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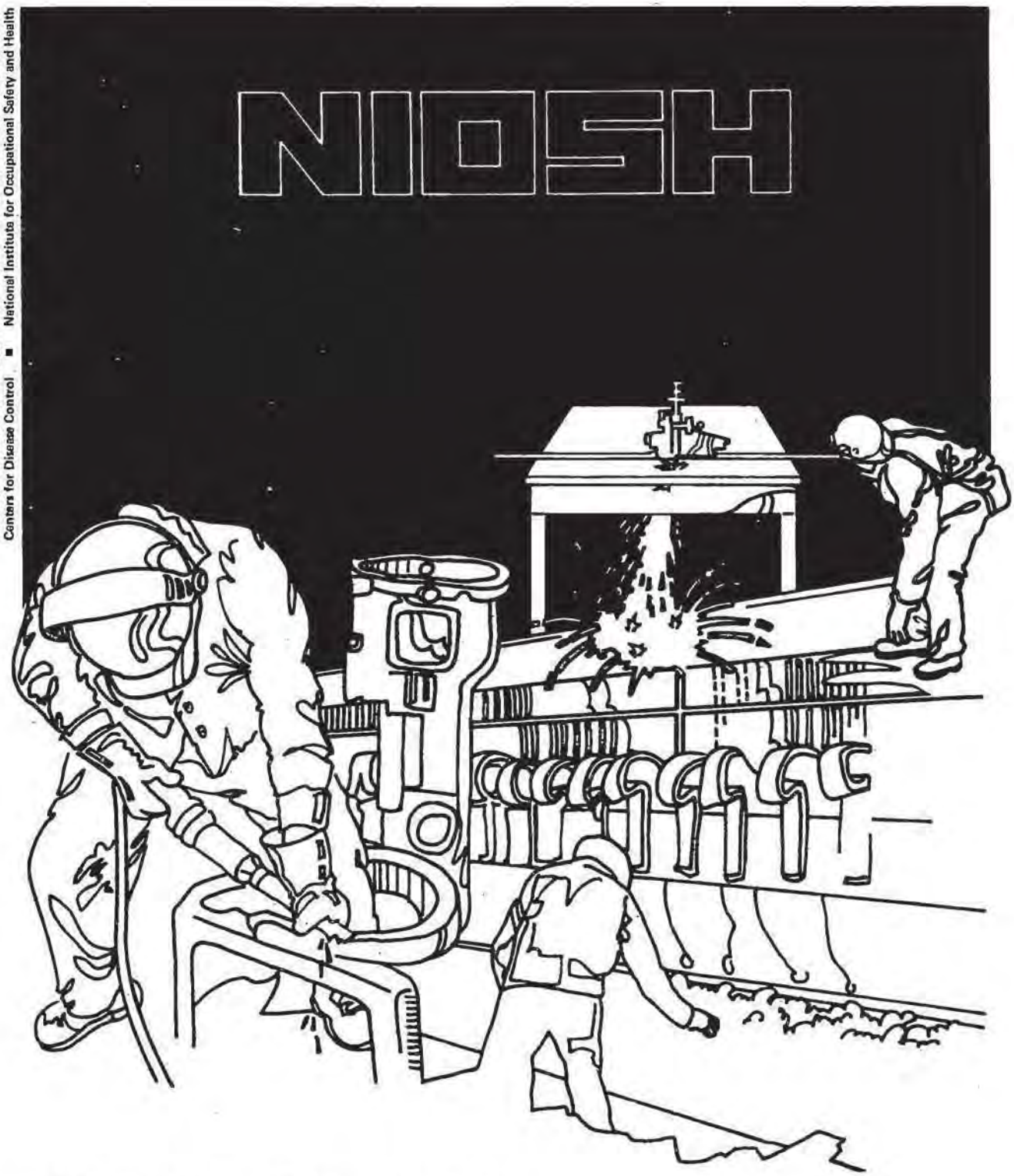

Health Hazard Evaluation Report

HETA 81-411-1182
CORHART REFRACTORY
LOUISVILLE, KENTUCKY

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.

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Corhart Refractory
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I. SUMMARY

In August, 1981, the National Institute for Occupational Safety and Health (NIOSH) received an employee request to evaluate environmental conditions at the Corhart Refractory's Louisville plant, where 130 workers are employed to produce refractory bricks.

Approximately ten years ago, employees in the No-Bake/Bake mold departments began experiencing transient irritation of the eyes, nose, and throat which they related to process fumes at their work site. Concern was also expressed about a number of cancer cases found among Corhart employees.

NIOSH visited the refractory on September 2, 1981. A follow-up visit from October 26-28, 1981, consisted of a walk-through of the facility, questionnaire distribution and collection, environmental sampling (phenol, formaldehyde, methylene bisphenyl diisocyanate, aromatic hydrocarbons, and unknown organics), and review of health records.

Environmental samples collected during the survey included six personal breathing zone (PBZ) and two area air (AA) samples for formaldehyde; 7 PBZ and 2 AA for MDI; 2 BPZ and 3 AA for phenol; 6 PBZ for C_8 through C_{11} molecular weight range aromatic hydrocarbons; 2 BPZ for unknown organics; and 1 bulk sample of fibrous material for asbestos analysis.

