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COMPREHENSIVE INDUSTRIAL HYGIENE SURVEY

OF

THE KOHLER COMPANY

CAMP KROFT

SPARTANBURG, SOUTH CAROLINA

SURVEY CONDUCTED BY:

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February 5, 1973

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Worker exposures to fibrous glass (14808607), free silica (7631869), and styrene monomer (100425) were determined at the Kohler Company (SIC-3431) in Spartanburg, South Carolina, during October 16 to 20, 1972. Noise exposures also were surveyed. Approximately 730 persons were employed at the facility. The company had onsite medical facilities staffed by three doctors and two nurses. The facility also maintained various safety and industrial hygiene programs. Fiber concentrations in the fibrous glass plastic operation ranged from 17.0 to 131.0 fibers per liter. Samples of total dust ranged from 0.21 to 5.74 milligrams per cubic meter (mg/cu m) for fibrous glass plastic operations. Concentrations of acetone (67641) ranged from undetectable to 130 parts per million (ppm). Concentrations of styrene were 7 to 188ppm. Detector tube samples for styrene monomer ranged from 70 to more than 400ppm. Personal silica dust, concentrations in the slip making area and casting area for vitreous china products ranged from 0.37 to 13.76mg/cu m, while stationary silica dust samples in the same area ranged from 0.14 to 4.17mg/cu m. Personal and stationary silca dust samples in the glaze mixing and spraying area ranged from 0.32 to 14.31mg/cu m. Noise levels ranged from 91 to 97 decibels, relative to the A weighted scale (dBA), compared with the current OSHA standard of 90 dBA. Styrene monomer and silica dust exposures exceeded current OSHA standards in several work sites. The author recommends improvements in the ventilation systems, use of appropriate respirators for exposed workers, and the use of hearing protection for slip batch operators.

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PLACE VISITED	:	Kohler Company Camp Kroft Spartanburg, South Carolina
DATES OF TRIP	:	October 16-20, 1972
PERSONS MAKING TRIP	:	Robert A. Curtis John M. Dement Harold J. Mangin Ralph D. Zumwalde
PERSONS CONTACTED	:	Donald M. Rowe, M.D., *Corporate Medical Directc* George Henley, *Corporate Safety Director* Marvin Dubois, *Plant Personnel & Safety Directc*
PURPOSE OF TRIP	:	To make a comprehensive industrial hygiene survey of both the fibrous glass and vitreous china operations.

INTRODUCTION

During the week of October 16-20, 1972, a comprehensive industrial hygiene survey was conducted at the Spartanburg, South Carolina facility of the Kohler Company. NIOSH personnel on the survey were Robert Curtis, John Dement, Harold Mangin and Ralph Zumwalde.

Products of this plant include fibrous glass and vitreous china bathroom fixtures. During the week approximately 120 air samples were taken in the various process areas to evaluate fibrous glass, free silica, styrene monomer and acetone exposures. A noise survey also was conducted. The following paragraphs describe the Spartanburg facility, sampling methods which were used, sample results and recommendations for improvements.

DESCRIPTION OF THE PLANT

The Spartanburg, South Carolina facility began operation in 1957 with the vitreous china operations. The fibrous glass reinforced plastics operation was not started until 1970 and is one of two such operations operated by the Kohler Company. The other fibrous glass operation is located in Toledo, Ohio. Corporate headquarters are located in Kohler, Wisconsin.

Products of this plant include fibrous glass and vitreous china bath fixtures. Plaster of paris molds for the vitreous china products also are made at the plant. Approximately 730 persons are employed at the plant with about 700 of these persons being blue collar workers. Only 30-40 of the employees work in the fibrous glass reinforced plastics operations. More than 80 percent of all production is done on the first shift.

MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

This plant has underway a number of excellent medical programs under the leadership of Dr. D. M. Rowe, Corporate Medical Director. Serving this plant are three local doctors and two full time nurses. In-plant medical facilities include several examination rooms, x-ray and audiometric testing equipment and a pulmonary function unit.

Pre-employment physicals are required of every new employee in addition to present employees returning from medical leave or from more than 30 days lay-off. The pre-employment examination includes a

14" x 17" chest x-ray, selective audiometry, serology, urinalysis, tuberculin skin test, x-rays of the lumbo-sacral spine including anterior-posterior and lateral views, sight screener tests, tetanus toxoid immunization, and pulmonary function tests for persons applying for work in the fibrous glass operations. In addition, prospective employees are required to complete a physical examination form (Attachment I) and an immunization history form (Attachment II). Persons 32 years and older also are required to take an EKG. Efforts are made to screen alcohol and drug problems with the pre-employment examination.

