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

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-182-334

NEW ENGLAND FOUNDRY
LAWRENCE, MASSACHUSETTS

OCTOBER 1976

I. TOXICITY DETERMINATION

A National Institute for Occupational Safety and Health environmental survey team conducted a health evaluation of the New England Foundry on December 17 and 18, 1975. Employees exposure to a number of potential health hazards in several work areas have been evaluated. The following determinations are based on environmental measurements of contaminants, medical interviews, a review of the pertinent literature, and observations of work practices and exposure controls.

1. Airborne concentrations of crystalline silica dust were found to be potentially toxic in all of the surveyed work areas. Exposure measurements were taken for both respirable and total dust, and in both the personal breathing zone and work areas for molders, coremakers, mullers, laborers, floormen, pourers, melters, and grinders.

2. Airborne concentrations of metal dusts and fumes of copper, zinc oxide and tin oxide were within accepted exposure limits during the period of this survey. However, lead dust and fumes were found to be potentially toxic in breathing zone measurements for melters, pourers, and grinders.

3. Ten of the 14 hydrogen cyanide and all of the phenols measurements were well within accepted exposure limits for the period of this survey based on coremakers breathing zone and area samples. The other four hydrogen cyanide samples were insufficient volume to detect below the criteria concentration. Limited area sampling and colorimetric tube measurements showed no evidence of exposure to pourers, molders or shakeout workers.

An OSHA industrial hygiene compliance inspection conducted in conjunction with an accidental death investigation was accomplished since our survey. Citations were given for zinc and lead exposures.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

a) New England Foundry, Lawrence, Massachusetts
b) Authorized Union Representative
c) U. S. Department of Labor - Region I
d) NIOSH - Region I

For the purpose of informing the 80 "affected employees", the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from the New England Foundry regarding the exposure of employees to high lead levels. The request included general foundry activities of grinding, molding, pouring, etc.

IV. HEALTH HAZARD EVALUATION

A. Process Description and Evaluation Design

This foundry is solely dedicated to mass production of meter parts for the Watts Regulator Company. This limited product line is highly automated. The average brass production is 32,000 pounds for the day shift and 20,000 pounds for the night shift. A small aluminum and tenzaloy casting process is operated on the average of one hour per week producing about 1500 pounds. Foundry activities have been catagorized in seven functional areas for treatment in this report: core making, mold making, melting, pouring, shakeout, cut off grinding, and sand preparation which includes mulling, sand pile and utility sand cleanup. Exposures are interdependent due to the close physical relationship of these areas as shown on the foundry floor plan, Figure I.

1. Sand Preparation Process Description and Evaluation Design

a. The foundry uses two types of sand preparations. One type is a pre-treated ACME Blend 4605 phenolic resin coated core sand. A grab sample of this sand was analyzed and found to contain 93.5% free crystalline silica. The second type is a mold sand mixture in the proportions of

2600 pounds New Jersey Overflow sand to 2 1/2 pounds of Southern Bentonite, 1 1/2 pounds of Liquid Flower, and 3 gallons of water to maintain a 2.9% moisture content. A grab sample of this mixture was analyzed and found to contain 30.6% free silica. Personnel assigned sand processing duties are two mullers and several utility workers. One muller is on duty each shift. Utility workers are assigned to sand pile and sand spillage clean-up in the conveyor pit below the molding machines. These requirements vary and are not always assigned to one person. The sand pile is returned sand and core bits from the automatic shaker. The worker sifts out core bits and returns the sand by wheelbarrow to the shakeout conveyor line for reprocessing.

No one was assigned conveyor pit clean-up during this survey. The production capacity was 500,000 pounds of molding sand mixture per 16 hour day processed by a single muller and stored in two 20 ton bins. An additional muller system with a 70 ton storage capacity was undergoing a break-in operation during the survey. There is no mechanical room ventilation in the muller and sand pile area. Sand is in evidence throughout this area due to the conveyor spillage and the free fall sand pile collection and sifting operation.

b. The evaluation of this process included two muller operators and two sand pile workers private interviews were conducted to determine whether workers had experienced work related adverse health effects. They were instrumented for respirable, silica sampling.

2. Core Making Process Description and Evaluation Design

a. Cores are produced by the hot box process. A list of equipment and production capacities is shown in Table 1. Core sand is gravity fed to the gas heated core boxes. The resin coated sand reacts in the 500°F box to form a solid core. There is no mechanical exhaust system in this portion of the building. The core making department is flanked by muller and sand pile operations on one side and a wheelabrator and shipping department on the other. The wheelabrator has a 7 cubic feet capacity. The castings are cleaned by a combination of tumbling action and a spray of #120 steel shot. This unit is exhausted through a baghouse. There are 10 core machine operators and three finishers. All operators rotate weekly on the various machines.

b. The evaluation of this process included eight core machine operators. Interviews as described previously were conducted. Seven personal breathing zone samples and four area samples were taken for phenol and hydrogen cyanide analysis. Two are total dust samples and one personal respirable sample were taken for silica analysis.

3. Mold Making Process Description and Evaluation Design

a. Mold making was accomplished with three SPO manual machines and two Hunter #10 automatics. There was a new Hunter #20 in place, but not yet operational at the time of this survey. This addition was estimated to increase the foundry's output capacity by 30% with a resultant 50% increase in molding sand usage. See the equipment list and production rates in Table 1. There was a deficiency in the general foundry exhaust system due to the absence of two large (five foot diameter) axial roof fans from their location over the furnace line. These have been made operational since this survey. Sand is delivered by overhead conveyor and excess sand is removed by below floor conveyors. Molds are sprayed with Delco product "Part Rite 123-3X" which was found to contain 57.7% toluene. Four hand molder operators and four Hunter operators are employed in this foundry.

b. For the evaluation of this process seven molders were interviewed and six were instrumented for respirable silica sampling. Four urine lead specimens were collected. Two area total silica samples were taken. Colormetric tubes were used to detect toluene.

