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 HE 77-98-587

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DU CO CERAMICS COMPANY
SAXONBURG, PENNSYLVANIA

APRIL 1979

I. TOXICITY DETERMINATION

The National Institute for Occupational Safety and Health conducted a combined environmental-medical evaluation September 1977 and March 1978 at Du Co Ceramics Company, Saxonburg, Pennsylvania. The following determinations are based upon environmental sampling, medical evaluations, observations of work practices, existing and/or proposed engineering controls, and a review of the pertinent literature.

Personal samples were collected for both work shifts to determine the airborne concentrations of free crystalline silica, total respirable dust, and asbestiform fibers (present in some of the talcs used at Du Co Ceramics). The effects of exposure to these contaminants were evaluated by administering: health questionnaires (i.e., occupational history, past medical history, smoking history, and respiratory questionnaires); physical examinations (with emphasis on the respiratory and cardiovascular systems); pulmonary function tests; and chest x-ray examinations.

During the survey periods investigated, a number of exposures to crystalline silica and total respirable dust were found to exceed the criteria set for this investigation. Also, three of the personal samples for asbestos fibers exceeded the current criteria of 0.1 fibers per cc recommended by NIOSH. All but one of these samples exceeded the current OSHA policy requiring medical examinations when employee exposures exceeded 0.1 fibers per cc. Consequently, due to the numerous respirators which were not functioning effectively control of worker exposure to both silica and asbestos contaminants should be a paramount concern.

The clinical examination results have not revealed severe adverse health effects to date. The overall prevalence (i.e., the percentage of the population studied in comparison to the national average) for obstructive ventilatory dysfunction in smokers was high which was to be expected. However, the presence of such abnormalities in those non-smokers in this population suggests that this is an effect of dust exposure. The prevalence for chronic bronchitis, and restrictive pulmonary dysfunction was low. Also, the prevalence of radiologic abnormalities detected on chest x-rays were low; it was nevertheless, higher in employees with longer duration since onset of exposure (i.e., exposure from the initial date the employee began working at an occupation where dust was or is presently a problem). This may indicate that exposure in the past could have been more hazardous, and that the need for appropriate medical surveillance should be implemented and/or maintained for early diagnosis of possible radiologic abnormalities.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, 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. 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:

a) Du Co Ceramics Company, Saxonburg, Pennsylvania
b) Authorized Representative of Local 8042, United Steelworkers of America
c) United Steelworkers of America, Pittsburgh, Pennsylvania
d) U.S. Department of Labor, Region III
e) NIOSH, Region III

For the purpose of informing the approximately 250 "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 in the place of employment might have potentially toxic effects as it is used or may be found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative of Local 8042, United Steelworkers of America, regarding exposures to workers to free crystalline silica, asbestos, and total respirable dust.

An interim SHEFS 1 Report, dated October 13, 1977, was distributed to representatives of both management and labor. Discussed in the report were the observations and preliminary findings of the NIOSH investigators during the environmental survey of September 8, 1977; recommendations to help improve the health and safety conditions in the employees' work environment were also included.

IV. HEALTH HAZARD EVALUATION

A. Process Description - Conditions of Use

Du Co Ceramics Company is involved in the production of various types of ceramic parts which are used in the manufacturing of electronic equipment, e.g., calculators, computors, heaters, capacitors, etc. In general, the production of these ceramic parts begins by first preparing raw materials via bulk scaling methods. Once the required amount of material has been prepared the batch is then mixed, milled, extruded or pressed into a required size or shape, and finally, cut and/or machined into the final product. The product is then glazed, kiln fired, and eventually prepared for shipping. (Refer to Figure 1 for specific material flow diagram.)

The environmental portion of this investigation centered primarily on: (1) Mixing/Ball Mill and Spray Dry departments, which employ eight people; (2) Cutting and Sagger Filling departments, which employ an average of 20 people; and (3) the Machining department, which employs approximately 30 people. Du Co Ceramics also employs an additional 25 active employees, i.e., foreman, office, lab, and administrative personnel. The majority of the remaining 250 employees work in the different departments illustrated in Figure 1. A description of the operations relative to each of the departments surveyed and the associated potential health and safety problems in those departments are discussed in the remainder of this section. Part VI of this report offers suggested industrial hygiene practices which can help minimize exposures to the contaminants that were found in those operations evaluated at Du Co Ceramics.

1. Mixing/Ball Mill and Spray Dry Departments

The Mixing/Ball Mill and Spray Dry Departments operate one shift per day and each of the employees working in these areas is responsible for performing approximately the same duties each day. Each of these departments is concerned with the initial phase of the ceramics operation, i.e., preparing the raw materials for the Pressing or Extrusion processes. Basically, all of the mixing operations begin by weighing raw materials, e.g., talcs, ball clays, kalons, etc., and then blending and/or milling the batch. If the material being prepared is for the extrusion operation, water and corn flower will be added to the batch to assure binding and maintainability during the extrusion process. In the granule operation, wax is added to the mix to assure binding and consistency of the granules. The following is a more specific description of each of the operations evaluated during the survey periods and the health and safety problems associated with those processes.

a. Mixing Department

There were three primary operations evaluated in the Mixing department, among these were the Batch Scale weighing process; Granule mixer and associated processes, and the Extrusion mixer process.

(1) Batch Scale Process: The weighing operator first receives bags of materials from raw material storage and it is his job to fill 1000 pound bins with ingredients for specific batches, i.e., the type and quantity of material used for the particular recipe. A fork lift is used to position the 1000 pound bin on top of a weighing scale which is housed in a partially enclosed hopper. An open grill workshelf compartment (positioned under a 2 x 2 1/2 foot exhaust hood) is mounted on top of the hopper. The operator loads the bags of material, from either side of the hopper, and places these into the compartment; cuts the bags open and the material drops into the bin. The operator then shakes the bags to remove any excess material, removes the bags from the compartment, and then throws the bags into a disposal bin. Finally, in order to get the exact amount for each of the ingredients used in the batch, the operator uses a shovel to transfer small quantities of the different ingredients and dumps these into the bin.

The hood described above was the only exhaust ventilation system used for this process and the flow rates obtained at the face of the loading compartment ranged between 200-250 feet per minute (fpm). A "Sly Dust" collection system, located approximately 30 feet from the weighing station, is used to power and clean the exhaust system. Once the sly dust collector filters the air it is then exhausted directly into the work environment. This system of air filtration was used throughout the Mixing/Ball Mill and Spray Dry departments and it was noted that directly above each of these exhaust stakes was a large accumulation of dust embedded on the ceiling.

The following are the specific problems that were noted during the review of this phase of the mixing operation: (1) The procedure of shaking out the bags and throwing them into a disposal bin contributed to an excessive amount of dust in and around the operator breathing zone; (2) The present means of exhausting within the building, via the sly dust collector, projects fine dust particles throughout this area, as well as agitating and projecting dust that has accumulated on the tops of the equipment, storage bins, and rafters; (3) The exhaust hood was damaged just above the hopper and this reduces the overall efficiency of the exhaust ventilation system; (4) A continual source of dust was seen to escape from the access area of the hopper, i.e., where the bins are positioned into and taken out of the hopper; (5) The respirator worn by the operator had an accumulation of dust inside the respirator. Inspection of the respirator pointed out the need for new head straps and intake and exhaust valves; and (6) It was noted that the weighing operator had a large amount of dust on his face, hands, and clothing.

(2) Granule and Extrusion Mixing Processes: Once the ingredients for a batch have been weighed, the next phase of the mixing process is to charge the mixer. This begins when the fork lift operator removes the bin from the hopper and transfers the batch of material to a skip hoist elevator (either the granule elevator or the extrusion elevator). The elevator carries the bin up to the top of the mixer where it is automatically dumped into the mixer's interior.

There are normally 2-3 operators who work in the mixing platform and it is their responsibility to operate and maintain the granule and extrusion mixers, as well as the other equipment on the mixing platform. The actual mixing process (either granule or extrusion) is performed in completely enclosed "Simpson" mixers. Each is equipped with an internal exhaust system which filters the air through a sly dust collector. Except for the extrusion mixer which will be discussed at the end of this section, all the equipment used on this platform is designed to prepare the material for the granule operation. After the granule batch has been thoroughly mixed and blended it is then automatically placed on a skip bucket which transfers the batch into a surge bin. The surge bin feeds the material, via a screw feeder, into a high speed "Hammermill" which is the first stage of micropulverizing the material into granules. The granules are then discharged onto a conveyor belt where they are eventually dumped onto a heat screen. Finally, from the heat screen the granules go onto another conveyor belt which carries the material through a "Jensen Dryer". The dryer removes any excess moisture in the granules and eventually separates the granules into one of three sizing bins. The Jensen Dryer system is equipped with an internal exhaust system which removed, via a sly dust collector, the dust created by this shaking and drying process.

The Extrusion mixing process uses basically the same procedures for mixing as that described for the granule mixing process, i.e., in terms of the techniques used for charging the mixer, cleaning the mixers interior, etc. However, unlike the granule mixing operation, once the batch has been mixed and blended it is then loaded back into the bins and transferred to the next phase of the extrusion process.

The following are the health and safety problems that were noted during the review of this phase of the mixing operation: (1) An excessive amount of dust is created when the skip hoist elevators (granule and extrusion) dumps the material into the mixers. At present there is no exhaust system to collect this dust at these points. This problems also exists when the skip bucket, used in the granule process, transfers the blended material from the mixer and dumps it into the surge bin. Also, the back plate on the surge bin had been removed and dust was seen to continually escape from this area; (2) Prior to preparing each new batch in a mixer the operator removes any excess material left on the mixing blades and the inside chamber walls. During this time the operator exposes himself to a tremendous amount of dust, especially when he reaches inside the dusty chamber to determine if he has effectively scraped off the built-up material from the previous batch; (3) Again, this operator, as well as the other operators on this platform, had an excessive amount of dust inside their respirators and their exhaust valves needed replacement; (4) Another source of continual dust was seen coming from the hammermill, the heat screen area, and from the conveyor belts, i.e., when the conveyor belts make their return the remaining material falls to the floor; (5) Other major sources of dust are at those points where the granules are being collected, i.e., after discharge from the Jensen dryer and at those points along the granule process where over spill occurs. At present, these collection devices do not have covers, lack appropriate chutes for transferring over spill materials into collection devices, and the collection containers were often seen to be overflowing; and (6) The problems mentioned earlier with the sly dust collection system, i.e., exhausting into the work environment, were also present with the dust collection system used here.

b. Ball Mill and Spray Dry Departments

There were a number of different operations evaluated in the Ball Mill and Spray Dry department, among these were the: "Munson" blender process; "Eirich" weighing and mixing operations; "Lancaster" weighing and mixing processes; and the "Ball Mill" processes (both wet and dry).

(1) Munson Blender: This process is a small operation which is used primarily for preparing materials for use in the extrusion process. The operation is performed by one person and it is his responsibility to charge the blender and maintain the equipment. The materials are first prepared in 1000 pound bins in the mixing departments batch scale operation. Once the ingredients are weighed the batch is transferred to the Munson blender, via fork lift, and loaded onto a skip bucket. The bucket elevates the material to the top of the blender and automatically dumps the load into the interior of the blender. Upon completion of the blending phase the batch is then fed back into a receiving bin which is directly adjacent to the blender. The bin is positioned inside a three sided loading compartment which has a feed chute attached to the roof. A ventilation hood, approximately 6 x 36 inches, is located two-thirds of the way up the back wall of the loading compartment and a flow rate of 125-175 fpm was measured for this exhaust system. It was noted during the review of this operation, that once the bin is inside the compartment, the exhaust hood is positioned approximately six inches below the top of the bin. This arrangement literally blocks the hood and reduces the face velocity (i.e., that area between the top of the bin and the opening of the loading compartment) to between 10-15 fpm.

The problems associated with this operation are as follows: (1) No ventilation is provided at the top of the elevator (skip bucket) and thus, while the bucket is dumping into the blender a large quantity of dust billows into the work area; (2) The present location of the ventilation hood in the loading compartment is inadequate for collecting the dust generated from this filling operation; and (3) The operator was provided a respirator, however, he did not always wear the respirator during the time he spent at this job.

(2) Eirich Weighing and Mixing Processes: The batch weighing and mixing operation for the Eirich process is performed by one operator. In the weighing process the operator takes 50 and 100 pound bags of various ingredients, tears the bags open, and dumps the materials into a 600 pound bin. The bin is positioned inside an elevator (skip hoist) during the weighing operation, and again, once the bags are emptied the operator shakes them to remove any excess. In order to assure that the exact proportions of each of the ingredients are in the batch, the operator transfers small portions of each from open bags and dumps these into the bin. After the batch is weighed it is then transferred up to the top of the mixer and automatically dumped into the mixers interior. Once the mixing phase is complete the contents are dumped into a 55 gallon drum and sent to the extrusion department. A final step in the mixing process requires the operator to clean the interior of the mixer before loading the next batch.