Results of these environmental samples are as follows: formaldehyde, non-detectable to 0.64 mg/M^3, all well below the OSHA standard of 2.5 mg/M^3 for a time weighted average (TWA), but based on the recent evidence on carcinogenicity NIOSH currently recommends that formaldehyde exposure be controlled to lowest possible levels; MDI, non-detectable to 0.0068 mg/M^3, all well below the OSHA standard of 0.20 mg/M^3 (10-minute ceiling) and the NIOSH recommended criteria of 0.20 mg/M^3 (20 minute ceiling) and 0.05 mg/M^3 (TWA); phenol, non-detectable to 0.64 mg/M^3, all well below the OSHA standard of 19 mg/M^3 (TWA), and the NIOSH recommended criteria of 20 mg/M^3 (TWA); C_8 through C_{11} aromatic hydrocarbons, 7.9 to 160.4 mg/M^3 (no standard established); unknown organics, major contaminants consisted of C_8 through C_{11} molecular weight aromatic hydrocarbons in amounts too low to quantitate; fibrous material, no asbestos detected.

Questionnaire survey revealed that compared to shipping and clerical workers, employees of the No-Bake Mold Department had a significantly higher prevalence of irritation of the nose (44%), throat (48%), skin (30%), and eyes (56%).

Findings of a proportionate mortality study conducted by the University of Cincinnati suggest there is no association between cancer deaths and past workplace exposures at the Corhart plants.

NIOSH concluded that current health effects are mild, transient and probably related to exposure to formaldehyde (non-detectable to 0.64 mg/M^3) combined with the added effects from low levels of phenol (non-detectable to 0.64 mg/M^3) and MDI (non-detectable to 0.006 mg/M^3) in the pepset. Recent findings regarding the potential of formaldehyde as a human cancer-causing agent make the necessity of reducing this exposure more urgent than in 1976. Recommendations to achieve this have been made.

KEYWORDS: SIC 3297, pepset, phenol, formaldehyde, aromatic hydrocarbons, methylene bisphenyl diisocyanate.

II. INTRODUCTION/BACKGROUND

On August 3, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request to evaluate occupational health concerns at Corhart Refractory in Louisville, Kentucky. There were two major health concerns - suspected excess cancer deaths attributable to past exposures; and sore throat, burning eyes, and nose bleeds, especially in the No-Bake Mold Department.

In June of 1973, OSHA conducted silica sampling in the "can cleaning", "hot hole" and "swing frame grinder" areas of the Corhart plant and found levels in excess of the standard. Citations were issued and resulted in the implementation of engineering controls.

In May, 1976, NIOSH investigated Corhart (HHE request RHE 75-160-285)[1] for complaints very similar to the ones expressed on the current request. Results of environmental sampling and medical investigation indicated employees in the No-Bake Mold Dept. experienced "mild transient mucous membrane irritation due to fumes (probably formaldehyde) emanating from the silica sand". Although no chemical concentrations sampled for, (phenylpropyl pyridine, toluene, xylene, formaldehyde, benzene, and petroleum distillate) were found to be in excess of then current environmental evaluation criteria, suggestions to improve the general and local ventilation system were made. However, in August of 1976, OSHA conducted silica sampling in the "can cleaning", "hot hole", and "swing grinding" areas. No silica was found in the "swing grinding" area but silica levels in the "can cleaning" and "hot hole" operation were not in compliance.

In 1977, OSHA again conducted silica monitoring at Corhart to evaluate the performance of engineering controls installed in the "can cleaning" and "hot hole" areas, and found no silica upon laboratory analysis, therefore the case was closed.

Environmental monitoring was conducted by Corhart for analysis of phenol, formaldehyde, and methylene bisphenyl diisocyanate (MDI) in the new and old No-Bake area in 1978, 1979, and 1980. Reports showed that levels of all three contaminates were significantly below the Threshold Limit Values (TLV's). However, the monitoring consisted of 60 minute area samples rather than personal full-shift time weighted averages (TWA's). In addition, information concerning sampling locations, times, and methods, as well as process conditions was limited, and therefore not sufficient to properly characterize exposure.

NIOSH conducted a walk-through survey on September 2, 1981, distributed a report of that visit on September 11, 1981, and conducted an environmental and medical survey on October 26-28 of that year.

Corhart refractories had two plants at the site - East and West -- until 1975 when the East plant, which employed 250 workers, was shut down and approximately 120 workers were laid-off. Currently, there are about 130 workers in the West Plant.

During a one-day visit on September 2, 1981, an opening conference was held with representatives of labor and management, and a two-hour walk-through of the entire facility was undertaken to observe the various processes and materials in use. A substantial amount of time was spent in the No-Bake Mold Department which was one of the suspected problem areas. Various health-related reports including results of a Proportionate Mortality Study, a report on exposure to radioactive material, and results of pulmonary screening were made available by management.

A follow-up visit was made on October 26-28, 1981, to complete the evaluation by collecting environmental air samples and medical data on employees.