4. Melting Operation Process Description and Evaluation Design

a. Melting is accomplished in three coreless induction furnaces of 2,000 pound capacities and a newly installed core channel furnace with a 7,000 pound capacity. The later was operational only 10 days at the time of this survey. There is an aluminum and tandaloy oil fired furnace recently installed to replace an electric furnace destroyed by explosion. The three smaller electric furnaces are exhausted through a Pangborn baghouse system. The absence of two large ceiling fans previously discussed left only four smaller two foot diameter wall exhaust fans at the furnace end of the foundry. A Holly make-up air system was installed in December, 1974. The composition of the melt is brass as defined in Reference 1. Analysis of typical raw ingots and final pours are included as Attachments 1,2, and 3. During the tapping operation each pouring ladle of 330 pound capacity receives two 4 ounce packages of phosphorous copper and a two pound ingot of zinc to control oxidation and replace zinc losses during melting by superheating. Four men are assigned melting duties, two on each shift.

b. The evaluation included one employee interview and one urine lead specimen. All four employees in this operation were instrumented for breathing zone metals and total dust sampling.

5. Pouring Process Description and Evaluation Design

a. Pouring is accomplished at 2200^{0} to 2280^{0} F in 330 pound capacity ladles suspended from overhead rails. Three or four ladles may be in use at once. Ladles are fitted with mobile local exhaust. Each mold pour varies from 12 to 25 pounds. A pourer averages as many as 30 to 35 ladles per shift. Pourers wear protective leggings and sleeves as well as goggles. None were observed utilizing respirators although they were reportedly available. Workers have a break between taps, however most were observed to remain in the vicinity of the furnaces.

b. In the evaluation of this process all three day shift and both night shift pourers were instrumented for metal and total dust sampling. Two day and two night pourers were interviewed and each provide a urine lead specimen. Colorimetric tubes were used for detection of hydrogen cyanide. phenols, and carbon monoxide.

6. Shakeout Process Description and Evaluation Design

a. Shakeout is accomplished along a conveyor line which extends nearly the full length of the foundry. After cooling, castings and molds are dumped by shakeout personnel. Mold sand and cores are transported the length of the line by vibration to the shaker. Castings are removed along the line by shakeout personnel and stacked in wheeled carts. The shaker is hooded and exhausted as is the conveyor drop chute which transports sand from the shaker to the main pit conveyor system for return to reprocessing. Single use respirator masks are available upon request. Ear protection is supposed to be worn in the shaker area. Shakeout personnel are assigned as needed to other utility work such as sand pile, pit clean-up, and transporting cores from the core makers to the molding area. Nine men are employed as floor men ("dumpers" and "shakeout"). Another five general utility men are employed. Normally six or seven floormen work the day shift and two or three the night shift.

b. In this evaluation six floormen were interviewed and seven were instrumented for silica sampling. Two area silica dust samples were taken.

7. Grinding (cut off) Process Description and Evaluation Design

a. The grinding activity is presently limited to the cutting off of excess metal from the castings. Three pedestal cut off wheels are positioned across the walkway from the shakeout line. They are locally exhausted, however the control is not effective due to the lack of properly designed enclosures. Workers wear face shields and gloves. Single use paper face masks were occasionally observed in use. Three grinders work variable hours normally two on days and one on nights. Overtime work and extra help is used when needed.

b. In evaluation of these processes the three regular grinders were interviewed and instrumented for metal and dust sampling during a full shift. Three additional two hour overtime workers were instrumented. Five urine lead specimens were collected from the three regular workers.

B. Evaluation Methods

This survey was begun on the night shift 1530 hours to 2400 hours December 17 and continued on the following day shift 0730 to 1530 hours. Due to the brief period between sampling shifts two sets of pumps were used to avoide the necessity of a recharge cycle. Personal breathing zone respirable silica samples were taken with Type G MSA pumps using 10mm cyclones at a sampling rate of 1.7 lpm. Total silica samples were taken with Gast pumps using 9 lpm limiting orifices. All samples were collected on MSA-FWSB filters and analyzed for quartz, cristobalite, and tridymite by X-ray diffraction.[4]

Metals and total dust were sampled with Type G MSA personal pumps at a sampling rate of 2 lpm on VM-1 closed face PVC filter cassettes. In addition to gravimetric analysis copper, lead, tin, and zinc analysis were accomplished by an atomic absorption method.[4]

Phenols and hydrogen cyanide sampling was with Type G personal pumps at a 1 lpm sampling rate. The impinger contained 15 ml of .1N NaOH. Analysis for phenols was by gas chromatography[4] and for HCN was by specific ion (CN^-) electrode.[4]

Urine lead analysis was by atomic absorption with methyl isobutyl ketone extraction. Unfortunately they were not corrected for variations in specific gravity. Therefore, the data was invalid and not included in this report. Scott Drager colorimetric tubes were utilized for detection of toluene, phenols, carbon monoxide, and hydrogen cyanide.

C. Evaluation Criteria

1. There are a number of criteria available to assess the potential toxicity of contaminant exposures under investigation. Those with widest usage are the CFR Title 29 Part 1910.1000 used in the enforcement of the Occupational Safety and Health Act, the Threshold Limit Values (TLV) recommended by the American Conference of Governmental and Industrial Hygienists, and third, the NIOSH Criteria Document Recommendations. These three criteria are included here in Table 2. Their comparison can be made only with an understanding of the differences in methods of measurement and in intended degree of protection. The criteria which in our opinion represents the best health protection has been applied.