In addition to pre-employment examinations, each employee is required to undergo a yearly examination which includes a chest x-ray. Pulmonary function tests are provided for fibrous glass workers. Other special tests are given as indicated.

According to Dr. Rowe, the major problem in this plant has been back injuries resulting from lifting. The chest x-ray program has picked-up several coin lesions but no silicosis cases or problems attributed to fibrous glass. Sensitization from toluene-2-4-diisocynate (TDI) exposure has not been noted.

The safety programs at this plant are administered by Mr. Marvin Dubois who functions as both plant Personnel and Safety Director.

Consultation on safety matters is provided by Mr. George Henley, Corporate Safety Director, located in Kohler, Wisconsin. Safety programs are co-ordinated through the plant union (Pottery and Allied Workers Union).

Industrial hygiene matters in this plant have been taken care of chiefly by Liberty Mutual, Kohler Company's insurance carrier, who surveys the plant every two years. The last survey was in May, 1972. During this survey, samples for styrene vapor were taken in the fibrous glass operations along with samples for silica in the vitreous china operations. Silica results have not yet been reported to the plant. Sound level measurements have been made by the company in most areas. No octave-band analysis have been performed.

Current personal protection programs in force at the plant include the use of safety glasses in the fibrous glass operations, hearing protection (Swedish Wood) in appropriate areas, and respirator protection where needed. In the fibrous glass operation, persons applying polyurethane foam are required to wear American Optical respirators approved for organic vapors. In the vitreous china operations, slip batchers, raw material grinders, glaze batchers, and glaze spray operators are required to wear American Optical respirators approved for fumes and dusts

DESCRIPTION OF THE PROCESSES

Fibrous Glass Operations

Fibrous glass reinforced bath fixtures are made in this plant using polyester resins and chopped fibrous glass roving. A list of raw materials for this process is presented in Table 1. The polyester resin as received is dissolved in styrene (about 70 parts polyester to 30 parts styrene) and is applied to waxed molds in a series of spraying operations. Styrene serves as a cross linking agent and produces a polymer of superior mechanical properties. Methyl ethyl ketone peroxide is used as a catalyst to speed up the reaction. Cobalt nephthenate also is used as an accelerator.

In the process, waxed molds are first sprayed with a coating of polyester known as "Gelcoat". This coating has colors added to it and serves as the finished surface. After the "Gelcoat" has been sprayed, the mold is placed in a curing oven to further affect polymerization and drive off unreacted styrene monomer.

A series of two laminating operations follow the "Gelcoat" operation. In these laminating operations, polyester resins are fed through a metered pump and mixed with the catalyst at the spray nozzle. The resins and catalyst are then sprayed with chopped glass onto the mold. Following each laminating operation, workers hand roll the fibrous glass into the polyester. After rolling, the molds are again placed in ovens for curing.

The final step in the laminating operation is the addition of polyurethane foam for sound deadening and added strength. The polyurethane is applied in a spraying process and uses 2,4-toluene diisocyanate. Nitrogen dioxide is used as the gas propellant in the spray system. Methylene chloride is used to clean the polyurethane spray gun.

Vitreous China Operations

Raw Material Mixing and Casting

Vitreous china bath fixtures (commodes, lavatories, etc.) are manufactured in this plant by a "slip casting" process. A list of raw materials for this process is given in Table 1. Clays, silica and feldspar are the major raw materials. The principal clay minerals are kaolinite, montmorillionite, and illite. Kaolin and flint also are used in the mix. Since kaolins are refractory, the feldspar serves as a flux (low-melting material) and the flint tends to prevent warping and sagging during firing. Ball clay is utilized to increase the workability of the mixture during the forming process prior to drying and firing, to add strength to the final product and to serve as a source of aluminum oxide and silica.

A schematic flow diagram of the slip mixing and casting operations is shown in Figure 1. The raw materials, clay, silica (sand), flint, feldspar and other minor ingredients are held in large storage hoppers and weighed into a conveying cart according to the mix desired. (The raw materials on the cart are then emptied into a blunger (mixer) where beaters break up the clay materials and combine all the raw materials with water. All raw materials must be of very fine particle diameter in order for a uniform suspension to result. A deflocculent (sodium silicate) is sometimes added to affect suspension. The homogeneous mixture of water and solid materials produced in the blunger is known as "slip" and contains approximately 50 percent water. The "slip" is next screened to remove large particles and pumped into a second agitator tank before casting. The slip then is pumped to the casting stations.