A. Process Description

Corhart Refractory produces refractory bricks which are used by the glass industry to line furnaces. Silica and alumina are melted down by two furnaces and poured into various sized sand molds where they harden, producing refractory bricks.

Environmental evaluation focused on the four areas of the plant where the No-Bake sand molds are formed; True Cast, VF, New No-Bake, and Old No-Bake, each containing one sand mixer. Mixers are conventional auger types except the one in new No-Bake which is a newer nonconvential enclosed mixer. Each requires one worker for operation. Dry sand at 90° F and binders, (phenol formaldehyde resin, methylene bisphenol diisocyanate catalyst, and a aromatic hydrocarbon solvent) are automatically fed into the mixers, and dropped into wooden forms for hardening. In the New and Old No-Bake area these forms are transfered to a rollover machine which removes the molds. Each rollover machine is operated by one employee. In the new and Old No-Bake, workers, called "mold toppers", manually fit each mold with a top or core and apply foundry paste to seal the mold. In the VF and true cast areas sand molds are manually removed from the forms and topped by the mixer operators and helpers. All newly formed molds are then loaded into metal containers called "cans" which are packed with loose sand for support and to slow refractory cooling after the pour. Cans are automatically moved by crane into the furnace area where molten silica is poured into the sand mold. The furnace operator is inside a climate control booth during the pour. Immediately after the pour, cans are moved by crane to the extra "hot hole" department of the furnace area where the pour funnels are manually removed. The cans are then transfered by crane to the "annealing building" where they are cooled for 4 days to 2 weeks. After cooling, cans are taken to a shake out area where hardened refractory is removed from the can and sent through the finishing department to be prepared for shipment.

B. Environmental Control

New and old "No-Bake" mixers and rollover machines are equipped with local exhaust ventilation hoods located on the side opposite the operator. Air is pulled through each hood by a 2 horse power fan with a rated capacity of 8000 cubic feet per minute (CFM) at 1/2 inch of static pressure. The true cast and VF areas relies on one general exhaust fan located in the ceiling of the VF area for air movement. The fan has a capacity rating of 6790 CFM at 0 static pressure. In the true cast area, a large door remains open to the outside allowing air flow through true cast into VF areas. There are five continuously operating 60" diameter exhaust fans in the ceiling above the extra hot hole department of the furnace area with a rated capacity of 33,000 SCFM at 0 static pressure. These fans effectively capture fumes escaping from the newly poured refractory while extra hot hole employees are removing the pour funnel before sending it to the "annealing building".

III. DESIGNS AND METHODS

A. Medical

1. Review of Records/Reports

(a) In response to the union request to investigate the concern about increased cancer rates, the management of Corhart engaged the University of Cincinnati to address this issue. Over the course of two years (1977 to 1979) three separate reports were generated.(2)

In summary, a slightly higher rate of cancer deaths than was expected was found; however, the investigator reported the increase was not statistically significant. Copies of all three reports were made available to NIOSH personnel during the site visit of September, 1981. No additional epidemiological studies of cancer were undertaken during this investigation.

(b) A separate report also issued by the University of Cincinnati under contract to Corhart Refractories evaluated potential exposure and protection of employees who worked with baddeleyite, a weakly radioactive zirconium oxide. The report concluded "there was no significant worker exposure to either uranium or thorium".(3)

(c) It was reported by the occupational health nurse that some health screening had previously been conducted at Corhart. In 1977, approximately 37% of employees x-rayed showed abnormal chest findings of an unspecified nature. Summary results from 1980 showed that 24% of employees tested had abnormal chest X-rays while 33% had abnormal pulmonary function tests. There was no association made between workplace exposures and these findings.

2. Questionnaire

To evaluate complaints of upper respiratory and mucous membrane irritation, a self-administered questionnaire was distributed to 31 workers from the No-Bake department. Information was obtained on occupational health history, present exposures, current health complaints, and medical history. The comparison (control group) was chosen from both the shipping department and clerical staff who had no known chemical exposure. The medical officer arranged to meet with the study participants in small groups to explain the purpose of the survey, elicit cooperation, and answer any questions. A total of 55 questionnaires was distributed for self-administration, and 51 were returned completed resulting in a return rate of 93%.

B. Environmental

Initial efforts were directed toward determining the chemical composition of the ingredients used in the sand molds and defining the exposed population of employees at the Cohart Refractory. This was done by reviewing material safety data sheets and correspondence with Cohart Refractory and their chemical supplier.

1. Formaldehyde

Six personal breathing zones and two area air samples were collected for formaldehyde on n-benzylethanolamine coated chromosorb 102 tubes with personal sampling pumps operating at 50 cubic centimeters of air per minute (cc/min). The samples were desorbed with 2 ml of iso-octane and analyzed by gas chromatography (GC) with a flame ionizater detector (FID) (NIOSH Method P & CAM 354).[4] This analysis is based on the reaction between formaldhyde and n-benzylethanolamine to produce benzyloxazolidine.