2. The criteria for the two materials lead and silica for which positive determinations were made is discussed in detail in References 2 and 3. The limited information presented here is intended to provide layman with a general knowledge of the basis for these exposure criteria.

a. The Lead Exposure Criteria[3] of 0.15 mg/M^3, time weighted average (TWA) is based on the belief that limiting airborne exposures to this level will avoid the absorption of airborne lead into the body in harmful amounts. At or below this exposure level most workers' blood leads should remain below 0.080 mg/100g and their urine leads should not exceed 0.20 mg/l when corrected to a reference specific gravity of 1.024. Control of airborne exposure levels alone does not guarantee workers' safety. Lead can enter the body in other ways such as smoking, through cuts, or eating in contaminated areas with soiled hands. The sum of these exposures determine the toxic effect on workers health. Therefore regular blood tests and close surveillance of work and hygienic habits must be accomplished along with air monitoring.

b. The criteria recommended for respirable crystalline silica[2] of 50 ug/M^3 (TWA) is based on the belief that this concentration is sufficiently low to protect workers from developing silicosis.

In comparison of the NIOSH recommended criteria with ACGIH TLV's[5] note that at high percent silica levels the ACGIH criteria approaches 100 ug/M^3 which is twice the NIOSH recommended exposure control level for quartz.

$$TLV = \frac{10\ mg/M^3}{\%\ SiO_2 + 2}$$ where % SiO_2 refers to the respirable fraction only.

The silica TLV for total dust is basically similar however the percent SiO_2 in this equation refers to total dust.

$$TLV = \frac{30\ mg/M^3}{\%\ SiO_2+3}$$

Note in Table 1 that the ACGIH total dust TLV equation is different from the OSHA criteria which has a (+2) in the denominator. This is because ACGIH revised their TLV for silica since the enactment of the OSHA regulations. At thie point it should be understood that respirable criteria are not directly comparable to total dust criteria since the respirable standard is applied only to a certain portion of the total dust which is of a size small enough to enter and be retained in the lungs. The samples collected for respirable fraction evaluation are taken through a cyclone sizing device.

3. Toxic Effects of lead[3] and free silica[2] are described here very briefly so that the reader will know the symptoms and health consequences of overexposure. The effects described depend upon a number of factors such as concentration and length of exposure, individual susceptibility, and possible synergistic effects of exposure to a combination of substances all at the same time.

a. Effects of lead poisoning include loss of appetite, metallic taste in mouth, constipation or diarrhea, anemia, irritability, fatigue, pallor, muscle and joint paints, muscle tremors and weakening of certain muscles, nausea often without vomiting, and colic (abdominal cramping). Headache usually occurs before or about the same time as onset of colic. Acute encephalopathy may follow ingestion or inhalation of large amounts of lead, and may develop quickly to seizures, coma, and death from cardiorespiratory arrest. A less severe exposure for long periods of time could produce loss of motor skills and of speech, and could lead to development of behavioral disorders. Another effect of lead poisoning may be a progressive and irreversible loss of kidney function.

b. The chief concern of excessive free silica exposure is the development of a condition termed silicosis. This form of pneumoconiosis usually occurs only after a number of years of exposure, although with severe exposure silicosis can occur in a short time. Early silicosis (termed "simple silicosis") is usually first diagnosed by chest X-ray examination. At this stage there is usually little if any functional impairment, and there are often no associated symptoms and signs. Symptoms occur when silicosis advances and becomes complicated by infection and emphysema.

The deposition of crystalline free silica in the lungs in sufficient amounts over a period of years may produce fibrous nodules. These nodules cause many individual alveoli (air sacs within lung) to be compressed and collapsed, thus reducing the function of the lungs. Continuous exposure to elevated concentrations of dust containing free silica may produce increased debilitating effects. These changes are marked by intolerance to exertion, episodes of coughing and production of thick purulent sputum. When silicosis has progressed to this point, the chest X-ray is usually read as "conglomerate silicosis". Conglomerate silicosis many times progresses in spite of termination of exposure and becomes incapacitating to affected workers.

D. Evaluation Results and Recommendations

1. Sand Preparation Activities

a. Findings

Among this group of workers respiratory irritation and chest problems were common complaints. Survey results showed exposures to free silica from slightly above to over twenty times the recommended NIOSH criteria. The results are shown in Table 3. The second sand pile workers exposure of 0.066 mg/M^3 respirable quartz was not representative of a full shift since he worked only one hour at sandpile duties before being transferred to outside duties. The new process equipment not yet operational at the time of the survey is a potential source of additional silica exposure. The stated intention to mechanize the sand pile operation would reduce exposures. Medical surveillance of exposed workers was inadequate.

b. Recommended Actions

Process modifications to reduce the exposures to sand pile workers should be implemented. Engineering controls for sand and dust leakage from the muller and conveyor operations should be implemented. Also increased emphasis should be placed on housekeeping. To reduce resuspension a vacuum pick-up should be incorporated rather than sweeping and shoveling.

A respiratory protection program should be established in accordance with OSHA regulations (29 CFR Part 1910.134) including environmental and medical surveillance as discussed in the general recommendations of this report. A medical survaillance program as outlined in the NIOSH Criteria Document (Reference 2) should be implemented.