In slip casting, the slip is poured into porous plaster of paris molds. The interior surfaces of the mold conform to the exterior surfaces of the ware to be molded. The water is absorbed by the plaster causing solid particles to build on the mold interior. The sodium silicate added to the mix keeps the solid particles in suspension and thus prevents forming thicker walls at the bottom of the mold. The mold is made in several parts for easy removal. Nepheline syenite is used as a dusting agent for the molds.

After the bath fixtures are removed from the molds, they undergo finishing by hand. This finishing corrects any imperfections in the shaping of the fixtures. Imperfections occur chiefly in seams of the molds and are removed by scrapping, carving, and grooving. Following the finishing process, the fixutres are placed in a drying oven to remove excess water.

Glazing and Kiln Firing

The next operation is to coat the fixtures with a ceramic glaze, which is manufactured at the plant. This glaze gives the products both color and a glossy finish. The glazes are mixed by hand from bags of the raw materials. The raw materials for a glaze batch are first emptied into a conveying hopper and then placed in a ball mixer for grinding, mixing and addition of water. After the materials are thoroughly mixed, they are pumped to large agitator tanks for storage until use. The glaze is applied by either an automatic or manual spraying process. A raw materials list for the glazes is given in Table 1.

Following the spray application of the glaze, the articles are placed in a kiln for firing. A tunnel kiln is used in this operation. A schematic diagram of a tunnel kiln is given in Figure 2. The fixtures are placed on a flat car and carried through the kiln where the temperatures are in excess of 2000°F. The color of the final product depends on the type of metal oxide added to the glaze (see raw material list of Table 1).

After leaving the kiln, the products are allowed to cool and flat surfaces such as commode bases are ground. The products are then inspected and packed for shipment.

INSPECTION OF THE PLANT

Potential Health Hazards

The following are potential health hazards which were noted during the survey:

1. Fibrous glass exposure (skin and respiratory)
2. Skin contact and respiratory exposure to styrene and acetone in fibrous glass-plastics operation

3. TDI exposure in polyurethane application of fibrous glass-plastics operation
4. Free silica exposure in various areas of the vitreous china operations
5. Exposure to metal oxides (see raw material list) in glaze batch and spray
6. High noise exposures in selected areas of both the fibrous glass and vitreous china operations

Housekeeping

In general, housekeeping in this plant is very good. The plant was built with expansion in mind; therefore, overcrowding is not a problem. Floor cleaning is done with both brooms and vacuum sweepers. Excessive use of compressed air for cleaning was not noted during the survey. Most cleaning operations are performed at the end of the first shift and during the second shift.

The slip casting area of the vitreous china operation is the dirtiest area in the plant. Slip casting is an inherently dirty operation and results in quantities of the slip being spilled onto the floor. As the slip dries, dust may arise from personnel and equipment movement through the area. A central vacuum system has been installed in this area for cleaning purposes; however, its use was not noted during the survey.

Ventilation

In the fibrous glass-plastics operation, spraying operations are conducted in ventilated spray booths equipped with a water screen. There are presently 6 booths in operation in this area, each rated at 18,000 cfm. Face velocities at the booth entrances were measured with an Alenor Velometer and found to be in excess of 100 fpm. Six more booths are planned for this area along with 4 make-up air units rated at 50,000 cfm each. Curing ovens for the styrene also are located in this area. Velocities at the oven openings were measured and found to be 50-75 fpm.

In the slip mixing area for the vitreous china products, local exhaust is provided at the bucket elevator for filling the storage hoppers, at the raw material discharge from the hoppers, and at the mixing blungers. Two "Wheelabrator" bag collectors are used with this system with a total design capacity of 62,350 cfm. Three roof fans also are located in the area with capacities of 24,000 cfm each. Hooding at each blunger consists of two inch slots located near the blunger entrance. Measurements at these hoods showed velocities to be extremely low. This was probably due to plugging as a result of low transport velocities in branches and mains.

Air conditioning allows the slip casting area to be maintained at 80°F, dry bulb, and 50 percent relative humidity. For purposes of product control a total of 9 air conditioning units are located in this area; the smallest having a capacity of 38,500 cfm and the largest a capacity of 42,000 cfm. Intake air is filtered through "American Roll-O-Mat" filters located at each unit. Air discharge grills are located approximately 15 ft. from the floor.

In the glaze mixing area, local exhaust ventilation is provided at the hand mixing station in the form of a slotted hood. Three roof fans rated at 24,000 cfm each (5 H.P.), also are located in the area. All spraying of the ceramic glaze is done in booths equipped with water screens. Hand spray booths are rated at 13,000 cfm each and automatic booths are rated at 20,000 cfm each.