2. MDI

Seven personal breathing zone and two area air samples for MDI were collected on a glass fiber filter impregnated with n-p-nitrobenzl - n-propylamine with personal sampling pumps operating at 1.0 Lpm. The filters were desorbed in 1 ml of methanol and each resulting solution was filtered through a 0.5 um nylon filter prior to injection into a high pressure liquid chromatograph using an ultra-violet detector (NIOSH Method P & CAM 347 with minor modifications).[4] The analysis is based on the conversion of the isocyanate to its corresponding area derivative.

3. Phenol

Two personal breathing zone and three area air samples for phenol were collected for phenol using a midget impinger containing 15 ml of 0.1N sodium hydroxide, as an absorbing solution, with sampler pumps operating at 1.5 Lpm. The analysis was done using a gas chromatograph equipped with a FID (NIOSH Method S-330 with minor modifications).[4]

4. Aromatic Hydrocarbons

Six personal breathing zone air samples for C_8 - C_{11} aromatic hydrocarbons were collected on charcoal tube (CT) using sampling pumps operation 0.05 Lpm. Liquid bulk samples were provided by Cohart's chemical supplier to be used as analytical standards for quantitations. Samples were desorbed with 2 ml carbon disulfide, and analysis was performed using a gas chromatograph equipped with a FID (NIOSH Method P & CAM 127 with minor modifications).[4]

5. Unknown Organics

Two personal breathing zone air samples for possible unknown organics collected on CT's using sampling pumps operating at 0.2 Lpm were submitted to the lab for gas chromatography/ mass-spectroscopy (GC/MS) analysis. The first CT sample was desorbed with 2 ml of carbon disulfide for qualitative indentification of the major organics present. The second CT sample was desorbed the same way and major organics identified on the first CT were quantitated using GC with a FID.

6. Asbestos

A bulk sample of a fibrous material was collected and submitted to the lab for analysis using polarized light microscopy and dispersion staining techniques.[4]

7. Ventilation

Ventilation measurement were made on the local exhaust hoods in the New No-Bake area and in the doorways of the VF and True Cast areas using a Kurz air flow meter.

IV. EVALUATION CRITERIA AND HEALTH EFFECTS

Exposure criteria have been developed to evaluate a worker's exposure to toxic substances in an occupational setting. Based on available human and animal studies, and industrial experience, these values represent levels to which it is believed that nearly all workers may be exposed for an 8 hour day, 40 hour workweek, throughout a working lifetime without adverse affects. The exposure criteria sited in this report are NIOSH recommended standards, The American Conference of Governmental Hygienists ACGIH "Threshold Limit Values for Chemical Substances and Physical Agents in the Workplace Environment" (TLV's), and OSHA standards[5] (See Table 1).

A. Formaldehyde[6]

Exposure to formaldehyde may produce irritation of the mucous membranes, eyes, nose, throat and respiratory tract. Its odor is detectable at less than 1 ppm and at 4-5 ppm lachrymation and burning of the nose and throat occurs. At concentrations greater than 10 ppm, difficulty in breathing, intolerable burning of nose and throat and substernal discomfort occurs. These symptoms may persist for several hours after high exposures have terminated. Dermal sensitization to formaldehyde may occur following repeated, direct contact with the skin. Skin sensitization to formaldehyde vapor is rare. The current OSHA standard was intended to protect workers against irritant effects. Recently, studies by CIIT and NYU have shown that formaldehyde induces a rare form of nasal cancer in rats and mice. Based on these animal studies NIOSH currently considers formaldehyde as a potential carcinogen and recommends that occupational exposure be reduced to as low as feasible.[7]

B. Phenol[8]

With rare exceptions, human exposure, in industry, has been limited to contact of phenol with the skin and to inhalation of phenol vapors. Intermittent industrial exposure has been reported to result in marked irritation of the mucous membranes of the eyes, nose, and throat. Chronic phenol poisoning has been infrequently reported. The symptoms include nausea, vomiting, difficulty swallowing, diarrhea, anorexia, headache, vertigo, and possibly skin eruption. With severe intoxication, there may be extensive kidney and liver damage.

C. Methylene Bisphenyl Diisocyanate (MDI)[9]

Exposure to high concentrations of MDI may produce symptoms of irritation of the skin and the mucous membranes of the eyes, nose, throat, and respiratory tract, as well as a chemical pneumonia. In certain individuals, respiratory tract sensitization to low levels of MDI may occur so that exposure to very low concentrations may provoke a severe asthmatic reaction. Individual susceptibility to sensitization is variable but does not appear to be related to a history of allergy; however, sensitization may follow several episodes of severe irritation.

D. Asbestos[10,11]

Available studies provide conclusive evidence that exposure to asbestos fibers causes cancer and asbestosis in man.

NIOSH believes that the OSHA standard of 2.0 fibers per cubic centimeter of air (8 hour TWA) does not provide adequate protection against cancer for two reasons: (1) the OSHA standard of 2 fibers/cc was established in 1969 by the British Occupational Hygiene Society for the limited purpose of minimizing asbestosis; and (2) no scientific

data exist to date supporting any safe level of asbestos exposure. In view of the above, the standard should be set at the lowest level detectable by available analytical techniques. At present, this would be 100,000 fibers per cubic meter of air averaged over and 8-Hour day.