2. Core Making Activities

a. Findings

Eight of the core making operators were interviewed. There were complaints of eye irritation and difficult breathing. Also skin burns were common. It was noted that these problems were more prevalent with the increased heat and "heavy air" during the hot summer months. All seven breathing zone phenol samples and four area samples for phenols and hydrogen cyanide were below the ACGIH TLV's. See Table 4 for the results. Two are total silica and one personal respirable sample were taken. The two total silica results were well above the ACGIH TLV's based on the per cent quartz. The 10% to 14% free silica of these area samples was twice that of the foundry area. The respirable sample was not above the NIOSH recommended criteria however this is not sufficient data to presume a safe exposure level. See Table 2. The higher per cent silica in these area samples may be due to the higher per cent in ACME core sand. Results of rafter samples taken from lights above core making machines show 46.5% free silica (quartz). Results of phenyl tests with Scott Drager colorimetric tubes taken directly over the hot cores were all less than the detection limit of 5 ppm.

b. Recommended Actions

Correction of the sand and dust control problems in the adjacent sand pile and whellabrator areas will improve conditions in the core area as well. The high free silica content of the samples strongly suggests that there is further contamination by the core sand itself. An engineering review of dust controls should be made for the core sand handling process. There is a need for improved housekeeping to minimize resuspension of the silica dust. A periodic survey should be made to determine the adequacy of controls. In the interim a respirator program should be implemented.

3. Mold Making Activities

a. Findings

Half of those interviewed complained of respiratory irritation. The results of breathing zone samples were all but one in excess of NIOSH criteria for free silica exposure ranging up to seven times the limit. See results in Table 2. The total silica area samples were below the ACGIH TLV's. These results are not contradictory since area samples are taken at fixed locations, are taken with different sampling devices, and are compared to different criteria. Urine lead results were not usable due to lack of specific gravity corrections. Rafter samples taken from overhead beams were 34% quartz. Colorimetric tube measurements for toluene in the molders breathing zone were less than 25 ppm, during peak exposures.

b. Recommended Actions

The combined effects of improved ventilation and increased contamination by process additions can not be predicted accurately. It is necessary to establish an environmental surveillance program and medical monitoring to determine if additional dust control measures are required. As an interim measure a respiratory protection program should be implemented. Here again medical surveillance should be implemented in accordance with Reference 2. The use of low free silica sand or substitution of other materials would be a possible solution.

4. Melting Activities

a. Findings

Personal breathing zone samples were below the TLV's for copper fumes and tin. The zinc oxide TLV was exceeded in one case and approached in another. The 0.15 mg/M^3 lead exposure criteria was exceeded for all four workers and was twice this recommended criteria for two of the workers. See results in Table 6. The urine specimens were not usable due to lack of specific gravity correction. Based on the average 5.2% silica found in the shakeout and molding areas adjacent to the furnaces it is considered appropriate to evaluate these total dust measurements by the total silica dust criteria. The exposures were two and three times the 4 mg/M^3 TLV for 5.2% silica dust. See Total Dust column of Table 5 for results.

b. Recommended Action

The combined effect of improved ventilation and increased contamination due to process changes can not be predicted. The area should be placed under environmental surveillance. Workers in this area should be placed on a respiratory protection program as an interim measure until effective exhaust system control of exposures to silica and lead is established. A medical surveillance program should be established in accordance with References 2 and 3.

5. Pouring Activities

a. Findings

The personal breathing zone samples were below ACGIH TLV's for copper and tin and only one approached the TLV for zinc oxide. However all but one sample exceeded the TLV for lead. Total dust exposures were all above the total free silica TLV based on area sample per cent free silica of 5.2 although none exceeded the nuisance dust TLV. See Table 6. Colorimetric tube tests for hydrogen cyanide and phenols were less than detection limit of 2 ppm for HCN and 5 PPM for phenol in the pourers breathing zone as well as the general pouring area. Carbon monoxide tests were less than 5 ppm in the breathing zone and less than 1 ppm in the general pouring area. Urine leads were not usable due to the lack of specific gravity correction.

b. Recommended Actions

It is uncertain what the combined effects of increased production and improved ventilation will be on this work environment. An environmental surveillance program should be implemented to establish the exposure conditions after the situation has normalized. As an interim measure, a respiratory protection program should be established until the effectiveness of ventilation controls can be determined and needed improvements completed.

6. Shakeout Activities

a. Findings

Of those interviewed over half complained of dust and respiratory irritation. One of these had recently experienced an acute clinical respiratory condition which necessitated his removal from the work place and a two week hospitalization. He stated his attending physician had indicated he was breathing in too much dirt and smoke. Respirable breathing zone samples were all but one in excess of the 50 ug/M^3 silica criteria recommendations. Total silica area samples were also above the ACGIH TLV for total free silica. See results in Table 2. Rafter samples taken from top of shaker enclosure were 4.7% quartz.

b. Recommended Action

The sand transport system requires engineering to reduce silica exposures below hygienic standards. Environmental surveillance should be established and a respiratory protection program implemented for the workers exposed to hazardous levels of silica dust.

7. Grinding (cut off) Activities

a. Findings

Interviews of regular grinders as well as occasional part time grinders revealed complaints of respiratory and eye irritation. This was considered to be one of the dirtiest jobs. Breathing zone sample results for tin, zinc, and copper were below ACGIH TLV's. Lead exposures were all above the TLV and half were twice the recommended levels. All total dust sample results were above the ACGIH 4 mg/M^3 TLV based on 5.2% total free silica taken from area samples. Full shift exposures were two to four times the silica TLV. One other sample is suspect due to improper wearing of the cyclone sampling device and is noted to be exceptionally high therefore was excluded from this analysis. See Table 6. The urine results are not usable due to lack of specific gravity correction.

b. Recommended Actions

Improved general exhaust and process controls as discussed throughout this report may reduce the grinders silica exposure. The metals exposures can be reduced by proper local exhaust enclosures on the cut off wheels. The ACGIH Industrial Ventilation Manual of Recommended Practices should be used as a guide. A respiratory protection program should be implemented until environmental surveillance shows adequate control of silica and metal dust exposures. Again a medical surveillance program should be established in accordance with Reference 2 and 3.