The only exhaust ventilation provided at this site was one six inch diameter exhaust duct which was positioned on the right side of the elevator shaft. The exhaust duct was located just above the loading bin and during the survey period this system was not operating.

The health and safety problems associated with the Eirich processes are as follows: (1) Shaking out the emptied bags increases the dust exposure to the operator; (2) Due to the amount of dust created during the weighing process, as well as the lack of proper exhaust ventilation, a means to reduce this exposure should be developed; (3) Again, once the elevator dumps the load into the mixers interior, dust billows into the atmosphere, and therefore, a means to reduce this dust problem should be designed here; (4) When the operator cleans the mixer he is exposed to an excessive amount of dust, especially when he inspects the interior; (5) The operator's respirator had faulty exhaust valves which increased the exposure to this person; and (6) An excessive amount of dust was present on the operators hands and clothing.

(3) Lancaster Weighing and Mixing Processes: This operation is performed by one person who is responsible for weighing the specific ingredients for a batch and loading this into the interior of the mixer. However, unlike the other mixing operations, the Lancaster mixer does not have an elevator to hoist the bags of material up and into the mixers interior. Presently, the bags are elevated on pallets up to the top of the platform by a fork lift. The operator then measures the proper quantities required for the batch and dumps the ingredients into the interior of the mixer by hand.

The health problems associated with this operation are as follows: (1) When the operator tears the bags and empties these into the mixer a significant quantity of dust is produced from this process; (2) No exhaust ventilation was provided at the point where the operator dumps the material into the mixer; (3) The respirator worn by the operator was loose fitting and the inhalation and exhaust valves needed to be replaced; and (4) A large quantity of dust was noted to be on the operators hands and clothing.

(4) Wet and Dry Ball Mills: There is one Wet Ball Mill and two Dry Ball Mills in this area. The work carried out here is performed primarily by one operator and it is his job to maintain the overall workings of these processes. The only ventilation used here was on the larger of the two dry ball mill machines which was fitted with an internal exhaust ventilation duct.

The problems associated with these operations were minimal, however, it was noted that the exhaust ventilation duct leading into the mill was damaged which can reduce the overall efficiency of this system. Also, the waste container which collects the dust from the bag house on this platform did not have a cover over the container and this contributes to the dust in and around this area.

2. Cutting and Sagger Filling Department

This department operates two shifts per day and each of the employees who work here is responsible for performing any one of a number of duties during the work shift. Basically, once the material has been extruded into long tubes, the next step of the operation is to cut this material into given lengths and prepare them for further machining and/or kiln firing. The cutting phase of the material (stock) is performed by either one of two "Barrel Cutting" machines (Old or New) or by one of the two "Belt Cutting" machines (Old or New). The old cutters are three horsepower (hp) driven machines which are used to cut small diameter stock and the new cutters are five hp which are used to cut the larger diameter stock. The sagger filling phase of this operation is primarily concerned with preparing the cut tubes for kiln firing or further machining. The following is a basic description of these processes and the problems that were noted during the investigation.

a. Belt Cutting

The belt cutting operation (either old or new) consists of one person loading and aligning the stock onto a receiving table which then feeds the stock into an automatic barrel cutter apparatus. Once the stock has been cut into smaller tubes they fall onto a conveyor belt where they are then placed in trays by any one of a number of operators who work along the conveyor. The trays, approximately 10x12x2 inches, have a mesh screen bottom which allows for easy cleaning of the tubes once the appropriate number has been packed into the tray. A cleaning (blow-off) process is performed at the end of the conveyor belt on either side of a specially designed down draft exhaust hood (approximately 12x24 inches). This allows the trays to sit directly on top of the hood while they are being cleaned off via the high pressure air hose. The final phase of this process is the removal of these tubes from the cleaning trays and placing these in "Saggers" to be transferred to the machining department for further precision machining.

The health and safety problems associated with this portion of the operation are as follows: (1) The existing canopy exhaust hood (approximately 3x5 feet) over the conveyor belts are presently operating at a face velocity of 850-900 fpm which is sufficient. However, the distance between the hood and the conveyor belt is approximately four feet which results in a decrease flow rate of 25-50 fpm at the source (i.e., at the point where the operator performs the job); (2) The conveyor belts do not have a means of properly removing and/or exhausting the ceramic dust which accumulates on the top of the conveyor belts. At present, this material falls approximately 4 feet into a cardboard box positioned on the floor at the end of the conveyor; (3) The job of blowing off the tubes in the specially designed down draft exhaust hood is not acceptable, i.e., when using the air nozzle dust particles are being dispersed into the operator's breathing zone and into adjacent work areas; (4) During the blow-off process protective goggles were not worn by the operator; and (5) The majority of respirators worn by those persons working in the belt cutting section were improperly fitted and needed maintenance, e.g., intake and exhaust valves, filters, straps, etc.

b. Barrel Cutting

The barrel cutting process (either old or new) is performed by one person who feeds and aligns the long stock onto the cutting drum. The material is automatically cut into specific lengths and then dropped into a large cardboard tote box. The cut tubes are then transferred to one of six cleaning blow-off booths where they are then dumped into a tray similar to that described above. The actual cleaning process requires the operator to blow-off the tubes with a high pressure air hose for approximately 3-5 minutes. Each booth stands about 3 feet off the floor, and is approximately 4 feet wide by 3 feet deep and has a ceiling height of 3 feet. A down draft exhaust hood (20x16 inches) is positioned in the middle of the interior table which allows the trays to sit directly on top of the hood during the cleaning process. Also, an additional exhaust hood (3x20 inches) is positioned directly above the down draft hood. These hoods can be regulated by a blast gate system which enables the two exhaust hoods to operate together or independently. At the time of this survey the exhaust systems were operating at a face velocity of approximately 180-200 fpm and 1200-1250 fpm, respectively.

There were no health problems noted in the barrel cutting process itself, however, the following problems were noted when the operator blows-off the tubes in the cleaning booths; (1) Dust particles are being dispersed into the operator's breathing zone, as well as the adjacent work areas; (2) The noise levels produced by this process are presently exceeding the existing noise criteria, and this require engineering controls to remedy this problem; (3) The operators were not knowledgeable of how the blast gate system operated, i.e., in terms of the most optimum position for exhausting the dust during the blow-off process; (4) Goggles were not worn during this blow-off process; and (5) The respirators worn by the operators were improperly fitted.

c. Sagger Filling

Once the tubes from the barrel cutting process have been cleaned they are placed back into the cardboard tote box. From here they are taken to the sagger filling area where their packed into saggers by one of the two operators working in this area.

There are no direct occupational health problems associated with this phase of the process. However, if either employee working in this section is required to use the blow-off booth they should be made aware of the most effective means of operating the ventilation system, as well as using the proper protective equipment, e.g., respirators, goggles, etc.

3. Machining Department

The Machining department operates two shifts per day and the employees working in this department change their work shift weekly, i.e., one week they work the day shift and the next week the evening shift. The materials machined here normally come from either the sagger/filling or press department. After the materials are received they are distributed to any one of the forty different work stations for further processing. There are two main processing lines and each accommodates 6-8 machines on each side of a line. The following are examples of some of the different types of machines used in this department: "Rouse Miller - cutting machines; "Dunmore" - abrasive grinding wheel; Form grinder; Swing saw; Vertical grover; Horizontal drill press; Topper; Lathe; "Royal Master" - threading machine; and a Clipping machine. Once the parts have been machined they are then vibrated (dry or wet), tumbled to a specified radius. Upon completion of this phase of the process they are sent to be media fired or back to the sagger/filling department for further processing.

All of the machines in this department except for the tumblers, are equipped with either a hood type or elephant trunk-type exhuast. Air flow measurements were obtained from both systems and for those machines along the north side of the wall the values ranged from 450-500 fpm. These levels were more than sufficient for the work being performed along this line, however, the flow rates obtained for similar machines located on the line in the center of the department, e.g., Dunmore and Rouse Miller, ranged between 50-75 fpm, which is insufficient. These reduced flow rates may be due to any one of the following: improper hood enclosure design; the distance between the source of particle generation and the exhaust hood; blockage at either the branch and/or main ducts; improper use of dampers; or the entire exhaust system for this work line was improperly designed, e.g., fan size, duct size, type of hood, etc. Also, it was noted that the Rousch Miller machines were equipped with an air jet dispersion system which is designed to remove excess dust from the ceramic parts after they have been machined. This arrangement as it is presently designed can produce a number of problems and these are discussed in the following paragraph.

The health and safety problems associated with the operations described above are as follows: (1) The local exhaust systems on each of the machines located in the center of this department are presently not adequate for the type of work being performed there; (2) The air jet dispersion system is not acceptable for two reasons; first, the present system causes particles to be dispersed into the operator's breathing zone and adjacent work areas, and secondly, it disrupts the air flow created by the exhaust ventilation system and thus reduces the collection efficiency of the hood; (3) Many of the operators were not using eye protection when using the machines; (4) In the majority of cases, respirators were improperly fitted, required maintenance, as well as restrictive for those persons who wore glasses; and (5) The vibrator tumblers are a constant irritation to the workers in this department, i.e., all the employees complained about the agitation/vibration they experienced at their work stations when these machines were operating.

B. Evaluation Progress and Study Design

1. Initial Survey - September 8-9, 1977

Personal and area samples were obtained to evaluate worker exposure to asbestos, silica, and respirable particulates. Bulk samples of the various ingredients used in the ceramics operation were obtained in order to determine the different types of asbestos and silica present in the work environment.

Preliminary medical screening was undertaken to evaluate the worker population at Du Co Ceramics. Emphasis was placed on that portion of the work population considered to be at higher risk. Also, it was confirmed that no medical surveillance had been in effect (i.e., no chest x-ray films and pulmonary functions tests had been performed, except for pre-employment examinations).

2. Followup Evaluation - March 14-17, 1978

Personal samples were taken throughout the Mixing/Ball Mill and Spray departments, the Cutting and Sagger Filling department, and the Machining department in order to fully characterize and assess the different work related exposures in these areas. A complete medical evaluation relating to the various contaminants of concern at Du Co was performed on the majority of the worker population.

C. Methods of Evaluation

1. Environmental Methodology

Individual workers' exposure to asbestos, silica, and respirable particulates were measured using the state of the art personal sampling techniques. The workers wore a personal sampling appartus consisting of a battery-powered pump and some type of filter collection device (placed at the breathing zone) which would be appropriate for the particular air contaminant being measured. The methods for collection and analyses for these substances are discussed below.

a. Asbestos

Airborne samples of asbestos were collected on 37 mm diameter 0.8 micrometer (um) pore size membrane filter mounted in an open face cassette. The sampling flow rate was set at 2.0 liters per minute (lpm) and the sampling period lasted a total of 2 hours and 10 minutes. The samples were analyzed by first clearing the membrane filter to make optically transparent followed by fiber counts at 400 to 500x magnification by phase contrast optical microscopy. Asbestos fibers are defined as those particles with a length greater than (>) 5 um and a length-to-diameter ratio of 3 to 1 or greater. This technique, by which only fibers longer than 5 um are counted, is recognized as only an index of total fiber exposure and does not imply that shorter fibers do not pose a health hazard.

b. Crystalline Silica

Airborne samples for respirable silica were taken with pumps using 10 mm cyclones at a sampling rate of 1.7 lpm. Total silica (total particulate) samples were taken with a pump and sampled at 1.5 lpm. All samples were collected on FWSB filters and analyzed for quartz and cristobolite via x-ray diffraction.

c. Respirable Particulate

The respirable dust measurements were presumed to consist primarily of the various ingredients used in the ceramic operations. The respirable dust concentrations were measured by drawing air at a flow rate of 1.7 lpm through a size-selective device. The device consisted of a 10 mm nylon cyclone which is designed to remove the non-respirable fraction of the total dust prior to collection of the respirable portion on the pre-weighed vinyl membrane filter. The filters are then subjected to gravimetric analyses as described for total dust. Total milligrams of crystalline silica is defined to include all crystalline forms of silica such as quartz, cristobolite, and tridymite.

2. Medical Methodology

The health hazards of concern at Du Co Ceramics are fibrogenic dust-talc, silica, and asbestiform fibers, as well as nuisance dust particulates. Adverse health effects of these inorganic particles are well known and specific. It is generally accepted that exposure to inorganic fibrogenic dust would result in detectable radiologic abnormalities after a period of time. This normally occurs in the order of years; the latency is shorter with higher exposure and longer with lower exposure.

Active workers and retirees or workers who had moved to other employment after working for at least 5 years at Du Co were requested to participate in the examination. An additional 11 employees with less than 5 years of employment, who were considered to be at risk, were also invited to participate in the examination. The definition of those persons at risk (low vs. high) is further defined in section D "Evaluation Criteria-Medical". A total of 198 employees and past employees fulfilled the above mentioned criteria and were sent invitation letters explaining the purpose and scope of the examination. The medical examination included: (1) A complete occupational history; (2) Past medical history; (3) Smoking history; (4) Respiratory questionnaire for chronic bronchitis (MRC); (5) Physical examination with special attention for the respiratory and cardiovascular system; (6) Pulmonary function tests (spirometry and flow-volume curves); and (7) Chest x-ray films.