E. Trimethylbenzene[12]

Trimethylbenzene (TMB) is the only aromatic hydrocarbon contained within the C_8 - C_{11} hydrocarbon mixture sampled for during the survey for which criteria has been developed. The liquid solvent may cause primary skin irritation, and inhalation of vapor has caused central nervous system depression, producing symtoms of nervousness, tension, anxiety, and asthmatic bronchitis at vapor concentration ranging between 50 and 280 mg/m^3. Based on these reports, the American Conference of Governmental Industrial Hygienist recommend that exposures be kept below 120 mg/m^3.[13] Since only a small percentage of the hydrocarbon mixture exposure concentrations shown in Table 8 is Trimethyl benzene, criteria cannot be applied as a rigid "safe" exposure limit for the C_8-C_{11} mixture. However, since the other components of the mixture are similar to TMB in molecular weight and compound class, it is probable that they are similar toxicologically. Therefore, the TLV criteria can at least give some idea of the degree and type of hazard that potentially exists due to the C_8 - C_{11} aromatic hydrocarbon mixture exposures.

V. RESULTS

A. Medical

1. Questionnaires

A total of 55 questionnaires was distributed for self-administration and 51 were returned completed, a return rate of 93%. A comparison of demographic characteristics of the exposed and non-exposed (control) group revealed both groups were primarily white males of similar ages with negligable difference in proportion of smokers (Table 2).

Workers in the No-Bake area experienced significantly more symptoms of skin and mucous membrane irritation than the non-exposed employees working in the shipping and clerical departments (Table 3). The frequency of other reported health problems are shown in Table 4.

A much higher percentage of reported symptoms was perceived to be work-related by the No-Bake employees when compared to the non-exposed group (Table 5). Specifically, the highest associations were found between workplace and eye irritation, nose irritation, cough, sore throat, skin problems, headache, and dizziness. As far back as 1976, employees in the refractory were relating the same health complaints to the use of Pepset.

One method of controlling for adverse health effects from chemical exposure is use of personal protective equipment (PPE) at the worksite. When questioned about the use of PPE, the No-Bake workers indicated that they did indeed use the equipment and for most of them, on a regular or daily basis (Table 6).

2. Report Review

Chest X-ray data available from previously done (1977) screening tests on the workforce, when stratified by work area, age, and mean number of years at Corhart, revealed the "Warehouse, Quality Control, and Technicians" group have the greatest percentage of abnormal X-rays (56%) (Tables 7 and 8). Since this group also has the greatest number of years on the job, there is a suggested association between duration of exposure and resultant health effects. In contrast, the group with the second highest percentage of abnormal chest X-ray results (53%) is the youngest with the shortest duration of exposure suggesting that perhaps the past level of chemical exposure in the "Can" area was higher than in other plant locations.

In 1977, the University of Cincinnati was retained by the company to investigate union complaints of an excess number of cancer deaths - particularly from lung cancer - among the Corhart workforce. Since that time, three reports have been released which identified through a proportionate mortality study, slightly elevated proportions of all cancers and lung cancer. The researcher concluded that "there is insufficient evidence to indicate any possible association between workplace and any cause of death including lung cancer".[2]

B. Environmental

1. Formaldehyde

Results of the samples collected for formaldehyde, (see Table 9), show exposures ranged from non-detectable to 0.64 mg/m^3, which are all below the OSHA standard of 2.5 mg/m^3 TWA. However, levels as low as 0.1 mg/M^3 have been associated with eye irritation, [6] and NIOSH currently recommends that formaldehyde exposure be controlled to the lowest extent possible based on recent evidence of carcinogenicity.

2. MDI

MDI exposure levels ranged from undetectable to 0.0068 mg/m^3 (See Table 10). These levels are well below the NIOSH recommended standard of 0.05 mg/m^3 (TWA) and 0.20 mg/m^3 (20 minute ceiling) and the OSHA standard of 0.20 mg/m^3 (10-minute ceiling). However, if employees became sensitized to MDI, levels below the standard could cause a reaction.

3. Phenol

Phenol exposure levels ranged from undetectable 0.64 mg/m^3, which are substantially less than the NIOSH recommended standard of 20 mg/m^3 (See Table 11).

4. Aromatic Hydrocarbon

Aromatic hydrocarbon levels with a molecular weight in the C_8-C_{11} range from 7.9 to 160.4 mg/m^3 (See Table 12). The general trend of the sample ranges shows that new and old No-Bake operators and mold topper #2 received the highest exposure. The mold topper and the old No-Bake mixer operator exposure levels were in excess of the 120 mg/m^3 Trimethylbenzene (TMB) TLV. The difference in the hydrocarbon exposure levels measured on the two mold toppers would not be expected and can be attributed to the fact that the sampling apparatus was removed from the mold topper #1 for an unknown amount of time during the sampling period, and therefore, measured a falsely low exposure level.

5. Unknown Organics

GC/MS analysis of air samples for organics collected on two extra hot hole people working in the furnace area showed extremely low exposure levels. Major contaminants on the sample consisted of aromatic hydrocarbons with a molecular weight in the C_8 - C_{11} range. This would be expected, since C_8 - C_{11} aromatic hydrocarbon solvent comprise a substantial percentage of the chemical mixture used in the No-Bake binding process.