8. General Discussion and Recommendations

There existed a general exhaust system deficiency throughout the period of our survey due to the absence of two large 5-foot roof axial exhaust fans which were removed for repairs. In addition the makeup air system was reportedly operating at only 70% efficiency due to need for filter maintenance. These facts when combined with major alterations in the production lines presently underway lead to a general recommendation; that those areas where either excessive exposure levels were found or where process changes might cause increased levels of exposure be placed under frequent environmental monitoring in accordance with NIOSH criteria documents for lead and crystalline silica.[2,3] Local exhaust and general ventilation requirements should be evaluated by experts. The American Conference of Governmental Industrial Hygienists (ACGIH) Publication Industrial Ventilation Manual of Recommended Practice[6] should be used as a guide. Of particular interest is Section 7 which deals specifically with foundry local exhaust design.

A number of verbal recommendations made during the exit briefing should be emphasized. The physical examination and environmental surveillance programs are inadequate. A sketchy preplacement medical questionnaire, and periodic (3 or 4 month) blood and lead examinations upon request are not sufficient. Efforts to accomplish follow-up blood tests were declined by the employer since they had already implemented a monthly test following the OSHA inspection. The lack of preplacement, periodic, and termination examination including chest x-rays, pulmonary function tests, blood metals, and audiometric exams where needed is self evident. The previous in-house environmental survey documentation provided for our review was limited to metals exposures and a noise survey. The lack of clearly documented methods, equipment certification, and qualifications of survey personnel performing the routine in-house periodic surveillance greatly reduces the credibility of the results. On January 18, 1974 an industrial hygiene survey performed by a private insurance company identified the high noise exposure areas and recommended a full audiometric monitoring program. These recommendations have not been fully implemented and should be.

A summary of specific recommendations by area follows:

1. Sand Handling

    a. Modify "sand pile" process to minimize personnel exposure probably by enclosed mechanical operation.
    b. Improved control of conveyor and muller dust and leakage.
    c. Increased emphasis on housekeeping with incorporation of vacuum pick-up rather than by shoveling or sweeping.
    d. Implement a respiratory protection program in accordance with 29 CFR Part 1910.134.

2. Core Making

    a. Implement controls in sand handling process above.
    b. Determine effectiveness of wheelabrator local exhaust system and make adjustments as required.
    c. Determine dust control requirements for core sand handling and make improvements if necessary.
    d. Increased emphasis on housekeeping.
    e. Resurvey to determine need for respiratory protection.

3. Mold Making and Shakeout

    a. Improve control of dust and leakage from sand conveyors.
    b. Correct general ventilation deficiencies and resurvey to determine adequacy of dust controls.
    c. Implement interim respiratory protection program for toxic dust.

4. Melting and Pouring

    a. Correct general ventilation deficiencies and resurvey to determine adequacy of dust and metal fumes control.
    b. Implement interim respiratory protection program for toxic dust and metal fumes.

5. Cut Off

   a. Provide engineering design and installation of proper local exhaust hood "enclosures" for pedestal cutoff equipment.
   b. Correct general ventilation deficiencies and resurvey to determine adequacy of silica dust controls.
   c. Implement respiratory protection program for silica dust and toxic metals.

V. REFERENCES

1. Encyclopedia of Chemical Technology, Vol. 6. "Copper Alloys (Casting)" pp. 249-252.

2. NIOSH Criteria for a Recommended Standard for Occupational Exposure to Crystalline Silica.

3. NIOSH Criteria for a Recommended Standard for Occupational Exposure to Inorganic Lead.

4. NIOSH Manual of Analytical (Methods, HEW Publication No. 75-121, 1974.) PICA Methods No. 116, No. 155, No. 109, No. 173, and No. S330.

5. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment Adopted by ACGIH for 1975.