For the questionnaire and medical examination a special examination form, precoded for computer handling of data, was used (See Attachment I). Chest x-ray films (PA) were read according to the ILO/UC International Classification for pneumoconiosis, by three independent readers; a consensus reading was recorded on a special precoded form.

The pulmonary function tests results were compared to predicted values (Morris, 1971) for males and females. The criteria for abnormalities were: Restrictive ventilatory dysfunction (Forced vital capacity (FVC) < 79% of predicted); Obstructive ventilatory dysfunction (Forced expiratory volume (FEV) per second <79% of predicted) and Forced expiratory flow $(FEF)_{25-75}$ <74.5%.

A total of 150 employees and retirees or workers who had left the Du Co Ceramics plant (after 5 years of employment) were examined. This accounted for 76 percent of the total population at Du Co Ceramics.

D. Evaluation Criteria

1. Environmental Criteria

There are several criteria used to evaluate the potential toxicity of air contaminants of an employee's work environment: (1) NIOSH Criteria Documents for Recommended Occupational Health Standards; (2) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's); and (3) Federal Occupational Health Standards promulgated by the U.S. Department of Labor. These criteria are based upon the current state of knowledge concerning toxicity of these substances.

The values for each contaminant are designed to allow an occupational exposure for an 8-hour work day up to a 10-hour work day, 40-hour work week. The Time Weighted Average (TWA) is that value given an employee over a normal lifetime, without the worker experiencing undue discomfort. In some instances, a few employees may experience discomfort at or below the criteria. There are some airborne contaminants for which this TWA is inappropriate, consequently, a Ceiling Value for interval of 15 minutes or less is given. This ceiling concentration should never be exceeded.

The present health criteria has been tabulated below.

Substance	Evaluation Criteria 8-hour Time Weighted Average (TLV-TWA) mg/M3)*	Ceiling Value
Silica		
Free Silica (respirable)[1]	.05	
Quartz (Total Dust)[2]	$\frac{30\ mg/M^3}{\%\ quartz + 2}$	
Respirable Nuisance Particulates	5	
Asbestos (Includes Talc-fibrous)[3]	0.1 fibers/cc**	0.5 fibers/cc

*mg/M^3 = appropriate milligrams of substance per cubic meter of air.

**fibers/cc = fibers per cubic centimeter of air.

1. NIOSH Criteria Document (1974). The OSHA Standard for respirable silica is calculated by dividing 10 mg/M^3 by the % quartz +2.

2. ACGIH TLV Document (1978). The OSHA Standard for respirable dust is 5 mg/M^3.

3. NIOSH recommends the following criteria for occupational exposure to airborne asbestos fibers. This also includes fibrous Talc. No employee may be exposed to an 8-hour time-weighted average airborne concentration of asbestos fibers in excess of 100,000 fibers greater than 5 micrometers (um) in length per cubic meter (or 0.1 fiber >5 um/cc) of air, as determined on the basis of a 40-hour work week. No employee may be exposed to airborne concentrations of asbestos fibers in excess of 500,000 fibers greater than 5 micrometers in length per cubic meter (or 0.5 fibers >5 um/cc) of air, as determined over a period up to 15 minutes. Also, it is current OSHA policy to require medical examinations when employee exposures exceed 0.1 fibers >5 um/cc. The NIOSH recommended standard is intended to; first, "protect against the non-carcinogenic effects of asbestos; and secondly, materially reduce the risk of asbestos-induced cancer (only a ban can assure protection against carcinogenic effects of asbestos)".

2. Medical Criteria

The medical criteria used to determine a toxic response to the substance under investigation consist of symptoms and signs which each agent produces when a toxic exposure occurs. A review of the known toxicological effects of the substances follows.

Exposure to inorganic particles such as the fibrogenic dusts silica, asbestos and talc, results in the slowly progressive development of pulmonary (parenchymal) fibrosis. In the case of silica exposure, a specific type of nodular fibrosis is characteristic; the silicotic nodules reach a point (after their size and number increases) when they become visible on chest x-ray films. The specific radiologic abnormalities detected after significant silica exposure are the small rounded opacities (corresponding to the silicotic nodules). These may vary in size, with diameters ranging from 1 to 10 mm; their profusion (number per surface unit) may also vary. In early silicosis the nodules are scarce; in the advanced forms of the disease numerous nodules per surface unit are found.

The nodular pulmonary fibrosis of silicosis may result in symptoms such as shortness of breath, cough, chest pain. The pulmonary function tests are not affected in a specific manner until the more advanced stages of the disease; because the bronchial mucosa is also affected by silica dust obstructive ventilatory dysfunction may result.

Asbestiform fibers and talc also induce fibrotic changes in the lung; the fibrosis associated with these materials is of the interstitial type. The characteristic radiologic changes are the small linear irregular opacities. These can vary in size and profusion. Asbestiform fibers and talc may also affect the pleura and pleural fibrosis (thickening) and/or pleural calcifications may appear on the chest x-ray.

The pulmonary function tests may be abnormal: restrictive pulmonary dysfunction (lower than normal forced vital capacity) is quite characteristic in cases with pronounced interstitial fibrosis; obstructive dysfunction may also be found and is thought to reflect the direct effect of the dust particles on the bronchial tree. Pulmonary fibrosis secondary to inorganic particles, silicosis, asbestosis and talcosis, may, if very marked, lead to congestive heart failure (Cor pulmonale), a late complication and a frequent cause of death for such patients.

Asbestos and talc exposure to talcs containing asbestiform minerals are also associated with a highly increased risk of developing lung cancer (this risk is much higher in workers who smoke cigarettes), and mesothelioma of the pleura or peritoneum. Gastrointestinal cancer is also found with a higher incidence in exposed individuals.

Nuisance dust has little adverse effects on the lungs and does not produce significant disease if exposures are kept under reasonable control. These dusts are biologically inert in that when inhaled the structure of the alveoli remains intact and little or no scar tissue is formed, and thus any reaction provoked is potentially reversible. Excessive concentration in the work area may decrease visibility, cause eye, ear, and nose discomfort. This can also create injury to the skin due to vigorous cleansing procedures necessary for their removal.

E. Evaluation Results and Discussion

1. Environmental Evaluation

Employee exposure to airborne crystalline silica, asbestos, and respirable dusts during the various stages of the ceramics production have been assessed.

a. Respirable Crystalline Silica

The ceramics parts produced at Du Co Ceramics vary in respect to the percent silica present in the products manufactured. Therefore, the potential exposure to silica is dependent on the particular ingredients used in the product and their silica content, as well as the production phase of the ceramics part, e.g., the weighing or mixing phase vs. the sagger filling or machining phase. Basically, the silica content in these products range from 1.3-19.7 percent for the ingredient TDM-W-98 and Sterling Ball Clay, respectively. The percent cristobalite in all the materials used at Du Co Ceramics was non-detectable.

During the September, 1977 survey, a total of 16 personal breathing zone respirable samples were collected during the investigation. A total of five of these samples were taken in the Mixing/Ball Mill and Spray Dry departments, eight from the Cutting and Sagger Filling departments, and three from the Machining department. The data are presented in Tables 1, 2, and 3, respectively. The concentrations for respirable silica ranged from 0.03 to 0.06 mg/M^3. Two of these samples exceeded the NIOSH recommended criteria of 0.05 mg/M^3. In each of these two cases the operators performed a job which put them in close proximity to large quantities of dust during their work period, e.g., granule mixing, cutting/filling and blow-off process. An additional job, batch scale operator, also had high levels (0.04 mg/M^3) of silica during this survey. This operator, like the mixing and blow-off operators mentioned above, perform jobs where large quantities of dust are found.

NOTE: Each of the above exposures were to employees who were wearing respirators, however, each respirator was in need of repair during this sampling period.

During the March 1978 investigation, a total of 46 samples were taken for respirable silica (Refer to Tables 1-3). Seven samples were taken in the Mixing/ Ball Mill and Spray Dry area and of this total four samples exceeded the NIOSH criteria. A total of 16 respirable silica samples were collected in the Cutting and Sagger Filling department and two of these, both from the blow-off cleaning operation, exceeded the NIOSH criteria. The remaining 23 samples were taken in the Machinery department and only one of these samples exceeded the criteria set for this survey. Again, in each case where levels exceeded the criteria, the operation was one in which the operator performed a task where high dust levels (either immediate area or background) were being generated. In two cases the Lancaster Mixer and Batch Scale operator, the levels were at least three times higher than the acceptable criteria for silica. It was noted earlier in the process description that both of these processes require the operator to load bags of material into receiving bins and in both cases exhaust ventilation was either lacking or inadequate. Again, each exposure was to an operator who wore a respirator that was not functioning properly.

b. Respirable Dust

During the September 1977 survey an additional 16 personal breathing zone samples were collected for respirable dust. Five of these samples were taken in the Mixing/Ball Mill and Spray Dry area, eight in the Cutting and Sagger Filling area, and three from the Machining area. The values obtained for respirable dust ranged from 0.05 - 6.06 mg/M^3 (Refer to Tables 1-3). Four of these samples exceeded the current NIOSH recommended standard of 5.0 mg/M^3.

During the March 1978 survey 46 personal samples were collected for total respirable dust. Again seven of these samples were taken in the Mixing/Ball Mill and Spray Dry area and two of these values exceeded the criteria set for total respirable dust (Refer to Table 1). Sixteen of the 46 personal samples were taken in the Cutting and Sagger Filling area for respirable dust and none of these exceeded the criteria (Refer to Table 2). The remaining 23 respirable dust samples taken during the March survey were collected in the Machining department and only one of these samples exceeded the criteria set for this survey (Refer to Tabel 3). It should be noted that this sample, like the respirable silica sample mentioned earlier which exceeded the criteria, were both taken at the same operation, i.e., the Rouse Miller process. In all the cases where the levels exceeded the criteria for respirable dust exposures, as well as a few which were close to the standard, the operation was one in which large quantities of dust are being generated. This was also true in operations where improper exhaust ventilation systems and/or improperly designed exhaust systems existed.

c. Asbestos

Asbestos samples were taken only during the September 1977 survey. The reason for this is due to the removal of all asbestos containing materials by Du Co Ceramics shortly after this NIOSH investigation. During the September survey, five processes were evaluated and in all but one operation, the Sagger Filling process, the asbestos levels exceeded the NIOSH criteria of 0.1 fibers/cc, where fibers greater than 5 micrometers (um) in length/M^3 of air were measured (Refer to Table 4). Again, in those areas where exposure levels exceeded the criteria for silica and respirable dust turned out to be the same areas where asbestos levels were exceeding the evaluation criteria.

2. Medical Evaluation

A total number of 150 persons were examined: 120 active workers and 30 individuals with past employment (retirees or persons who had discontinued their employment after at least 5 years at Du Co Ceramics).

The age and sex distribution of the examined group (Table 5) indicated a preponderance of women (74.7% of those examined) and of persons in the age group over 50 years (52.7%).

The distribution of those examined according to years since onset of exposure to fibrogenic dust in the plant showed that in 74.7% of the cases, duration since onset of exposure exceeded ten years (Table 6).

The various job designations of the workers examined and their distribution according to the current job are given in Table 7.

In agreement with the industrial hygiene evaluation, the various job designations were classified in four categories - exposure classification 1 to 4, 1 being the highest and 4 the lowest exposure code (Table 8).

Since many employees had held jobs in many different plant areas during their period of employment, each examinee received an objective rating derived from the exposure code of each area and the duration of time spent on that job. This job-exposure index was constructed by a) totalling the products of exposure classification and duration for each job assignment listed by the subject and b) deriving the individual job-exposure index (JEI) by dividing the sum from (a) by the total number of years worked at the Du Co facility.

The distribution of all examinees according to this job-exposure index and years since onset of exposure showed that almost half of them had a JEI (of 1, 1-2, 2 and 2-3) indicating relatively higher dust exposure (Table 9).

The analysis of the smoking habits in the examined group indicated that more than half (57%) of the women and almost half (46%) of the men had never smoked. The proportion of present smokers was very similar (34% in women and 30% in men), but there were many more ex-smokers (individuals who had discontinued smoking for more than 2 years) among the male employees (Table 10).

Chest x-ray changes, parenchymal and/or pleural, were found in a very small proportion of those examined: in three cases small rounded and irregular opacities, in four cases small irregular opacities only; pleural thickening was present in two other cases, in one in association with small irregular opacities. The radiologic changes, in all cases without exception, were slight (small opacities profusion 1/0 or at most 1/1).