6. Asbestos

Analysis of the bulk sample of fibrous material showed no asbestos content (Although we were not able to identify any current exposure, this sample was taken since workers reported past exposure while employed at Corhart, but the actual purpose for its use at that time is not clear).

7. Ventilation

Ventilation measurements showed air flow through the door between the outside and the true cast area in a range of 200 to 300 feet per minute (FPM) and in the range of 150 to 200 FPM in the doorway between VF and true cast areas. This indicates that there is good general air movement through these areas which probably supplies ample fresh air to employees as long as the door remains open and the fan is operating properly. However the general fresh air supplied to the area may not always prevent over exposure to mixer operators who are working closely with off gassing sand in the absence of local exhaust ventilation. The

center face velocities local exhaust hood on the rollover machines and the mixers in the New and Old Bake areas were 500 FPM, and 1000 FPM on the mixer's hood. A slot velocity of 2000 fpm is recommended for side draft hoods in the ACGIH Industrial Ventilation manual. Therefore, capture velocities are probably not sufficient to prevent the escape of fumes and vapors into general room air.

8. Work Practices

Work practices were observed during the survey and two situations were noticed where minor changes could significantly alter employee exposures. They are: (1) manual removal of the sand mold from the form in the True Cast area; and (2) positioning of the New No-Bake mixer by the operator. Recommendations on how to alter these work practices were discussed in a closing conference with members of the union and management, were stated in a response letter dated September 11, 1981, and are included in a later section of this report.

VI. DISCUSSION/CONCLUSIONS

Mucous membrane irritation and skin problems were found to be significantly more prevalent in No-Bake workers than in non-exposed workers (See Table 10). All of these effects have been previously associated in the scientific literature with workplace exposure to several chemicals in use at Corhart, specifically phenol, MDI, and formaldehyde. Eye irritation has been associated with formaldehyde levels found at Corhart, while employee exposures to unknown levels of MDI in the past could have caused sensitization and therefore exposure levels lower than the present recommended standard could adversely affect previously sensitized employees.

Nose bleeds, which were originally reported to be a problem, were not a commonly reported symptom of the sample group. These findings verify the verbal information given by the company's Occupational Health Nurse.

To further explain the high percentage of chest X-ray abnormalities found among the younger members of the workforce, we reviewed the brick-making operation: During the process, each mold is fitted with a top and sealed and then sent to the "Can Area" where it is loaded into metal cans and packed with loose sand. We know that, in the past, a sand with a higher free silica content was used. OSHA surveys done prior to 1977 revealed that workers in several areas of the plant including the "Can", "hot hole", and "swing grind" areas were exposed to higher than recommended levels of silica dust. Since silica exposure has been associated with adverse pulmonary effects, it is feasible that the frequency of abnormal chest X-rays seen in this subgroup of workers reflects this particular exposure.[14]

Unfortunately, the type of abnormality found upon the X-rays was not specified in the available report; results were only summarized and therefore the percent of abnormal results representing silicosis is debatable. On the other hand, the company has altered the process, resulting in a reduced exposure to silica as evidenced in environmental reports issued by OSHA (1977).

Since the exposure situation has been improved and since the data on actual number of cases of silicosis is lacking, NIOSH is not able to make any further recommendations about this particular exposure at this time.

A majority of exposed workers reported that they use gloves and eye protection on a regular (daily) basis. Although this is an acceptable method of reducing skin and mucous membrane irritation, the use of personal protective equipment as a primary means of controlling chemical exposures is not encouraged by NIOSH. Substitution of a hazardous material, or control through engineering techniques, such as improvement of the existing ventilation system, is a preferred approach and is stated as such in the Recommendations section of this report.

Follow-up of the suspected excess of cancer among the Corhart employees does not seem to be indicated at this time due to lack of strong evidence associating the reported cancer rate for this population and workplace exposure. Likewise, review of previous reports indicates no serious hazard exists to employees at the refractory from exposure to baddeleyite.

In summary, data from previous investigations of this worker population have not demonstrated a significant health hazard to exist from exposure to baddelyite. Likewise, results of a proportionate mortality study failed to demonstrate an association between cancer deaths and workplace exposures. Therefore, the following recommendation are not directed at either of these two reported health concerns but rather are made to effectively reduce the current adverse health effects -- mucous membrane and skin irritations -- which we feel are significant and related to present-day chemical exposures

VII. RECOMMENDATIONS

1. Establishment of a health surveillance system (which would periodically evaluate the health status of the work force) emphasizing the respiratory system, skin, and mucous membranes. Determination of methods of surveillance and frequency of such should be made by the plant's occupational health nurse.

2. Encouragement from both union and management to employees to report any health problems which are suspected to be work-related. Regular collection and interpretation of this data would help identify any problem areas of the plants or developing work-related disease trends.

3. Discriminatory use of personal protective equipment -- impervious gloves to alleviate skin contact, and perhaps, eyewear and respirators to control adverse effects from fumes.

4. Environmental monitoring should be done routinely for formaldehyde, silica, MDI, and aromatic hydrocarbon by trained professionals, and the subsequent analysis done by an industrial hygiene certified lab.