6. ACGIH Industrial Ventilation, a Manual of Recommended Practice, 14th Ed.

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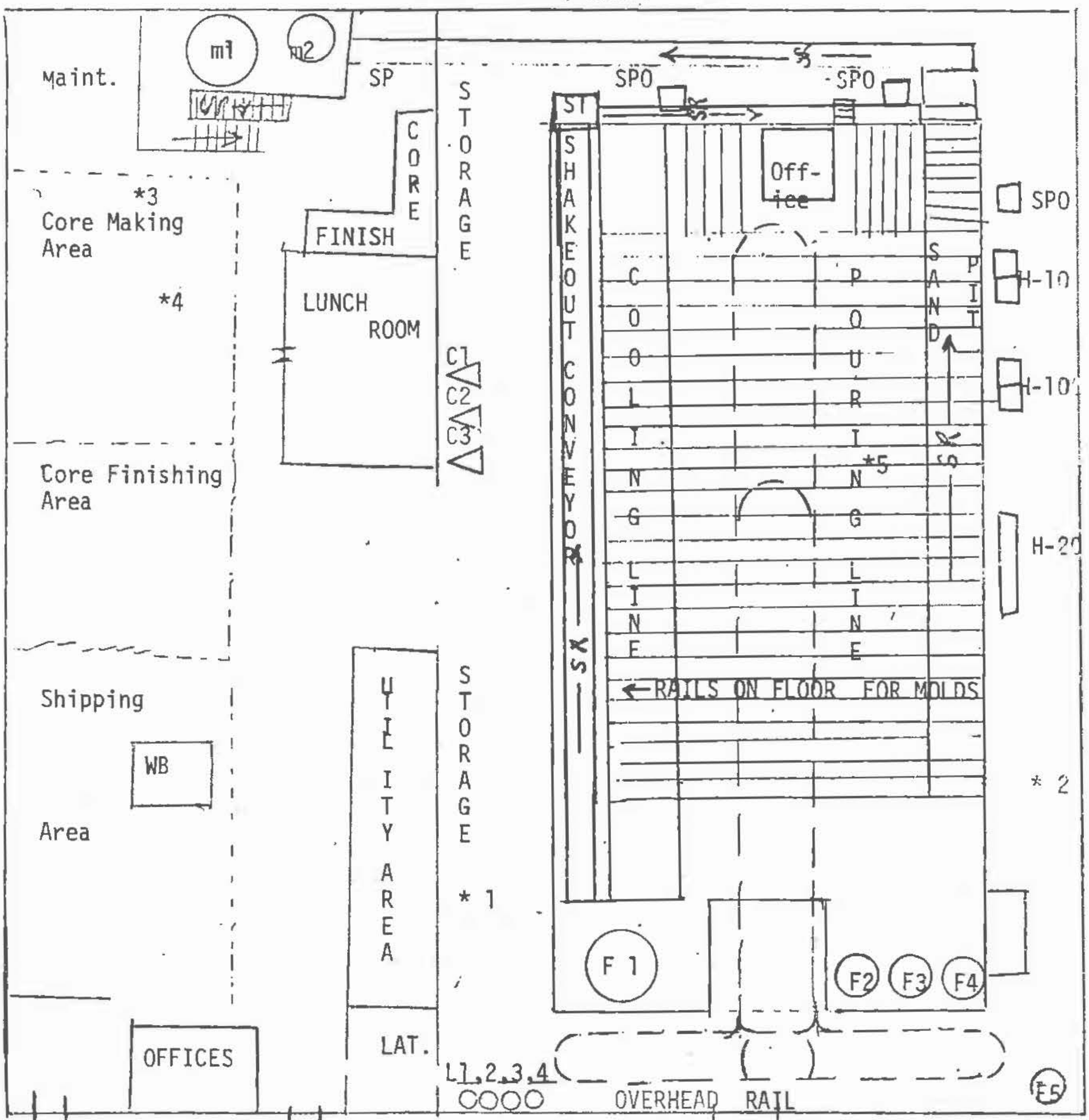
RHE 75 - 182
NEW ENGLAND FOUNDRY (not to scale)
LAWRENCE, MASS.



See Legend on Page 2

FIGURE I

FIGURE I
NEW ENGLAND FOUNDRY (CONTINUED)
LEGEND

M1 - New Muller and Storage Bin (two story structure)

M2 - Old Muller and Storage Bin (two story structure)

SR - Sand Return Conveyors

SP - Sand Pile Operation

SI - Shaker

MAINT - Maintenance Shop

Sand PIT - Sand Conveyor Pit

WB - Wheelabrator (two story structure)

C1, C2, C3 - Pedestal Cut Off Grinding Operation

L1, L2, L3, L4 - Four Ladle Heating Stations

*1 - Shakeout Area Sampling Location (HCN, Phenol, SiO)

*2 - Molding Area Sampling Location (HCN, Phenol, SiO)

*3 - Core Making Area Sampling Location (HCN, Phenol, SiO)

*4 - Core Making Area Sampling Location (HCN, Phenol)

*5 - Pouring Area Sampling Location (HCN, Phenol)

F1 - New Electric Furnace 7000 pound capacity

F2, F3, F4 - Old Electric Furnaces 2000 pound capacity

F5 - Oil Burning Furnace for Aluminum

SPO - Manually Operated Molding Machine

H-10 - Automatic Molding Machine

H-20 - New Automatic Molding Machine

TABLE 1

New England Foundry
Lawrence, Mass.

December, 1975

Process Equipment and Production Rates

Core Making Machines			Biweekly
Type	Quantity	Cycles/Shift	Work Cycle
SCB #9	4	1100 Blows	73% (5.8 hr/dy)
Standard Redford	4	610 Blows	63% (5 hr/day)
Large Redford	1	310 Blows	63% (5 hr/dy)
Harrison	1	600 Blows	< 1 hr/day
Dependables	2	400 Blows	37% (3 hr/dy)

Molding Machines

SPO (Hand Molders)	3	250-275 Molds per Man Shifts
Hunter #10 Automatic	2	600 Molds Per Man Shifts
Hunter #20 Automatic	1	Estimated 600 molds (larger) Per Man Shift (i.e. 30% Production Increase)

Table 2

New England Foundrv
Lawrence, Mass.