Table 11 gives the characteristics of the cases with radiologic changes; the overall prevalence for the entire group examined is 6%. Although the working force was predominantly female, most examinees with radiologic abnormalities were male. In 6 out of the 9 cases, the job exposure rating indicated work in areas with relatively high exposure; duration of exposure was very long in most cases (up to 40 years), in only one case was it less than 10 years. None of these examinees was a current smoker; four had never smoked and five were ex-smokers.

Table 12 gives the prevalence of radiologic abnormalities as related to years since onset of exposure. This was higher in examinees with more than 10 years (7%) than in those with less than 10 years since onset of exposure (3%). The difference did not reach the level of statistical significance.

Chronic bronchitis (according to the MRC criteria) was diagnosed in 9 female workers and in none of the male workers. Even when taking into account the fact that there were a few cases in which the answers were thought to be inconclusive, this represents a low prevalence of chronic bronchitis in an industrial population (Table 13).

When analyzing the presence of chronic bronchitis in relationship with smoking habits in women (Table 14), it becomes obvious that, contrary to what would be expected, the prevalence of chronic bronchitis was higher in female employees who had never smoked or were ex-smokers than it was in current smokers. This rather unexpected finding probably indicates that dust exposure may result in a proportion (about 10%) of employees with chronic bronchitis.

Analysis of pulmonary function tests results indicated normal values in 63% of examinees (Table 15). Restrictive pulmonary dysfunction (pure) was found in less than 5% of cases.

Obstructive pulmonary dysfunction, as indicated by a lower than normal forced expiratory volume per second, was found as an isolated abnormality in 2 cases. Another, more sensitive indicator of obstructive ventilatory dysfunction, a lower than normal FEF_{25-75} was more often detected, and was the single most frequent abnormality (18.4% of cases).

Ventilatory dysfunction of a mixed pattern (restrictive and obstructive) was present in 10.2% of cases.

When analyzing the pulmonary function tests results in relation to smoking habits, it is found that the examinees who never smoked and the ex-smokers have a higher percentage of normals than the current smokers (Table 16). Restrictive dysfunction (pure) is not influenced by smoking, while the indicators of obstructive ventilatory dysfunction are more prevalent in current smokers.

Years since onset of exposure did not correlate with any of the indicators of ventilatory dysfunction (Table 17).

Analysis of pulmonary function abnormalities as related to job-exposure index (Table 18) showed a higher proportion of normal values in examinees with the lowest exposure index (4). The only abnormality present in a significant proportion of these workers was the lower than normal FEF_{25-75}. This may indicate that dust exposure, even when slight or moderate in degree, may affect flow rates.

V. SUMMARY AND CONCLUSIONS

A medical and environmental evaluation was conducted among ceramic workers. The purpose of this study was to assess the concentrations of air contaminants in the work environment, as well as to detect the potential for chronic health problems resulting from exposure to silica and asbestos which are being generated during the various phases of the ceramic production process.

Breathing zone samples were taken for asbestos, respirable silica and dust. In a number of those jobs considered to be at risk, i.e., occupations where exposures were coded 1-3 as referenced in Table 18, exposure levels did exceed the recent hygienic standards.

Medical questionnaires which included occupational histories, past medical histories, and smoking histories, were administered; physical examinations, including chest x-rays and pulmonary function tests were performed. A total of 150 individuals were interviewed and examined (this was more than the actual number of those who had initially sent in a confirmation indicating that they would participate) which was considered excellent. The overall prevalence of radiologic abnormalities detected on chest x-ray films was low; it was nevertheless higher in employees with longer duration since onset of exposure.

This may indicate that exposure in the past could have been more hazardous, and that appropriate medical surveillance has to be implemented for early diagnosis of radiologic abnormalities.

The prevalence of chronic bronchitis was low; this condition was detected in women only and seemed to indicate a higher susceptibility of women to the effects of dust on the bronchial tree. The lack of any correlation with smoking tends to reinforce this interpretation.

The low prevalence of restrictive pulmonary dysfunction is consistent with the low prevalence of parenchymal pulmonary radiologic changes. The higher prevalence of obstructive ventilatory dysfunction, and especially of the lower than normal FEF_{25-75}, suggests that this parameter is more susceptible to dust effects. The lack of correlation with duration of exposure may indicate that this effect has no long latency period which is a common finding in dust exposures. The higher prevalence of obstructive ventilatory dysfunction in smokers was to be expected; the presence of such abnormalities in non-smokers confirms that this is also an effect of dust exposure.

Based on the results of this survey, it appears that a potential health hazard existed and still exists for those workers considered at high risk, e.g., granule mixer operators, batch scale operators, lancaster mixer operators, rouse miller operators, and workers performing blow-off operations. This conclusion is based on the following evidence: elevated air concentration of respirable silica, respirable dust and asbestos (which had been used in the ceramics process prior to October 1977); the higher incidence of radiologic abnormalities in employees with longer duration since onset of exposure; and the incidence of obstructive ventilatory dysfunction in non-smokers which suggests that this is an effect of dust exposure.

VI. RECOMMENDATIONS

In view of the findings of NIOSH's environmental and medical study, as well as personal communications with individuals at Du Co Ceramics, the following recommendations are made to ameliorate potential health hazards and to provide a better work environment for the employees covered by this determination. These recommendations are also based on NIOSH's review of those ventilation proposals submitted by Hemeon Associates - Air Pollution Research Engineers, Pittsburgh, Pennsylvania.

A. Medical

Periodic medical examinations, on an annual basis, including annual chest x-ray films, and pulmonary function tests should be planned. If abnormalities are detected the possibility of assigning the person to one of the least exposed areas should be considered. This procedure, either permanently or temporarily, should also be developed for any person who has any form of chronic or acute respiratory difficulties.

B. Engineering Controls

Whenever possible, engineering controls are the preferred method for decreasing environmental exposures to toxic substances for the protection of the employees' health. A number of ventilation problems were noted in each of the processes described in Section IV-A of this report. These have been summarized below and recommendations have been given at the end of each of the separate sections.

1. Mixing/Ball Mill and Spray Dry Departments

The exhaust ventilation problems that were found in these departments are: (a) Batch Scale process - Sly dust collector exhausting within building, damaged hood, and dust escaping from hopper access area; (b) Granule and Extrusion Mixing - Dust created by skip hoist dumping and sly dust collector exhausting within building; (c) Munson Blender process - Dust created by skip hoist dumping and the location of the exhaust hood in the loading compartment; (d) Eirich processes - Improper exhaust ventilation at the elevator/loading bin area and dust created by skip hoist dumping; (e) Lancaster processes - Dust created at the point where the operator dumps the bags into the mixer; and (f) Wet and Dry/Ball Mill processes - The exhaust duct leading into the mill was damaged.

Therefore, due to these ventilation problems the following recommendations should be attended to as soon as possible if they have not been already. 1) In those areas where sly dust collectors are operating, e.g., batch scale, granule and extrusion, etc., these systems should be exhausted outside or into another area of the plant. This should then reduce and/or eliminate the dust being agitated by the turbulance from these systems. 2) Exhaust ventilation systems should be installed at those points where skip hoists are dumping into mixers. This would facilitate in reducing the dust being generated at these points, as well as throughout the entire department (Refer to Figure 1 for example). 3) Exhaust ventilation systems should be installed and/or maintained in those areas where operators are presently dumping bags of material into either a mixers interior or at those points where materials are being weighed, e.g., batch scale, Eirich process, Lancaster operation, etc. 4) Any existing exhaust ventilation systems which are damaged, e.g., hoods, ducts, and/or filters, should be restored to their original condition or replaced as necessary. Also, any of these systems that have hoods which are improperly located and/or insufficiently designed should be repositioned or redesigned in order to increase the capture velocity of those systems and thus effectively collect the contaminants at the source.

2. Cutting and Sagger Filling Departments

The exhaust ventilation problems noted in these areas are: (a) the distance between the canopy hood and the conveyor belt; (b) the downdraft exhaust hood (positioned at the end of the conveyor belts) which is used to clean the materials after their cut; and (c) the exhaust problems in the blow-off cleaning booths. Each of these problems have been addressed by Hemeon Associates and they proposed to redesign each of these systems. These proposals should effectively resolve the problems that will eliminate the exposure to the operator.

3. Machining Department

The exhaust ventilation problems in the machining department centered primarily on the lack of proper exhaust systems on those machines located in the center and the problem with the air jet dispersion systems. Again, Hemeon Associates have addressed these problems and have proposed systems which should effectively reduce and/or eliminate these exposures.

C. Personal Protective Procedures

1. Respiratory Protection

When the limits of exposure cannot be immediately met by limiting the concentrations in the work environment, via engineering and administrative controls, the Du Co Ceramics Company should utilize a program of respiratory protection to protect those persons exposed. This program must be an official written respiratory program. The following is a brief description of some of the primary concerns which should be addressed:

- There should be an established in-plant procedure and means and facilities provided to issue respiratory protective equipment to decontaminate and disinfect the equipment, and to repair or exchange damaged equipment. Records of these activities should be maintained.

- Employees should be given instructions on the use of respirators assigned to them, on cleaning respirators, testing for leakage and proper use.

- Respirators should be issued with caution. There might be individuals in the group for whom wearing a respirator carries certain specific dangers, i.e. highly increased resistance to airflow in a person with compromised pulmonary function may be associated with acute respiratory insufficiency. Employees experiencing frequent and continuous breathing difficulty while using respirators should be evaluated by a physician to determine the ability of the worker to wear a respirator.

Further information on this topic is available in the NIOSH Publication 76-189 "A Guide to Industrial Respiratory Protection." This publication was sent to both management and union officials. With this information a respiratory program can be designed similar to that described in the OSHA requirements outlined in 29 CFR part 1910, 134, and therefore, should assist management in developing an effective respiratory program. Finally, for those individuals who are not getting a proper respiratory face mask fit alternative respirators should be made available. There are a number of different designs and sizes, both large and small, on the market today and these alternatives should be sought out.

2. Personal protective clothing should be provided to employees working in those areas where ceramic dust is presently being generated in excessive amounts, i.e., in any area where cutting, milling, blowing-off parts, mixing, etc., is being performed. This clothing should be disposable clothing or clothes to be worn at work only, e.g., lab coats, jump suits, etc. These should be either washed or disposed of according to need, e.g., excess dust accumulation, damage, etc. Separate lockers for work clothes and personal clothing should be provided.

3. Shower facilities should be provided for those persons who are continuously exposed to silica. These are necessary for the use of workers before leaving the plant in order to prevent the inadvertent contamination of their homes and families.

4. Protective goggles should be provided and worn by every employee who must use the existing blow-off operations, as well as the employees who use the air-jet dispersion systems in the machining department.

D. Other Recommendations

1. Exposure to dust can be significantly reduced by improvement in housekeeping, particularly in: raw material storage, batching, blending, ball milling, various screening operations, cut-off and ceramic machining. Large accumulations of dust from these operations are ubiquitous - continuously created and redistributed. Shop vacuum cleaners or vacuum lines would eliminate this problem. Also, an addition to the existing maintenance program should be initiated, that is, a portion of the present clean-up should; either weekly, bi-weekly, or monthly, concern itself with the cleaning of specific areas which are presently producing and collecting large quantities of dust, e.g., warehouse, machinery, rafters, shelves, light fixtures, etc.

2. There were a number of locations where dust collectors were not directly connected to waste containers, e.g., Jeffery dryer, Batch scale, Eirich mixer, wet-dry ball mill, surge bin. etc. When these exhaust systems were in operation, each dust collection container was a continuous source of low level dust emission. Therefore, appropriate waste containers or barrels should be tightly connected to their respective dust collectors (Refer to Figure 3 for examples).

3. At those processes where conveyor belts are being used, appropriate devices should be designed to scrap residual materials off the belts; collect the waste material, and exhaust the fine particules which are generated from this procedure (Refer to Figure 4 for examples).

4. The exposure created when the operator cleaned the granule or the extrusion mixers, should be eliminated. Therefore, it is recommended that air nozzles be installed inside the mixers, and that this operation be conducted by automatic controls with the mixer doors closed.

5. Workers should be educated as to the synergistic effect of cigarette smoking and dust exposure in producing bronchitis and obstructive pulmonary disease; and also a higher risk of developing lung cancer.

6. Employees should be educated to eat only in dust free areas, especially designated areas. Such areas, sufficient to accomodate the number of employees, should be provided.

7. At night waste barrels throughout the plant were collected and dumped into a large open container which is located in the mixing area. Because of the other dust problems in this area this dumping should be carried out in the raw materials warehouse or outside the plant.

8. The back plate on the surge bin was removed and therefore, should be replaced after each time work has been performed on this machine. This will also assist in reducing the amount of dust in this area.

9. The safety rail located next to the surge bin was removed during both investigations, and thus, this rail should be replaced when the need does not require it to be down.

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Union and Management:

NIOSH is thankful to the management and the employees of Du Co Ceramics Company for their cooperation and assistance with this Health Hazard Evaluation. The information gathered from this study will not only assist in maintaining the health and safety of those persons working at Du Co Ceramics, but also other companies who perform similar operations.