5. Minor changes in specific work practices used by the true cast and the new No-Bake mixer operators would help to reduce exposures, for example:

   a. the true cast operator should have the sand mold on a platform when cleaning off rough edges. This would prevent the operator from leaning over the top of the off gasing sand mold and inhaling rising vapors.

   b. The new No-Bake mixer operator should keep the outside door closed in the area, because the air flow from the door interferes with the local exhaust hoods' collection efficiency. Since this door is usually opened when employees feel the need for fresh air, a general air intake fan should be installed in the area in a location where it would not interfere with local exhaust air flow.

   c. Appropriate changes should be implemented so that the new No-Bake mixer operator does not stand between the mixer and the local exhaust hood during time periods, when the mixer is not in operation.

Finally, management should maintain a continuing education program for employees on proper work practices, and continually study and work on changing work practices that would result in decreasing employee exposure levels.

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IX. DISTRIBUTION AND AVAILABILITY OF REPORT

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

Copies of this report have been sent to:

1. Corhart Refractory
2. President, United Steelworkers of America, Local 14084
3. OSHA, Region IV
4. NIOSH, Region IV

For the purposes of informing the approximately 130 affected employees, copies of the report shall be posted by the employer in a prominent place accessible to the employees, for a period of 30 calendar days.

TABLE 1

Evaluation Criteria for Chemical Exposure

SUBSTANCE	NIOSH RECOMMENDED STANDARD (mg/m^3)	OSHA STANDARD (mg/m^3)	ACGIH TLV's mg/m^3
Formaldehyde	*	2.5, 8-hour 4.2, 10-minute ceiling 8.3, peak	3.0, TWA
Methylene Diphenyl Diisocyante	0.05, 10-hour TWA 0.20, 20-minute ceiling	0.20, 10-minute ceiling	0.2, TWA
Phenol	20, 10-hour TWA 60, 15-minute celining	19, TWA. --	19, TWA 38, 15-minute ceiling
Total aromatic hydrocarbons**	--	--	
Trimethyl benzene	--	--	125, TWA
Asbestos	Below detectable limit of NIOSH Method P & CAM 239 0.1 fiber/cc, when specified sampling volumns are used	2.0 fiber/cc, TWA	--

TWA - weighted average level (8-hour unless otherwise listed).
fibers/cc - Fibers of asbestos per cubic centimeter of air.
mg/m^3 - milligram of contaminant per cubic meter of air.
peak - Limit never to be exceeded for any time period.
*NIOSH recommends that formaldehyde exposure be as low as feasible.
*There is not standard for an aromatic hydrocarbon mixture.

Table 2. Demographic Features of the Sample and Control Groups*

	Mean Age	White		Non-White		Smokers
		Male	Female	Male	Female	
SAMPLE (N = 24)	37.9	19	4	2	0	20 (74%)
CONTROL(N = 27)	37.0	12	9	2	0	15 (63%)

*(unknown: 1 sample, and 1 control)

Table 3. Symptoms of Statistical Significance

Symptom	x^2	P Value
Eye Irritation	12.75	.001(highly significant)
Nose " "	4.55	.05 (significant)
Sore/Dry Throat	5.66	.02 (significant)
Skin Problems	*	

* Fischers Exact Test used

Table 4. Number and Percent of Workers Reporting Symptoms

Symptoms	No-Bake Dept.		Shipping/Clerical	
Eye Irritation	15	(56%)	2	(8%)
Sore/Dry Throat	13	(48%)	4	(17%)
Nose Irritation	12	(44%)	4	(17%)
Skin Problems	8	(30%)	1	(4%)
Cough	6	(22%)	5	(21%)
Headache	5	(21%)	4	(17%)
Wheeze/S.O.B.	3	(11%)	2	(8%)
Chest Tight/Pain	3	(11%)	0	(0%)
Dizziness	2	(8%)	0	(0%)
Nausea/Vomiting	1	(4%)	0	(0%)

Table 5. Perceived Association between Workplace Exposure and Symptom

Symptom	Percent Thought to be Work-Related	
	No-Bake Dept.	Shipping/Clerical
Eye Irritation	87	0
Nose Irritation	75	25
Nose Bleeding	0	0
Cough	66	0
Sore/Dry Throat	69	50
Wheeze/S.O.B.	33	50
Nausea/Vomiting	100	0
Chest Tight/Pain	67	0
Skin Problems	63	0
Headaches	67	25
Dizziness	50	0

Table 6. Use of PPE by No-Bake Workers (N = 27)

Item	No. of Workers Using It	Used on Daily Basis
Gloves	21	13
Eye Protection	25	19
Respirator	4	1
Other	2 **	2

** safety shoes and hard hat.

Table 7. Overall Results of Screening Tests on Corhart employees, 1980

Test	Number Tested*	No.of Abnormal Results (%)
Chest X-Ray	260	62 (24%)
PFT	236	79 (33%)