TOXIC MATERIAL	MULTIPLE CRITERIA - Table 1		
	NIOSH[a] RECOMMENDED	ACGIH TLV[b] 1975 Book	Title 29 Part 1910, Subpart G [c]
Crystalline Silica: Quartz	50 ug/M^3 of all respirable Crystalline Silica	$\frac{10\ mg/M^3\ \text{Resp Dust}}{\%\ \text{Quartz} + 2}$	(from Table G-3)
Respirable Cristobalite and Tridymite		Use 1/2 (Quartz TLV Equation)	(from Table G-3)
Total Crystalline Silica	Not Recommended	$\frac{30\ mg/M^3\ \text{Total Dust}}{\%\ \text{Quartz} + 3}$	(from Table G-3) $\frac{30\ mg/M^3\ \text{Total Dust}}{\%\ \text{Quartz} + 2}$
Nuisance Dust	No Recommendation Published	Total: 10 mg/M^3 or 30 m PPCF	(from Table G-3) Total: 15 mg/M^3 or 50 m PPCF Respirable: 5 mg/M^3 or 15 m PPCF
Lead	0.15 mg/M^3		(from Table G-2) 0.2 mg/M^3
Cu Fumes Cu Dust	No Recommendation Published	0.2 mg/M^3 1.0 mg/M^3	(from Table G-1) 0.1 mg/M^3 1.0 mg/M^3
Zinc Fumes		5 mg/M^3	(from Table G-1)
Tin	No Recommendation Published	2.0 mg/M^3	(from Table G-1)
Hydrogen Cyanide	No Recommendation	10 ppm = 11 mg/M^3	(from Table G-1)
Phenols		5 ppm = 19 mg/M^3	(from Table G-1)
Toluene	100 ppm		(from Table G-3) 200 ppm

MULTIPLE CRITERIA TABLE - 2 (cont)

a. All NIOSH recommended criteria cited here are time weighted averages (TWA) designed to protect the health and safety of workers for up to a 10-hour workday, with the exception of lead which is for an 8-hour workday, 40 hour workweek over a working lifetime. Compliance with all sections of the applicable standard should prevent adverse effects on the health and safety of workers.

b. American Conference of Governmental Industrial Hygienists Threshold Limit Value's refer to time-weighted average concentrations for a 7- or 8-hour workday and 40-hour workweek. They represent conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse effects. These limits are intended for use in the practice of industrial hygiene and should be interpreted and applied only by a person trained in this discipline.

c. From CFR Title 29 Part 1910.1000 Occupational Safety and Health Standards, Subpart G Occupational Health and Environmental Controls, air contaminants: any employee exposed to any material listed in Table G-1, G-2, or G-3 of this section shall be limited in accordance with the requirements of the following paragraphs of this section. (See Federal Register June 27, 1974, Vol. 39, Number 125 for full discussion) Criteria cited here from Tables G-1, G-2, and G-3 all are based on an 8-hour work shift of a 40-hour workweek time weighted average exposure.

Table 3

Silica Data Record

New England Foundry
Lawrence, Mass.

NIOSH/HETAB Survey: Dec. 17, 1975 (N-shift) (1530-2400 hrs) (D-shift) (0730-1530 hrs)

Type of Work or Area Location	Shift	Sample Period (Hrs)	Sample Volume (M^3)	Respirable* Quartz %	Respirable* Quartz mg/M^3	Respirable* Total mg/M^3	Total Dust % Quartz	Total Dust % Crist**	Total Dust Total mg/M^3	ACGIH TLV mg/M^3
Muller	D	6.35	.625	3.31	.077	2.32				1.88
Muller	D	5.75	.657	21.07	1.35	6.22				0.43
Utility (sand pile)	N	6.00	.561	16.35	1.05	6.40				0.54
Utility (sand pile)	D	6.68	.714	2.43	.066	1.37	Note: Changed Assignment worked sand pile only one hour			2.26
Utility (core transport)	D	5.69	.581	3.33	.083	2.48				1.88
Core Maker	D	6.63	.651	1.74	.028	1.58				2.67
Core Area	N	6.66	3.600				12.57	1.02	2.275	1.93
Core Area	D	7.5	4.050				8.1	1.58	12.342	2.70
#10 Hunter Molder	N	4.28	.384	7.86	.365	4.64				1.01
#10 Hunter Molder	N	6.0	.564	4.22	.082	1.93				1.61
#10 Hunter Molder	D	5.91	.602	2.81	.128	3.34				2.08
SPO Molder	D	6.5	.612	5.05	.072	1.42				1.42
SPO Molder	D	6.0	.605	.66	.006	8.89	Suspect Sample			3.76
SPO Molder	D	6.5	.608	4.08	.056	2.69				1.64
Hunter #1 Area	N	6.5	3.483				5.17	<1.1	3.196	3.67
Hunter #1 Area	D	7.1	3.834				2.3	<0.8	4.722	5.66
Floorman	N	6.1	.671	5.44	.091	1.67				1.34
Floorman	N	6.37	.595	2.64	.116	4.39				2.16
Floorman	N	6.73	.644	4.36	.075	1.71				1.57
Floorman	N	6.60	.620	4.81	.100	2.07				1.47
Floorman	D	5.43	.571	3.18	.010	3.14				1.93
Floorman	D	5.77	.690	2.53	.057	2.23				2.21
Floorman	D	5.74	.617	2.51	.055	2.19				2.22
Shakeout Area	N	6.55	3.537				5.94	.55	5.960	3.36
Shakeout Area	D	7.1	3.834				5.22	.85	5.499	3.65
NIOSH Criteria					.050					

*Note: All Respirable Sample Analysis below detection limits of <0.038 mg for Cristobalite and <0.010 mg for Tridymite.

** Cristobalite

TABLE 4

HCN & PHENOL - DATA RECORD

NEW ENGLAND FOUNDRY
LAWRENCE, MASS.

