mg per sample.

Table 12

Personal Breathing Zone and Area Concentrations of Airborne Inorganic Fluorides

Wellman Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration mg/m^3
12-13	Furnace tender	0735-1551	936	0.03
12-14	Furnace tender	0733-1551	906	0.03
12-15	Furnace tender	0728-1550	924	0.02
12-13	Mg melt room: platform at #3 titler furnace	0747-1557	980	0.05
12-14	Mg melt room: platform at #3 titler furnace	0710-1600	1060	0.05
12-15	Mg melt room: platform at #3 titler furnace	0742-1542	960	0.04
Environmental Criteria				2.5

Table 13

Personal Breathing Zone Concentrations of Inorganic Metals for Furnace Tenders

Wellman-Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sampling Period	Sample Volume Liters	Concentration - ug/m^3 Aluminum	Barium	Magnesium	Beryllium
12-13	0736 - 1556	962	17.3	12.0	144	ND*
12-13	0731 - 1552	940	16.8	15.7	222	ND
12-13	0733 - 1557	948	23.0	18.5	188	ND
12-13	0732 - 1550	938	19.1	6.7	76.8	ND
12-13	0734 - 1553	940	18.7	17.2	268	ND
12-14	0723 - 1557	922	34.7	37.3	269	ND
12-14	0725 - 1558	866	24.6	13.7	390	ND
12-14	0729 - 1551	946	30.1	12.9	205	ND
12-15	0716 - 1550	968	18.4	7.4	195	ND
12-15	0721 - 1600	970	19.3	15.5	248	ND
12-15	0730 - 1558	952	14.7	7.9	162	ND
12-15	0720 - 1551	956	12.9	1.1	53.2	ND
12-15	0730 - 1600	944	15.6	3.1	206	ND
Environmental Criteria			10000	500	10000	0.5

*Denotes none detected. The analytical limit of quantitation is 1.0 ug per filter.

Table 14

Personal Breathing Zone Concentrations of Inorganic Metals

Wellman-Dynamics Corporation
Creston, Iowa

December 13-14, 1983

Date	Sample Description	Sample Period	Sample Volume Liters	Concentration - ug/m3 Aluminum	Magnesium	Beryllium
12-13	Welder	0636 - 1411	828	21.4	61.7	ND*
12-13	Welder	0618 - 1410	944	17.3	640	ND
12-14	Welder	0611 - 1440	818	19.2	161	ND
12-14	Welder	0606 - 1424	928	16.7	84.5	ND
12-14	Welder	0605 - 1425	914	24.5	4301	ND
12-13	Weld Cleaner	0612 - 1413	864	14.4	24.3	ND
12-14	Weld Cleaner	0609 - 1423	890	79.3	46.3	ND
Environmental Criteria				10000	10000	0.5

*Denotes none detected. The analytical limit of quantitation is 1.0 ug per filter.

Table 15

Personal Breathing Zone Concentrations of Ozone

Wellman Dynamics Corporation
Creston, Iowa

December 13-14, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration ug/m^3	8-hour TWA
12-13	Welder	0605-0650	45	77.8	
12-13	Welder	0650-0735	45	86.7	
12-13	Welder	0735-0820	45	91.1	
12-13	Welder	0821-0906	45	80.0	
12-13	Welder	0921-1006	45	73.3	
12-13	Welder	1006-1051	45	80.0	
12-13	Welder	1051-1136	45	75.6	
12-13	Welder	1219-1304	45	88.9	
12-13	Welder	1304-1349	45	62.2	
					79.5
12-14	Welder	0807-0852	45	66.7	
12-14	Welder	0852-0937	45	82.2	
12-14	Welder	0937-1000	33	31.1	
12-14	Welder	1044-1131	45	84.4	
12-14	Welder	1250-1335	45	118	
12-14	Welder	1335-1420	45	109	
12-14	Welder				80.5
Environmental Criteria					200

*The time-weighted averages are for the total sample periods (6.75 and 4.5-hours, respectively) which is assumed to represent the 8-hour time-weighted average (TWA).