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Table 1
Summary of Personal Sampling Concentration Data
for
Respirable Free Silica and Respirable Particulate
Mixing/Ball Mill and Spray Dry Department
Du Co Ceramics Company
Saxonburg, Pennsylvania
September 1977 and March 1978

Sample Date	Sample Number	Job Description and/or Classification	Sample Time (Hrs)	Sample Volume (M^3)	Atmospheric Concentration (mg/M^3) Respirable Silica	Resp. Dust
9/12/77	2	Granule Mixer	6.30	.64	*.06	*6.7
9/12/77	6	Granule Mixer	6.30	.64	.03	.33
9/12/77	12	Ball Mill Operator	3.30	.36	.03	1.5
9/12/77	27	Batching Scale	6.30	.64	.04	2.0
9/12/77	28	Materials Handler	6.30	.64	.03	1.0
3/15/78	2394	Batch Scale	6.3	.64	*.08	4.2
3/15/78	2409	Dryer	6.3	.64	.03	2.2
3/15/78	2393	Granular Mixer	6.3	.64	.03	3.7
3/15/78	2406	Lancaster Mixer	6.3	.64	*.05	2.2
3/15/78	*1603	Extrusion Mixer	6.3	.64	.03	1.9
3/16/78	2377	Lancaster Mixer	7.0	.71	*.18	*5.6
3/16/78	2365	Batch Scale	7.0	.71	*.17	*7.1
Environmental Criteria					(NIOSH) 0.05 mg/M^3	(ACGIH) 5 mg/M^3
Limits of Detection					0.03 mg/M^3	0.01 mg/M^3

* Exceeds the criteria set.
M^3 = Volume of air measured in units of cubic meters.
mg/M^3 = Approximate milligrams of substance per cubic meter of air.

Table 2
Summary of Personal Sampling Concentration Data
for
Respirable Free Silica and Respirable Particulate
Cutting and Sagger Filling Department
Du Co Ceramics Company
Saxonburg, Pennsylvania
September 1977 and March 1978

Sample Date	Sample Number	Job Description and/or Classification	Sample Time (Hrs)	Sample Volume (M^3)	Atmospheric Concentration (mg/M^3) Respirable Silica	Resp. Dust
9/12/77	3	Cutting/Filling	6.0	.61	.04	.30
9/12/77	8	Sagger Mover	6.0	.61	.01	.15
9/12/77	10	Cutting/Filling/Blow-off	6.0	.61	*.05	*5.5
9/12/77	13	Sagger Filler	6.0	.61	.01	.46
9/12/77	14	Checker	6.0	.61	.03	.05
9/12/77	20	Cutting/Filling	6.0	.61	.02	.59
9/12/77	22	Sagger Mover	6.0	.61	.02	.09
9/12/77	23	Sagger Mover	6.0	.61	.01	.09
3/15/78	3940	Cutting/Filling	6.0	.61	N.D.	.93
3/15/78	2392	Cutting/Filling	6.0	.61	N.D.	.61
3/15/78	2389	Cutting/Filling	6.0	.61	N.D.	.96
3/15/78	2398	Cutting/Filling	6.0	.61	N.D.	.32
3/15/78	1497	Sagger Mover/Blow-off	6.0	.61	*.06	2.0
3/15/78	2402	Sagger Mover	6.0	.61	N.D.	.65
3/16/78	2366	Cutting/Filling	6.0	.61	N.D.	.95
3/16/78	2384	Cutting/Filling	6.0	.61	N.D.	2.0
3/16/78	2367	Cutting/Filling/Blow-off	6.0	.61	*.07	2.8
3/16/78	2376	Cutting/Filling	6.0	.61	N.D.	1.7
3/16/78	2379	Sagger Mover	6.0	.61	N.D.	.70
3/16/78	2397	Cutting/Filling	6.0	.61	N.D.	1.6
3/16/78	1596	Cutting/Filling	6.0	.61	N.D.	.33
3/16/78	1499	Cutting/Filling	6.0	.61	N.D.	.26
3/16/78	1498	Cutting/Filling	6.0	.61	N.D.	.36
3/16/78	2385	Cutting/Filling	6.0	.61	N.D.	.54
Environmental Criteria					(NIOSH) 0.05 mg/M^3	(ACGIH) 5 mg/M^3
Limits of Detection					0.03 mg/M^3	0.01 mg/M^3

*Exceeds the criteria set.
M^3 = Volume of air measured in units of cubic meters.
mg/M^3 = Approximate milligrams of substance per cubic meter of air.

Table 3
Summary of Personal Sampling Concentration Data
for Respirable Free Silica and Respirable Particulate
Machinery Department
Du Co Ceramics Company
Saxonburg, Pennsylvania
September 1977 and March 1978

Sample Date	Sample Number	Job Description and/or Classification	Sample Time (Hrs)	Sample Volume (M^3)	Atmospheric Concentration (mg/M^3) Respirable Silica	Respirable Dust
9/12/77	1	Rouse Miller	6.0	.61	N.D.	*5.0
9/12/77	5	Rouse Miller	6.0	.61	N.D.	*6.0
9/12/77	9	Checker	6.0	.61	N.D.	1.31
3/15/78	1495	Horizontal Drill Press	6.0	.61	N.D.	.35
3/15/78	1597	Lathe	6.0	.61	N.D.	.31
3/15/78	2372	Rouse Miller	6.0	.61	N.D.	4.2
3/15/78	2390	Dumore	6.0	.61	N.D.	.87
3/15/78	2411	Dumore	6.0	.61	N.D.	.77
3/15/78	2391	Checker	6.0	.61	N.D.	.31
3/15/78	2364	Set-Up	6.0	.61	N.D.	.24
3/15/78	2410	Set-Up	6.0	.61	N.D.	.38
3/15/78	1598	Dumore	6.0	.61	N.D.	.55
3/15/78	2407	Swing Sow	6.0	.61	N.D.	.61
3/15/78	2403	Drill Cut	6.0	.61	N.D.	.41
3/15/78	1502	Form Grinde-2	6.0	.61	N.D.	.39
3/15/78	2405	Checker	6.0	.61	N.D.	.25
3/15/78	2404	Rouse Miller	6.0	.61	N.D.	1.6
3/15/78	1600	Rouse Miller	6.0	.61	*0.05	*7.2
3/16/78	2368	Machine Labor	6.0	.61	N.D.	.38
3/16/78	2383	Dumore	6.0	.61	N.D.	.80
3/16/78	2373	Rouse Miller	6.0	.61	N.D.	2.7
3/16/78	2369	Checker	6.0	.61	N.D.	.42
3/16/78	2378	Horizontal Drill Press	6.0	.61	N.D.	N.D.
3/16/78	1493	Form Grinder	6.0	.61	N.D.	.90
3/16/78	2370	Dumore	6.0	.61	N.D.	.41
3/16/78	2382	Rouse Miller	6.0	.61	N.D.	1.7
Environmental Criteria					(NIOSH) 0.05 mg/M^3	(ACGIH) 5 mg/M^3
Limits of Detection					0.03 mg/M^3	0.01 mg/M^3

*Exceeds the criteria set.
M^3 = Volume of air measured in units of cubic meters.
mg/M^3 = Approximate milligrams of substance per cubic meter of air.

Table 4

Summary of Personal Sampling Concentration
Data for Asbestos Fibers

Sample Number	Job Description and/or Classification	Sample Time (Hrs.)	Sample Volume (Liters)	Atmospheric Concentration Fibers >5 µm in length/M^3 of air
2	Batch Scale	2.10	260	*.13
3	Granular Mixing	2.10	260	*.14
4	Rouse Miller	2.10	260	*.14
5	Sagger Filling	2.10	260	.01
Environmental Criteria				(NIOSH) 0.1 fibers/cc

*Exceed NIOSH Criteria and OSHA policy requiring medical examinations.

M^3 = Volume of air measured in units of cubic meters.

Fibers/cc = fibers per cubic centimeter of air.

Table 5

Distribution of Ceramic Plant Workers by Age and Sex

Age (Years) \ Sex	Female Workers	Male Workers	Total Number	Total %
less than 30	15	4	19	12.7
30 - 39	13	7	20	13.3
40 - 49	22	10	32	21.3
>50	62	17	79	52.7
Total	112 (74.7%)	38 (25.3%)	150	100.0%

Table 6

Distribution of Ceramic Plant Workers by Years Since Onset of Exposure and Sex

Years since onset of exposure	Female workers	Male workers	Total Number	%
less than 5	8	2	10	6.7
5.1 - 10	20	8	28	18.7
10.1 - 20	53	17	70	46.7
over 20	31	11	42	28.0
Total	112 (74.7%)	38 (25.3%)	150	100.1

Table 7

Distribution of Workers According to Job Designations (Current or Last Job)

Job	Number	Job	Number
Mixers	4	Machine design	1
Extrusion	7	Machine checker	1
Cutters	10	Glazers	3
Cutting machine set-up	1	Sort & pack	25
Tube breaking	1	Inspection	11
Saggar table	3	Sample checkers	2
Pressers	21	Shipping	6
Press checker	1	Maintenance	8
Press set-up	1	Toolmakers	1
Press adjuster	3	Die setters	3
Kiln operators	2	Die makers	2
Grinders	4	Loading trucks	1
Machining	26	Managerial (engineer)	1
Machine set-up	1		

Table 8

Du Co Ceramics, Health Hazard Evaluation

Job and Exposure Codes

Code	Job
01	Mixers
02	Extrusion
03	Cutters
04	Cutting machine set-up
05	Tube breaking
06	Sagger table
07	Pressers
08	Press checker
09	Press set-up
10	Press adjuster
11	Kiln operator
12	Grinders
13	Machining
14	Machine design
15	Machine set-up
16	Machine checker
17	Glazers
18	Sort and Pack
19	Inspection
20	Sample checkers
21	Shipping
22	Maintenance
23	Toolmaker
24	Die setter
25	Die maker
26	Loading trucks
27	Managerial (engineer)
28	Ex-employee

Exposure code (1 to 4; 1 is the highest exposure)

Code	Operation
1	Mixing
2	Cutting, machining
3	Sagger table
4	All other job categories

Table 9

Distribution of Ceramics Plant Employees by
Years Since Onset of Exposure and Exposure Category

Exposure Category \ Years since onset	<5	5.1-10	10.1-20	>20	Total Number	Total %
1	0	1	1	1	3	2.0
1 mixed (1-2)	0	0	6	2	8	5.3
2	6	5	8	8	27	18.0
2 mixed (2-3)	2	5	15	4	26	17.3
3	2	1	1	1	5	3.3
3 mixed (3-4)	0	8	14	12	34	22.7
4	0	8	25	14	47	31.3

Table 10

Smoking Habits in 150 Ceramic Plant Workers

Sex / Smoking status	Female workers Number	%	Male workers Number	%	Total Number	%
Current smoker	38	34.0	11	30.0	49	33.0
Ex-smoker (> 2 years)	10	9.0	9	24.0	19	13.0
Never smoked	64	57.0	17	46.0	81	54.0
Total	112	100.0	37	100.0	149	100.0

Table 11

Chest X-Ray Abnormalities in Ceramic Plant Workers

Study Number	Sex	Years Since Onset of Exposure	Exposure Rating	Smoking Status	Chronic Bronchitis	Pulmonary Function Abnormalities	X-Ray Abnormalities
017	M	21	4	Non-Smoker	No	None	Rounded and Irregular opacities
057	M	16	1.06	Ex-Smoker	No	None	Rounded and Irregular opacities
060	M	33	2	Non-Smoker	No	None	Rounded and Irregular opacities
044	M	19	1.05	Ex-Smoker	No	Restrictive and Obstructive	Irregular opacities
061	F	22	2	Non-Smoker	No	Restrictive	Irregular opacities
087	F	34	4	Non-Smoker	Yes	None	Irregular opacities
152	M	9	3.55	Ex-Smoker	No	None	Irregular opacities
054	M	29	2	Ex-Smoker	No	None	Irregular opacities and Pleural thickening
077	M	40	2.31	Ex-Smoker	No	None	Pleural thickening

Table 12

Chest X-Ray Abnormalities and Duration Since Onset of Exposure

Years Since Onset of Exposure	Chest X-Ray			
	Normal		Abnormal	
	Number	%	Number	%
≤ 10	37	97.0	1	3.0
> 10	103	93.0	8	7.0
Total	140 (94.0%)		9 (6.0%)	

Table 13

Chronic Bronchitis in 150 Ceramic Plant Employees

Chronic Bronchitis	Female workers		Male workers		Total	
	Number	%	Number	%	Number	%
Present	9	8.5	0	0.0	9	6.3
Absent	97	91.5	37	100.0	134	93.7
Total	106	100.0%	37	100.0%	143	100.0%

Table 14

Smoking Habits and Chronic Bronchitis in

Ceramic Plant Employees (Female Employees)