*out of 314

Table 8. Chest X-Ray Results from 1977 on 314 Corhart Employees

Dept.	No. CXR	No.Abnormals (%)	Mean Age	Mean No. Yrs. at Plant
Development	9	1 (11)	46.3	21.4
Can	19	10 (53)	38.3	12.9
Maintenance	60	24 (40)	51.6	21.1
Finish/Ship	61	23 (37)	47.4	20.7
Warehouse, Q.C. & Techs	9	5 (56)	54.3	28.5
Yards & Gen Duty	25	9 (36)	46.6	21.4
Molds & Patterns	62	21 (34)	41.8	16.2
Personnel	8	4 (50)	45.2	17.4
Customer Svc.& Pdt.Planning	10	3 (30)	46.4	16.9
Engineering	10	3 (30)	48.0	16.6
Furnace	41	16 (39)	46.2	21.2

TABLE 9

Personal and Area Air Samples for Formaldehyde
Corhart Refractory
Louisville, Kentucky
HETA 81-411

PERSONAL SAMPLES

JOB/LOCATION	SAMPLE TIME	AIRBORNE FORMALDEHYDE CONCENTRATION (mg/m^3)
New no bake mixer operator	7:15 a - 2:50 p	0.29
Core blower	7:20 a - 2:43 p	ND
Old no bake mixer operator	7:15 a - 2:50 p	0.64
VF mixer operator	7:40 a - 2:20 p	0.3
New no bake rollover operator	10:00 a - 2:50 p	0.04
New no bake mixer operator	2:20 p - 2:55 p	ND
AREA SAMPLES TAKEN IN DUPLICATE		
New no bake beside mixer	2:12 p - 2:45 p	ND *
OSHA standard		2.5 TWA 4.2, 10-minute ceiling 8.3, peak
NIOSH recommended criteria		*

* - NIOSH recommends that formaldehyde exposure be as low as feasible
ND - Indicates that concentration was not detectable by current Analytical methods.
mg/m^3 - Milligrams of contaminant per cubic meter of air.
TWA - 8 hour time weighted average.
peak - Limit not to be exceeded for any length of time.

TABLE 10

Personal and Area Air Samples for Methylene Bisphenyl Diisocyanate(MDI)
Corhart Refractory
Louisville, Kentucky
HETA 81-411

PERSONAL SAMPLES

JOB/LOCATION	SAMPLE TIME	AIRBORNE MDI CONCENTRATION (mg/m^3)
New no bake mixer operator	7:15 a - 2:50 p	0.0047
Old no bake mixer operator	7:15 a -11:56 a	0.0068
Core blower/New No-Bake	7:20 a - 2:43 p	ND
New no bake rollover operator	7:30 a - 2:43 p	ND
VF mixer operator	7:40 a - 2:22 p	0.0017
Old no bake rollover operator	8:10 a - 2:50 p	ND
New no bake mixer operator	2:20 p - 2:37 p	0.029

AREA SAMPLES

On new no bake mixer	7:10 a - 2:15 p	0.011
Beside new no bake mixer	2:12 p - 2:30 p	ND

OSHA standard	0.2, 10-minute ceiling
NIOSH recommended standard	0.05, TWA
TWA - 8 hour time weighted average.	0.2, 20-minute ceiling

TABLE 11

Personal and Area Air Samples for Phenol
Corhart Refractory
Louisville, Kentucky
HETA 81-411

PERSONAL SAMPLES

JOB/LOCATION	SAMPLE TIME	AIRBORNE Phenol CONCENTRATION (mg/m^3)
True cast mixer operator	8:45 a - 2:28 p	0.40
Old no bake rollover operator	8:10 a - 2:15 p	ND

AREA SAMPLES

On old no bake mixer	8:25 a - 2:15 p	ND
On new no bake mixer	8:25 a - 2:15 p	0.64
On new no bake mixer	2:22 p - 2:38 p	ND
OSHA standard		19, TWA
NIOSH recommended standard		20, TWA 60, ceil

TWA - 8 hour time weighted average.
Ceil - 15 minute ceiling level

TABLE 12

Personal and Area Air Samples for C_8 through C_{11}
Aromatic Hydrocarbons
Corhart Refractory
Louisville, Kentucky
HETA 81-411

PERSONAL SAMPLES

JOB/LOCATION	SAMPLE TIME	*HYDROCARBON CONCENTRATION (mg/m^3)
VF mixer operator	7:40 a - 8:40 a	50.0
New no bake mixer operator	7:15 a - 2:50 p	92.2
Old no bake mixer operator	7:15 a - 2:50 p	125.0
Core blower	7:20 a - 2:43 p	7.9
Mold topper #1	7:25 a - 2:50 p**	14.4**
Mold topper #2	7:25 a - 2:50 p	160.4
ACGIH, TLV		none ***
OSHA standard		none
NIOSH recommended standard		

* A pure bulk of the aromatic hydrocarbon solvent contained in the mixture of chemicals used to bond the sand molds together in the no bake process was provided by Corharts chemical supplier for use as a standard in quanitation of the air sample analysis.

** See page
*** As discussed in the criteria section of this report, the only component of the hydrocarbon mixture levels shown in this table for which criteria has been developed for is Trimethyl benzene (TMB). The ACGIH TLV for TMB is 120 mg/m^3 for an 8-Hour time weighted average.

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