NIOSH/HESB SURVEY: 17 Dec. 75 (1730-2400) 18 Dec. 75 (0730-1530)

AREA OR TYPE WORK	SHIFT	SAMPLE PERIOD (HRS)	SAMPLE VOLUME (m^3)	SAMPLE LOSS* FACTOR	PHENOL mg/m^3	PHENOL mg/m^3 CORRECTED	HCN mg/m^3	HCN mg/m^3 CORRECTED
SCB-9 Operator	N	Broken TRAP MAX 1.75	.105	1.59	1.62	2.37	<23.39	<37.19
Small Redford (#2) Same Operator	N	4.1	.215	1.09	1.44	1.57	<16.13	<17.58
SCB-9 Operator	N	6.33	.380		<.079		<9.02	
SCB-9 Operator	N	5.71	.338	1.16	.50	.58	<7.92	<9.2
Small Redford Operator #3	D	6.35	.204	1.12	1.42	1.59	<11.12	<12.52
SCB-9 #1 Operator	D	6.4	.370	1.17	.73	.85	<6.84	<8.0
Harrison #1 Operator	D	6.3	.212	1.19	2.69	3.21	<11.18	<13.34
SCB-9 AREA	N	6.6	.395	2.44	.13	.32	<3.06	<7.48
SCB-9 AREA #2	N	6.6	.375	1.22	.48	.59	<6.66	<8.16
SCB-9 AREA	D	6.6	.396	1.19	.58	.69	<5.45	<6.47
Small Redford (#3) AREA	D	5.35	.321	1.13	1.09	1.23	<8.92	<10.08
5 ft. above pouring line & Near middle of line	N	5.66	.350	1.18	.31	.365	<9.16	<10.80
	D	6.45	.400	1.19	.35	.416	<5.4	<6.42
15 ft. from the Shakeout line near Furnace End - 5ft above floor	N	5.4	.355	1.16	.14	.162	<8.51	<9.87
	D	6.55	.400	1.2	.35	.29	<5.06	<6.07
ACGIH TLV						19.0 mg/M^3		11.0 mg/M^3

*Sample Loss Factor = ml sample shipped to laboratory / ml sample received by laboratory

+Correction: Multiply mg/m^3 times Sample loss Factor

Table 5

DUST AND METALS - DATA RECORD

NEW ENGLAND FOUNDRY
LAWRENCE, MASS.

NIOSH/HETAB SURVEY: 17 Dec. 75 (1530-2400) 18 Dec. 75 (0730-1530)

Type Work	Shift	Sample Period (hrs)	Sample Volume (M3)	Copper		Lead		Zinc Oxide		Total Dust	
				mg	mg/M^3	mg	mg/M^3	mg	mg/M^3	mg	mg/M^3
Melt	N	5.95	.71	.081	.114	.232	.327	4.196	5.909	7.2	10.14
Melt	N	5.90	.652	.039	.060	.128	.196	2.054	3.151	3.64	5.58
Melt	D	6.55	.720	.083	.114	.219	.300	3.424	4.690	6.34	8.68
Melt	D	5.5	.618	.043	.069	.138	.223	.513	.830	7.13	13.31
Pour	N	6.66	.74	.042	.057	.125	.169	2.080	2.810	4.08	5.51
Pour	N	6.82	.90	.065	.072	.125	.139	2.017	2.246	4.80	5.34
Pour	D	3.00	.30	.033	.110	.077	.257	.951	.2803	2.01	6.7
*		2.55	.32	.020	.063*	.054	.169*	.854	2.67*	1.52	4.75*
Pour	D	5.95	.71	.056	.078	.141	.198	2.029	2.86	4.14	5.83
Pour	D	6.15	.69	.073	.106	.203	.296	2.801	4.08	5.00	7.29
GR	N	1.83	.22	.098	.445	.041	.186	.210	.956	1.00	4.54
GR	N	1.75	.21	.054	.257	.032	.152	.183	.871	1.09	5.19
GR	N	4.25	.666	.611	.917	.199	.299	.773	1.16	5.74	8.62
GR	N	1.83	.218	.185	.849	.086	.394	.498	2.284	3.06	16.51
GR	D	8.10	.948	.584	.616	.284	.299	1.805	1.904	9.83	10.37
GR**	D	8.15	.96	3.84	4.0**	1.34	1.395**	4.357	4.539**	37.59	39.15**
	Criteria			TLV Fumes	.2 +		.15		5.0		4.0++
				TLV Dust	1.0						

* Pump failed during above sample. Second filter and pump used.
** Suspect sample. Found filter in wrong position end of first hour.
\+ Use Fume Criteria for Melting and Pouring. Use Dust for grinding.
++ Based on 5.2% Free Silica content in area samples.

ANALYSIS REPORT

Colonial Metals Co.

Main Office Columbia, Pa. 17512
Phone Area Code 717 684-2311 to 19
Telex: 848-428

NON FERROUS METALS

Our 9161 Your 36917-D

Customer Watts Regulator Co. Date December 3, 1975

Heat No. 2723 Invoice 38738

Material C1 Metal Ingot Weight 28664

Aluminum	
Copper	80.20
Tin	2.80
Lead	6.56
Iron	.24
Antimony	.08
Nickel	.46
Manganese	
Magnesium	
Zinc	9.62
Silicon	
Sulphur	.033
Phosphorus	.007

Elect. Cond. ________

Yield ________

Tensile ________

Elong ________

B H N ________

CHEMIST

ATCH 1

ANALYSIS REPORT

Colonial Metals Co.

Main Office Columbia, Pa. 17512
Phone Area Code 717 684-2311 to 19
Telex: 143-428

NON FERROUS METALS

Our 9161 Your 36917-N

Customer Watts Regulator Co. Date December 4, 1975

Heat No. 3693 Invoice 38786

Material 81 Metal Ingot Weight 19769

Aluminum	
Copper	81.03
Tin	2.93
Lead	7.50
Iron	.03
Antimony	.06
Nickel	.68
Manganese	
Magnesium	
Zinc	7.76
Silicon	
Sulphur	.007
Phosphorus	.003

Elect. Cond. ______

Yield ______

Tensile ______

Elong ______

B H N ______

CHEMIST

ATCH 2