	Chronic Bronchitis			
	Present		Absent	
Smoking Status	Number	%	Number	%
Current smoker	2	5.9	32	94.1
Ex-smoker	1	10.0	9	90.0
Never smoked	6	9.7	56	90.3
Total	9		97	

Table 15

Pulmonary Function (PFT) Abnormalities in Ceramic Plant Employees

PFT	Female workers (N = 109) Number	%	Male workers (N = 38) Number	%	Total Number	%
Normal	70	64.2	23	60.5	93	63.2
Restrictive dysfunction FVC<79% of predicted	6	5.5	1	2.6	7	4.8
Obstructive dysfunction						
- FEV_1<79.5% of predicted (only)	2	1.8	0		2	1.4
- FEF_{25-75}<74.5% (only)	21	19.3	6	15.8	27	18.4
Total obstructive dysfunction	24	22.0	8	21.0	32	21.7
Mixed (restrictive and obstructive dysfunction)	9	8.3	6	15.8	15	10.2

Table 16

Pulmonary Function (PFT) Abnormalities and
Smoking in Ceramics Plant Employees

PFT	Current Smokers (N = 48) Number	%	Ex-Smokers (N = 19) Number	%	Never Smoked (N = 79) Number	%
Normal	26	54.2	12	63.1	54	69.0
Restrictive dysfunction FVC<79% of predicted	1	2.1	0		6	7.6
Obstructive dysfunction						
- FEV_1<79.5% of predicted (only)	2	4.2	0		0	
- FEF_{25-75}<74.5% (only)	13	27.1	1	5.3	13	16.5
Total obstructive dysfunction	16	33.3	3	15.7	13	16.5
Mixed (restrictive and obstructive dysfunction)	5	10.4	4	21.1	6	7.6

Table 17

Pulmonary Function (PFT) Abnormalities and Years Since Onset of Exposure in Ceramics Plant Employees

PFT \ Years since onset of exp.	Less than 5 (N = 9) Number	%	5.1 - 10 (N = 27) Number	%	10.1 - 20 (N = 69) Number	%	Over 20 (N = 42) Number	%
Normal	4	44.4	17	63.0	47	68.0%	25	60.0
Restrictive dysfunction FVC $<$ 79% of predicted	1	11.1	0		4	5.8	2	4.8
Obstructive dysfunction								
- $FEV_1 < 79.5\%$ of predicted (only)	0		0		1	1.4	1	2.4
- $FEF_{25-75} < 74.5\%$ (only)	3	33.3	6	22.2	10	14.5	8	19.0
Total obstructive dysfunction	3	33.3	6	22.2	12	17.4	11	28.5
Mixed (restrictive and obstructive dysfunction)	1	11.1	4	14.8	6	8.7	4	9.5

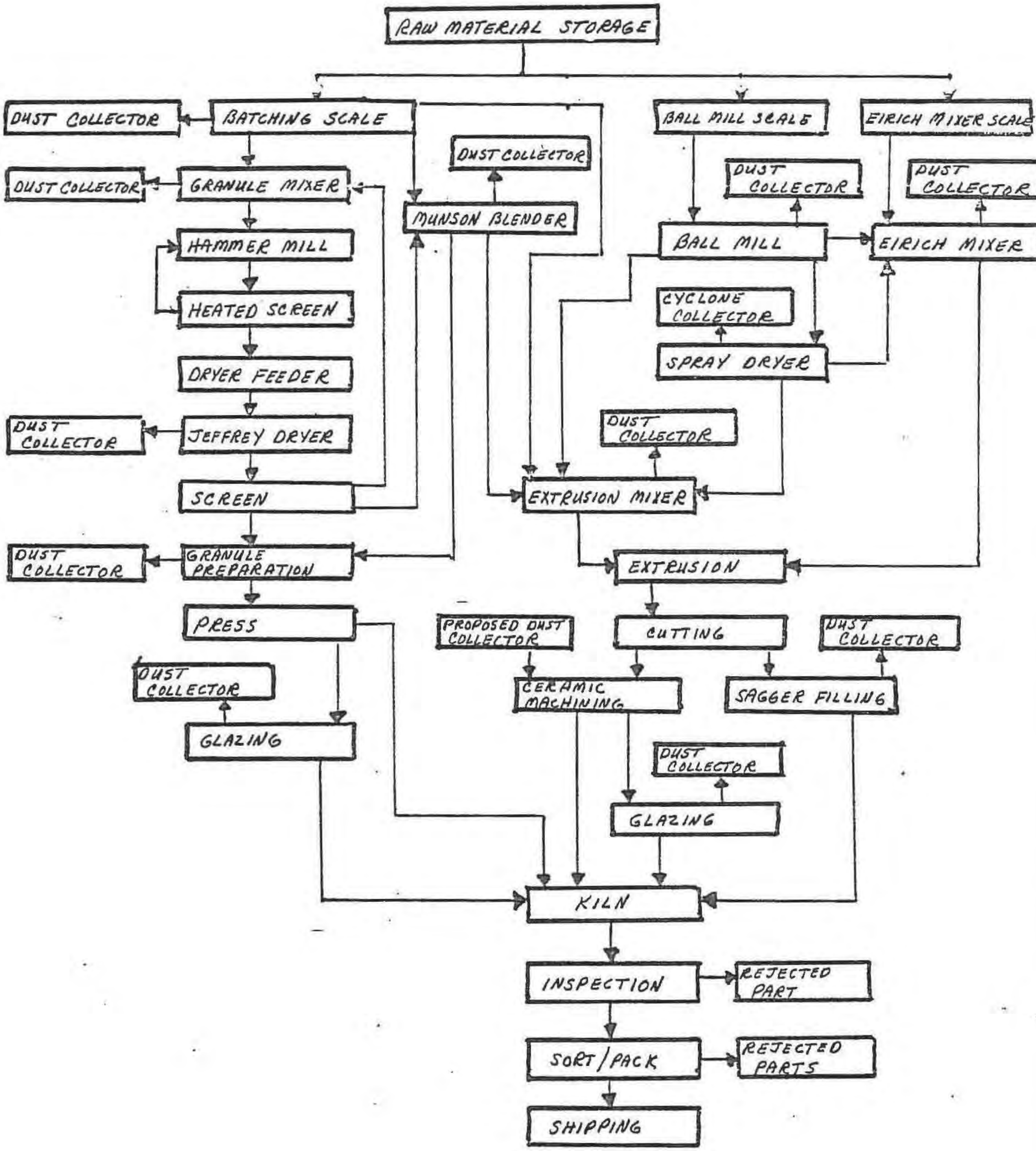
Table 18

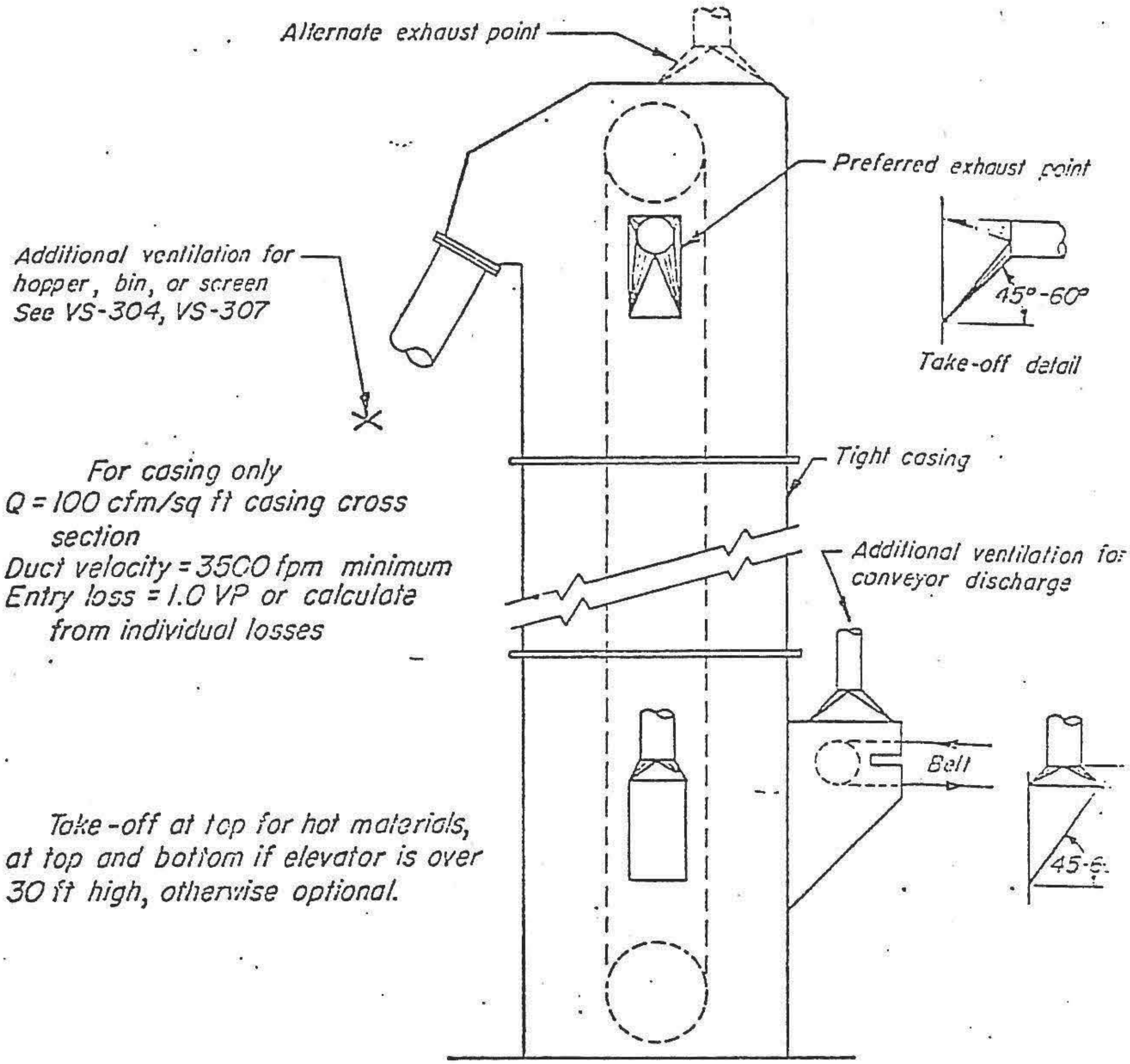
Pulmonary Function (PFT) Abnormalities and Category of Dust Exposure in Ceramics Plant Employees

PFT	1 and 1 - 2 (N = 11) Number	%	2 and 2 - 3 (N = 51) Number	%	3 and 3 - 4 (N = 38) Number	%	4 (N = 47) Number	%
Normal	7	63.6	28	55.0	24	63.1	34	72.3
Restrictive dysfunction FVC<79% of predicted	0		3	5.9	3	7.9	1	2.1
Obstructive dysfunction								
- FEV_1<79.5% of predicted (only)	1	9.0	0		1	2.6	0	
- FEF_{25-75}<74.5% (only)	2	18.2	10	19.6	5	13.2	10	21.3
Total obstructive dysfunction	3	27.3	11	21.6	6	15.7	12	25.5
Mixed (restrictive and obstructive dysfunction)	1	9.0	9	17.6	5	13.2	0	

FIGURE 1

MATERIAL FLOW DIAGRAM





For casing only
Q = 100 cfm/sq ft casing cross section
Duct velocity = 3500 fpm minimum
Entry loss = 1.0 VP or calculate from individual losses

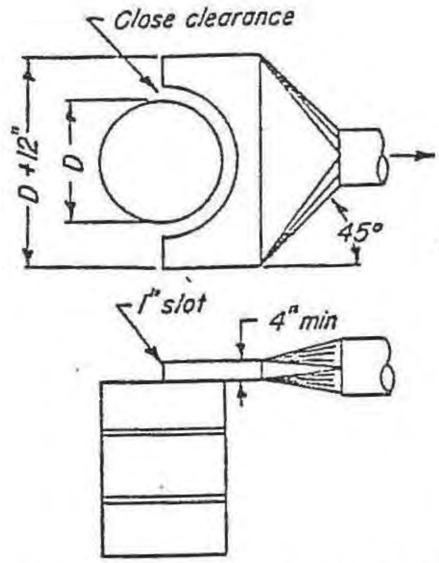
Take-off at top for hot materials, at top and bottom if elevator is over 30 ft high, otherwise optional.