Table 16

Airborne Concentrations of 1,1,1-Trichloroethane (1,1,1-TCE) and Perchloroethylene in the Welding Shop

Wellman-Dynamics Corporation
Creston, Iowa

December 13-15, 1983

Date	Sample Description	Sampling Period	Sample Volume Liters	Concentration - ug/m³ 1,1,1-TCE	Concentration - ug/m³ Perchloroethylene
12-13	Area sample: supervisor's desk	0614-1408	34.3	-	0.58
12-14	Area sample: supervisor's desk	0606-1425	26.4	-	1.14
12-15	Area sample: supervisor's desk	0604-1420	23.1	-	0.87
12-1	Area sample: supervisor's desk	0609-1423	21.7	175	-
Environmental Criteria				1900	339

Table 17

Demographics

Wellman Dynamics Corporation
Creston, Iowa

HETA 83-015

Total - 36	Age range	Age mean	Length of Employment range	Length of Employment average	Smokers #	Smokers %	Allergic History #	Allergic History %
Core (15)	24-60	39	5-19	11	7	(46)	5	(33)
Dry Sand Moldings (9)	23-42	29	5-16	7	5	(50)	5	(55)
Knock-out (4)	25-58	36	6-17	9	4	(100)	1	(25)
Welding (4)	23-38	32	3-19	9	0	(0)	1	(25)
Furnace (2)	22-31	25	4.5-5	4.75	1	(50)	1	(50)
Shakeout (1)	29	29	5	5	1	(100)	0	(0)
Green Sand (1)	40	40	16	16	0	(0)	0	(0)

Table 18

Summary of Reported Symptoms

Wellman Dynamics Corporation
Creston, Iowa

HETA 83-015

Total (35)

Symptom	Core (15)	Mold (9)	Knockout (4)	Welding (4)	Totals (29)
Cough	6 (40) (83)*	4 (40) (100)*	4 (100) (50)*	1 (25) 0*	12 (45)
Wheezing	4 (26) (25)*	1 (10) (100)*	2 (50) (50)*	1 (25) (100)*	8 (28)
Shortness of breath	11 (75) (82)*	6 (60) (83)*	3 (75) (33)*	3 (75) (67)*	23 (80)
Nasal Stuffiness	10 (67) (40)*	9 (90) (100)*	4 (100) (50)*	0 0 -	23 (80)
Nose irritation	8 (53) (88)*	8 (80) (75)*	4 (100) (50)*	3 (75) (67)*	23 (80)
Eye irritation	8 (53) (88)*	6 (60) (100)*	2 (50) (100)*	3 (75) (100)*	19 (66)
Sore Throat	5 (33) (60)*	2 (20) (100)*	1 (25) (100)*	0 0 -	8 (32)
Light headedness	4 (27) (80)*	5 (50) (80)*	1 (25) (100)*	1 (25) (100)	10 (34)

*Percentageof employees associating the symptom with aparticular job, process, or exposure.

Table 19

Chronic Respiratory Symptom Prevalence by Work Area

Wellman Dynamics Corporation
Creston, Iowa

HETA 83-015

	Chronic cough		Chronic phlem with cough		Chronic shortness of breath	
Total (36)	#	%	#	%	#	%
Core (15)	2	(13)	2	(13)	2	(13)
Mold (10)	2	(20)	2	(20)	1	(10)
Knock-Out (4)	4	(100)	4	(100)	2	(50)
Welding (4)	1	(25)	1	(25)	1	(25)
Furnace (2)	0	(0)	0	(0)	1	(50)
Shake-Out (1)	0	(0)	0	(0)	1	(100)

Chronic -- during the past two (2) years.

Table 20

SUMMARY OF PULMONARY FUNCTION TEST RESULTS

Wellman Dynamics Corporation
Creston, Iowa

HETA 83-015

Mean Value

Job Category	Test Year	Number Tested	FEV_1	% Predicted FEV_1	FEV_1/FVC	FVC	% Predicted FVC
Furnace Tender/	82	8	4.11	94	0.85	4.84	91
Metal Pourer	83	6	4.02	94	0.84	4.80	90
Core	82	4	3.77	95	0.85	4.60	94
Knockout	83	4	3.43	87	0.82	4.18	86
Welder	82	4	3.44	83	0.88	3.92	77
	83	4	3.47	85	0.81	4.30	85
Sandmixer or	82	2	3.10	83	0.86	3.62	74
Shakeout	83	4	2.76	77	0.84	3.28	71

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