Belt speed	Volume
Less than 200 fpm	— 350 cfm/ft of belt width. Not less than 150 cfm/ft of opening
Over 200 fpm	— 500 cfm/ft of belt width. Not less than 200 cfm/ft of opening

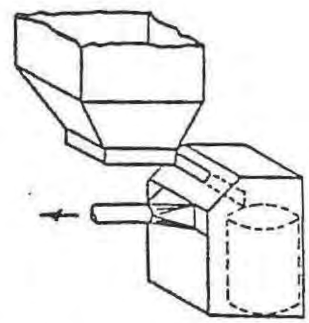
AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

BUCKET ELEVATOR VENTILATION

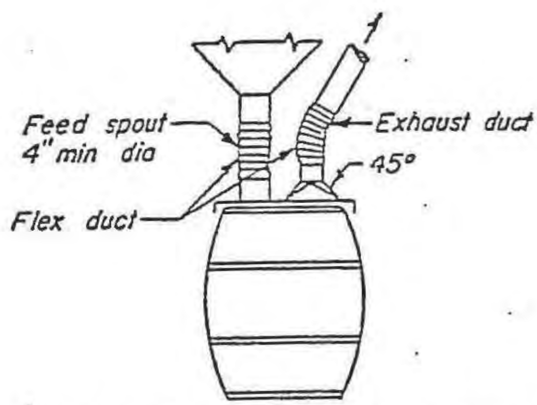
DATE 1-66 | VS-305



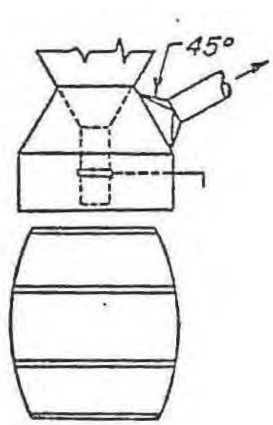
Q = 100 cfm/sq ft barrel top min
Duct velocity = 3500 minimum
Entry loss = 0.25 VP + 1.78 slot VP
Manual loading.



Q = 150 cfm/sq ft open face area
Duct velocity = 3500 fpm minimum
Entry loss = 0.25 VP for 45° taper

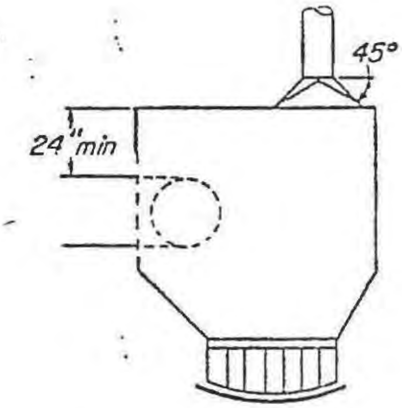


Q = 50 cfm × drum dia (ft) for weighted lid
150 cfm × drum dia (ft) for loose lid
Duct velocity = 3500 fpm minimum
Entry loss = 0.25 VP

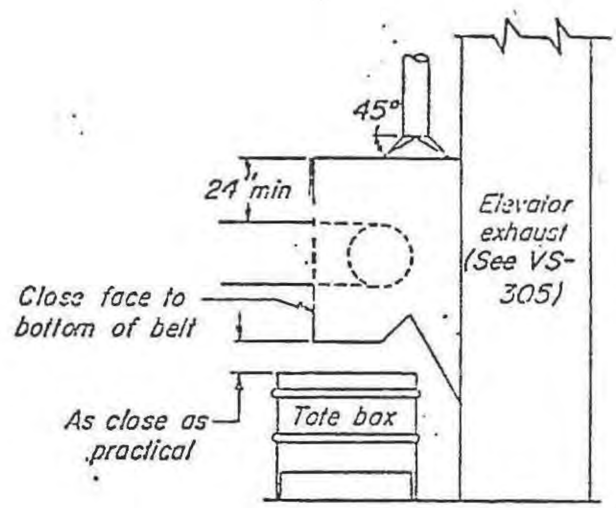


Q = 300-400 cfm
Duct velocity = 3500 fpm min
Entry loss = 0.25 VP

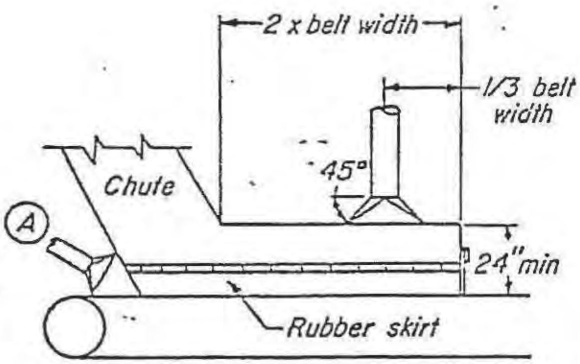
AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS	
BARREL FILLING	
DATE 1-64	VS-303



1. Conveyor transfer less than 3' fall. For greater fall provide additional exhaust at lower belt. See 3 below.



2. Conveyor to elevator with magnetic separator.



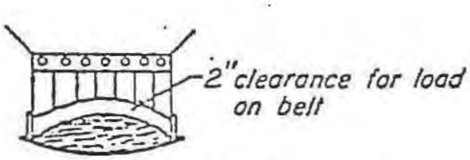
3. Chute to belt transfer and conveyor transfer, greater than 3' fall.
Use additional exhaust at (A) for dusty material as follows:
Belt width 12"-36", Q=700 cfm
above 36", Q=1000 cfm

DESIGN DATA

Transferpoints:
- Enclose to provide 150-200 fpm indraft at all openings.
- Minimum Q=350 cfm/ft belt width for belt speeds under 200 fpm
  = 500 cfm/ft belt width for belt speeds over 200 fpm and for magnetic separators
- Duct velocity =3500 fpm minimum
- Entry loss = 0.25VP

Conveyor belts:
- Cover belt between transfer points
- Exhaust at transfer points
- Exhaust additional 350 cfm/ft of belt width at 30' intervals. Use 45° tapered connections.
- Entry loss = 0.25 VP

Note:
Dry, very dusty materials may require exhaust volumes 1.5 to 2.0 times stated values.



Detail of belt opening

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

CONVEYOR BELT VENTILATION

DATE	1-72	VS-306

ATTACHMENT I

TO THE PATIENT: Please print the requested information. Do not put more than one letter or number in each box.

ESL use only ID # [| | | A | 1]

LAST NAME [| | | | | | | | | | | | | | 5]

FIRST NAME [| | | | | | | | | | 20]

MIDDLE INITIAL [| 30]

DATE OF BIRTH (month, day, year) [| | | | | | 31]

STREET ADDRESS [| | | | | | | | | | | | | | | | | | | | 37]
Leave blank space between each word

CITY [| | | | | | | | | | | | | 57]

STATE [| | 69]

ZIP CODE [| | | | | 71]

(PUNCHER: Do not punch below this line)

TELEPHONE [| |] - [| |] - [| | |]
area

DATE OF EXAMINATION (month, day, year) [| | | | |]

TO THE PATIENT: PLEASE SIGN CONSENT FORMS ON FOLLOWING PAGES

THE MOUNT SINAI MEDICAL CENTER
ONE GUSTAVE L. LEVY PLACE • NEW YORK, N.Y. 10029

OF THE CITY UNIVERSITY OF NEW YORK

Mount Sinai School of Medicine • The Mount Sinai Hospital

Subject Consent Document

Purpose: The purpose of this clinical examination of employees of the Du-Co Ceramics Co. plant is to determine what, if any, adverse health effects have resulted from past and present dust exposure.

Consent to Participate:

I, ______________________________, age __________, hereby voluntarily agree to undergo standard medical examinations and tests which will be utilized to determine whether health hazards exist in my work.

It is my understanding that these tests will include occupational smoking, alcohol and past medical histories, a questionnaire related to respiratory symptoms and a physical examination. Chest x-ray films and breathing tests will also be performed.

Although these examinations are not meant to replace a general medical examination, being more limited and specific in scope, they may nevertheless provide data of importance concerning my health and physical condition. Further, I understand that I may withdraw from the examination at any time.

My identity and my relationship to any information (1) disclosed by me in completing any project questionnaire and (2) reported by me or derived from me during my participation in the above-named project shall be kept confidential and will not be disclosed to others without my written consent except as required by law and except that such information will be used for statistical and research purposes in such a manner that no individual can be identified. I understand that if any information is found out concerning me that can endanger the health and safety of others, this information will be given to the proper authority.

If any of my medical records are required for purposes of this project, a separate written consent for release of the records will be requested from me.

I will be sent a report on the findings of my examination, and if I so request, my physican will also be sent a copy of this report.

I acknowledge that the nature and purposes of the examination have been fully explained to me. I also acknowledge that I have had an opportunity to ask any questions I have with respect to the examination and that all such questions have been answered fully.

(Signature)______________________________(Date)__________

THE MOUNT SINAI MEDICAL CENTER
ONE GUSTAVE L. LEVY PLACE • NEW YORK N.Y. 10029

OF THE CITY UNIVERSITY OF NEW YORK

Mount Sinai School of Medicine • The Mount Sinai Hospital

PERMISSION FOR MEDICAL EXAMINATION

I, ________________________________, age ____________, hereby voluntarily agree to have a venopuncture for blood samples to include blood chemistries and complete blood count, and also a urinanalysis.

These testing procedures do not carry any risk and do not imply any significant discomfort. The benefit is a more complete health status evaluation.

I am free to terminate my consent and to discontinue participation in these procedures at any time without prejudice to myself.

The results of the above-mentioned tests will be included in the report on the findings of my examination, which will be sent to me.

(Signature)__________________________ (Date)_________________

OCCUPATIONAL HISTORY

ID# | | | B | 1

(Prior to Present Employer)

Period From/To	Type of Industry	Classification of Work	Dept	Description of Work	Exposures

Code these significant past exposures and time period:

1. Coal
2. Silica (other than a ceramics plant)
3. Asbestos
4. Welding
5. Other dust
6. Irritant gases and/or fumes

Exp	Year		Year
		to	5
		to	10
		to	15
		to	20
		to	25
		to	30

OCCUPATIONAL HISTORY - Present Plant

Period From/To	Job Title	Dept.	Description of Work	Exposures and Respiratory Protective Devices

INTERVIEWER: Please be sure to ask the following questions;

1. Do you have a second job in addition to working with Du-Co?
2. Do you have any hobbies or non-occupational activities that involve hazardous exposures
3. Do you live with anyone that works with chemicals or dust exposure?

Intvwr's Initials ________

ID # | | | C | 1 |

OCCUPATIONAL HISTORY - Present Job

Year started in current plant →			5
Total years in current plant →			7
Total years fibrogenic dust exposure (silica, talc, clay) (Include jobs prior to Duco, if applicable.) →			9
Year first dust exposure (Include jobs prior to Duco, if applicable.) →			11

CURRENT job assignment, exposure code, period

OTHER job assignments and level of exposure (Latest dates first)

Job and Exposure Code

Job		Exp.	Year			Year		
					to			13
					to			20
					to			27
					to			34
					to			41
					to			48

ID # | | | D | 1 |

PROTECTIVE EQUIPMENT and PERSONAL HYGIENE

INTERVIEWER: Circle positive answers and enter the code numbers and year started in columns.

Did you use a filter respirator?
01. Infrequently
02. Occasionally
03. Usually

Did you use a cartridge respirator?
04. Infrequently
05. Occasionally
06. Usually

Did you use an air supply respirator?
07. Infrequently
08. Occasionally
09. Usually

10. Are gloves used?
11. Are separate work clothes used?
12. Are separate lockers provided for street and working clothes?
13. Are work clothes laundered by company?
14. Do you wash your hands before eating?
15. Do you wash your hands before smoking?
16. Do you shower before leaving the plant?
17. Do you eat in a specially designated, clean area?
18. Do you eat at your work site?
19. Do you smoke at your work site?

Code		Year		
				5
				9
				13
				17
				21
				25
				29

Code		Year		
				33
				37
				41
				45
				49
				53

RESPIRATORY QUESTIONNAIRE

These questions are mainly about your chest. Please answer YES or NO whenever possible. INTERVIEWER: Circle all positive answers and enter code on following page.

Cough

01. Do you usually cough first thing in the morning?
(Count a cough with first smoke or on first going out of doors. Exclude clearing throat or single cough.)

02. Do you usually cough during the day? (Ignore occasional cough.)

03. If yes, do you cough like this on most days for as much as 3 months of year?

Have you been coughing like this:
04. No persistent cough
05. Less than 2 years
06. More than 2 years

Phlegm

07. Do you usually bring up phlegm from your chest first thing in the morning? (Count phlegm with first smoke or on first going out of doors, or swallowed phlegm. Exclude phlegm from nose.)

08. Do you usually bring up phlegm from your chest during your waking hours?

09. If yes, do you bring up phlegm like this on most days for as much as 3 months each year?

Have you done so for:
10. No persistent phlegm production
11. Less than 2 years
12. More than 2 years

What color is your sputum or phlegm?
13. Does not apply
14. Whitish
15. Yellow and/or green
16. Grey and/or black

Is your cough and/or phlegm related to any season?
17. Does not apply
18. Spring
19. Summer
20. Fall
21. Winter
22. All year

23. In the past 3 years have you had period of (increased) cough and phlegm lasting 3 weeks or more?

24. If yes, more than one such period?

Have you ever coughed up blood?
25. Only occasionally
26. Only occasionally with severe cold
27. Sputum streaked with blood (frequently)
28. Hemorrhage
29. Other

____

30. If yes, was this in the past year?

Breathlessness

31. Are you troubled by shortness of breath when hurrying on level ground?

32. If yes, do you get short of breath walking with other people your age?

33. If yes, do you have to stop for breath when walking at your own pace on level ground?

Wheezing

34. Does your chest ever sound wheezing or whistling?

35. If yes, do you get this most days, nights, or both?

36. Have you ever had attacks of shortness of breath with wheezing?

37. If yes, was your breathing normal between attacks?

Weather

38. Does the weather affect your chest? (Record YES only if adverse weather definitely and regularly causes chest symptoms.)

39. If yes, does the weather make you short of breath?

What kind of weather?
40. Heat
41. Cold
42. Dampness
43. Dryness
44. Any extreme

Nasal Catarrah

45. Do you usually have a stuffy nose or catarrah at the back of your nose in the winter?

46. Do you have this in the summer?

Chest Illnesses

ID | | | | E | 1 |

ENTER BELOW ALL POSITIVE RESPONSES TO QUESTIONS 1 - 51

START HERE ↓

		5			25			45
		7			27			47
		9			29			49
		11			31			51
		13			33			53
		15			35			55
		17			37			57
		19			39			59
		21			41			61
		23			43			

47. During the past three years have you had any chest illness which has kept you from your usual activities as much as a week?

48. If yes, did you bring up more phlegm than usual in any of these illnesses?

49. How many illnesses like this in the past three years?

50. 1 - 2

. 3 or more

51. Do you have a heart condition for which you are under a doctor's care?

If yes, specify condition and drug therapy:

____

____

Tobacco Use

52. Do you now smoke cigarettes? → [63] 1=YES

53. IF NO: Have you ever smoked cigarettes? (Count as YES anyone who has smoked more than 1 cig/day) → [64] 2=NO

IF NO to both questions, proceed to question 54.

How old were you when you started smoking regularly? → [65]

How old were you when you last gave up smoking cigarettes? → [67]

In what year did you stop smoking? → [69]

How many do/did you smoke on the average? (cig. NOT packs) → [71]

Do/did you inhale the cigarette smoke? → [73] 1=YES 2=NO

What do/did you mostly smoke? Type: 1 = filter, 2 = non-filter, 3 = NA → [74]

Size: 1 = regular, 2 = king size, 3 = 100 millimeter → [75]

54. Do you smoke a pipe? → [76]

55. IF NO: Have you ever smoked a pipe? (more than 1/day) → [77] 1=YES

56. Do you smoke cigars? → [78] 2=NO

57. IF NO: Have you ever smoked cigars? → [79]

58. DOES THE PHYSICIAN THINK THAT THE PATIENT FULFILLS CRITERIA FOR CHRONIC BRONCHITIS? 1 = yes, 2 = no, 3 = can't specify → [80]

ID # | | | | F | 1 |

Alcohol

Do you drink alcoholic beverages? → (1= yes; 2= no) [ ] 5

IF NO: How old were you when you gave up drinking? → [ ] 6

IF YES: How old were you when you first started to drink? → [ ] 8

About how often do you drink some kind of alcoholic beverage? → [0] 10

1= daily 3= 1-2 times/wk 5= less than 1/mo
2= 3-4 times/wk 4= 1-2 times/mo 6= NA

When you drink beer, about how many 12 oz. cans/bottles do you usually drink? (Record 00 if doesn't drink beer.) → [ ] 12

How many 12 oz. cans/bottles per week on the average? → [ ] 14

When you drink wine, about how many glasses do you usually drink? (Record 00 if does not drink wine.) → [ ] 16

How many glasses of wine/week on the average? → [ ] 18

When you drink mixed drinks/liquor, about how many drinks do you usually have? (Record 00 if does not drink liquor.) → [ ] 20

About how many shots/week do you usually drink? (10 shots= 1 pint) → [ ] 22

Have your drinking habits changed over time? (1= yes; 2= no) → [ ] 24

If you reduced your alcoholic beverage intake, indicate the year: → [ ] 25

FOR PHYSICIAN: If an ex-alcoholic, indicate the year in which discontinued drinking. → [ ] 27

(PUNCHER: Continue Card F on next page)

PAST MEDICAL HISTORY

ID # [| |]

puncher: do not punch

Age: [| | 29]   Sex: (0= female; 1= male) [| 31]

PHYSICIAN: Summarize from MRC questionnaire:

Smoking history: 1= never smoked 2= current smoker 3= ex-smoker [| 32]

Chronic bronchitis: 1= present 2= absent 3= can't specify [| 33]

Have you ever been hospitalized?

Date	Hospital	Reason

Have release forms been signed? ____________________

When did you have your last chest x-ray? Month / Year [| | | | 34]

Medications

01. Diuretics (water pills)
02. High blood pressure meds (other)
03. Nitroglycerine
04. Digitalis
05. Other cardiac
06. Antihyperlipidemics
07. Anticoagulants (blood thinners)
08. TB medication
09. Long-term antibiotics
10. Short-term antibiotics
11. Steroids - oral
12. Steroids - topical
13. Broncho-dilators
14. Insulin
15. Oral diabetes meds
16. Thyroid meds
17. Gout medication
18. Tranquilizers
19. Anti-depressants
20. Anti-psychotics
21. Sleeping pills daily
22. Have you ever had radiotherapy?
23. Anti-convulsants
24. Anti-inflammatories
25. Laxatives
26. Antihistamines
27. Decongestants
28. Analgesics
29. Antacids
30. Other ____________

Record below all medications currently used by patient.

		38			46			54
		40			48			56
		42			50			58
		44			52			60

PAST MEDICAL HISTORY (contd.)

PHYSICIAN : Circle all positive answers and enter code on following page

Have you ever been told by a doctor that you had any of the following conditions? INDICATE YEAR diagnosis established.

Cardio-Vascular

01. Heart murmur
02. High blood pressure
03. Heart attack
04. Angina
05. Claudication
06. Any other heart condition for which you are under a doctor's care?

07. Other

Pulmonary

08. Pneumonia
09. Pleurisy
10. Asthma
11. Bronchitis
12. Emphysema
13. Bronchiectasis
14. Pulmonary tuberculosis
15. Other

Gastrointestinal

16. Gastric or duodenal ulcer - told by MD
17. Gastric or duodenal ulcer - UGIS
18. Bleeding from ulcer
19. Other GI bleeding
20. Hiatus hernia
21. Hepatitis
22. Jaundice
23. Gallbladder disease
24. Liver disease
25. Enlarged liver
26. Cirrhosis
27. Ulcerative colitis
28. Diverticulitis
29. Other

Genitourinary

30. Kidney disease (indicate type)

31. Kidney stones
32. Urinary infection
33. Blood in urine (not caused by above)
34. Protein in urine (not caused by above)

If male:

35. Prostate enlargement
36. Vasectomy

If female:

37. Hysterectomy
38. Menometrorrhagia
39. Tubal ligation
40. Other

Skin

41. Psoriasis
42. Eczema
43. Other

Blood

44. Anemia
45. Low white blood count
46. Sickle cell
47. Thallassemia
48. Other

ENT

49. Glaucoma
50. Cataracts
51. Weak or lazy eye
52. Optic neuritis
53. Impaired hearing
54. Meniere's syndrome
55. Other

Nervous System

56. Seizure disorder
57. Stroke
58. Parkinson's Disease
59. Migraine headaches
60. Psychiatric illness
61. Other

____

Accidents

62. Job
63. Automobile
64. Other

____

Type of injury:

____

Musculoskeletal

65. Rheumatoid arthritis
66. Other arthritis
67. Back injury
68. Degenerative disc disease
69. (With neurologic involvement)
70. Other

____

Metabolic

71. Thyroid disease or goiter
72. Diabetes
73. Gout
74. Fever (unexplained)
75. Other

____

Cancer

76. Skin
77. Throat
78. Lung
79. Stomach
80. Bowel
81. Rectum
82. Prostate
83. Breast
84. Cervical
85. Uterine
86. Other

____

87. Other (not listed above)

____

____

____

ID #

			G	1

Code		Year		
				5
				9
				13
				17
				21
				25
				29
				33
				37
				41

Enter above all positive responses

PHYSICAL EXAMINATION

ID = [| | | H | 1]

Height: [| | 5]
(In inches)

Weight: [| | | 7]
(In lbs.)

Age: [| | 10]

Sex: [| 12]
(0= female; 1= male)

Pulse rate: [| | | 13]
(80= 080)

Blood pressure: [| | / | | 16]
(120/80= 120/080)

Race: [| 22]
1= White
2= Black
3= American Indian
4= Oriental

EXAMINING PHYSICIAN: [| | 23]

01= And'son	05= Hlstein	09= S'koff
02= Daum	06= Lilis	10= Velez
03= F'bein	07= Moses	11=
04= Frank	08= R'man	12=

URINALYSIS:

Protein: [| 25]
0= -
1= +
2= ++
3= +++

Glucose: [| 26]
0= -
1= +
2= ++
3= +++

Hematocrit [| | 27]

PUNCHER: Card H continues on page 17

PHYSICAL EXAMINATION (Continued)

INSTRUCTIONS: Check box in front of each group of findings; record positive findings in summary box on next page using the code number of finding.

Nl. Abn. [ ] [ ] **Heart Rate**
01. Irregular
Other ____________

Nl. Abn. [ ] [ ] **General Appearance**
02. Obese
03. Underweight
04. Appears chronically ill
05. Pale
06. Cyanotic
Other ____________

Nl. Abn. [ ] [ ] **Extremities**
07. Clubbing
08. Familial clubbing
09. Ankle edema
Other ____________

Nl. Abn. [ ] [ ] **Skin**
10. Seborrhea
11. Acne vulgaris
12. Psoriasis
13. Eczema
14. Warts
15. Folliculitis
16. Rash ____________
Other ____________

Nl. Abn. [ ] [ ] **Eyes**
17. Pupils (specify) ____________
18. Sclera icteric
19. Conjunctiva pale
20. Conjunctiva injected
Other ____________

Nl. Abn. [ ] [ ] **Mouth**
21. Gingivitis
22. Edentulous
Other ____________

Nl. Abn. [ ] [ ] **Thyroid**
23. Enlarged
24. Nodular
Other ____________

Nl. Abn. [ ] [ ] **Lymphadenopathy**
25. Cervical
26. Supraclavicular
27. Axillary
28. Inguinal
Other ____________

Nl. Abn. [ ] [ ] **Chest Inspection**
29. Increased AP diameter
30. Flaring of costal margins
31. Skeletal deformity
Other ____________

Nl. Abn. [ ] [ ] **Chest Percussion**
32. Dullness, right
33. Dullness, left
34. Dullness, bilateral
35. Hyper-resonant, right
36. Hyper-resonant, left
37. Hyper-resonant, bilateral
Other ____________

Nl. Abn. [ ] [ ] **Auscultation**
38. Decreased, right
39. Decreased, left
40. Decreased, bilaterally
41. Wheezing and/or rhonchi in localized area
42. Wheezing and/or rhonchi, diffuse
43. Lengthening of expiratory phase
44. Moist rales
Other ____________

Nl. Abn. [ ] [ ] **Rales**
45. RAAL
46. RPAL
47. RMAL
48. R-Base
49. LAAL
50. LPAL
51. LMAL
52. L-Base
53. Diffuse (more than 3)
Other ____________

ID # [| |] (Do not punch)

Nl. Abn. [|]

Heart Sounds

54. Murmur
55. Distant heart sounds
56. P II > A II

Other ______

Nl. Abn. [|]

Abdominal Tenderness to Palpation

57. RUQ
58. RLQ
59. Epigastric
60. Peri-umbilical
61. LUQ
62. LLQ
63. Diffuse

Other ______

Nl. Abn. [|]

Liver

64. Palpable
65. Tender

Span on mid-clavicular line:

66. 11 cm.
67. 12 cm.
68. 13+ cm.

Consistency:

69. Increased firmness
70. Irregular nodular

Other ______

Nl. Abn. [|]

Spleen

71. Palpable
72. Enlarged

Record 2 dimensions by percussion:

______ cm.

Nl. Abn. [|]

Kidneys

73. Palpable, right
74. Palpable, left

Nl. Abn. [|]

Abdominal Masses by Palpation

Location, size, consistency:

______

______

Nl. Abn. [|]

Deep Tendon Reflexes

75. Ankle - hyperactive
76. Ankle - decreased
77. Ankle - absent
78. Knee - hyperactive
79. Knee - decreased
80. Knee - absent

Nl. Abn. [|]

Tremor

81. Outstretched hands
82. Intentional
83. Face

Other ______

84. Other neurologic: ______

85. Other significant (from any preceding category): ______

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PHYSICIAN COMMENTS

(Include here all recommendations, use back if necessary)