The inspection and testing area for the vitreous china products is air conditioned. The system for this area is rated at 45,000 cfm. The finish product storage area is not air conditioned but is provided with 3 roof fans at 24,000 cfm each and two make-up air units at 40,000 cfm each. The kiln area is separated from other production areas by an aluminum curtain. A total of 10 roof fans rated at 50,000 cfm each are located over the kilns. Supply air for the kilns is maintained by 10 axial flow fans rated at 15,000 cfm each.

SURVEY PROCEDURES

Samples were collected in this plant for evaluating exposure to fibrous glass dust, styrene monomer, acetone and silica dust. A noise survey also was conducted. The following paragraphs describe the methods used to collect and analyze the air samples and make noise measurements.

Airborne fibrous glass samples were collected in the fibrous glass-plastics operation for evaluation by fiber count and total dust weight. Personal samples for fiber count were collected on Millipore Type AA cellulose ester membrane filters at a calibrated collection rate of 2.0 lpm with an open filter face. Fibers less than 10 microns in diameter (potentially respirable) were counted at 430X magnification (4mm acromatic objective with NA=0.65) by the phase contrast method recommended by NIOSH for asbestos fibers.[1] A size distribution (length and diameter) for airborne glass fibers also was determined using a "Leitz" rotating stage phase contrast microscope at 400X magnification and a calibrated "Porton" reticle.

Personal samples for total dust (silica and fibrous glass) were collected in the fibrous glass plastics and the vitreous china operations on Mine Safety Appliance (MSA) polyvinyl chloride membrane filters (5μ pore size) at a calibrated flow rate of 2.0 lpm. Three piece 37mm millipore filter holders were used with only the small plug removed (leaving a 4mm diameter opening). All filters were tared and re-weighed on the 20 milligram "A" scale of a Chan Gram Electrobalance. Total dust concentrations are reported in milligrams per cubic meter of air (mg/m^3).

Samples for styrene monomer and acetone were collected in the fibrous glass-plastics operation. These samples were collected by passing the vapors through activated charcoal at a sample rate of one lpm. All samples were taken over a ten minute timing period. Laboratory analyses for the absorbed solvents (acetone and styrene) were performed by desorption with carbon disulfide and introduction into a gas chromatograph equipped with a flame ionization detector.[7] Concentrations were computed by comparing the resulting curves with standard curves for styrene and acetone.

Several "Drager" (Monostyrene 50/a) detector tube samples for styrene also were taken in the fibrous glass-plastics operation.

Personal respirable samples for free silica were collected in the vitreous china operations. These samples were collected on MSA polyvinyl chloride filters using a 10mm nylon cyclone[2] presampler with an air flow rate of 1.7 lpm. Respirable sample pumps were fitted with pulsation dampeners as described by LaViolette and Reist.[3] Sample weighing procedures were the same as previously described for total dust samples.

In addition to personal samples, both total and respirable stationary samples for free silica were collected in the vitreous china operations. Total mass samples were collected on 37mm "Flotronics" silver membrane filters at a flow rate of 7.4 lpm. Respirable mass samples were collected using a horizontal elutriator presampler meeting the Walton[4] design criteria and 37mm (MSA) polyvinyl chloride filters at an air flow of 10.0 lpm. Constant flow was maintained in both sampling procedures by use of a critical orifice with a regain section.

Air samples for free silica were analyzed in two ways. All samples collected on polyvinyl chloride filters (personal and general air) were analyzed using the colorimetric method of Talvitie.[5] General air samples collected on silver membrane filters were analyzed using x-ray diffraction.[6]

In addition to air sampling, noise level measurements were made in most areas. The measurements were made on both the "A"-slow and "C"-slow scales in order to provide some indication of the frequency distribution of the noise. A General Radio Type 1565-A sound level meter calibrated with a Type 1562-A calibrator was used for all measurements.

RESULTS AND DISCUSSION

Fibrous Glass Plastics Operations

Results of air samples for both fiber count and total dust weight in the fibrous glass-plastics operation are shown in Tables 2 and 3. Although no meaningful standard for fibrous glass exposure has yet been extablished, levels found in this plant would appear low based on results of either sample method. The highest fiber concentration was found for a fibrous glass spray operator and was only 131 fibers ≤10 micrometers in diameter per liter of air. The highest total dust concentrations were found for cutter and grinder operators. Comparing these values with the simultaneous count samples shows that most of the dust in the cutting and grinding area was most likely plastic material rather than fibrous glass. Plastic dust concentrations do appear to be excessive in hand cutting and grinding operations.

An airborne fiber size distribution for the fibrous glass operation is given in Figure 3 of the Appendix. The median diameter was found to be approximately 4.0 microns and the median length approximately 35 microns. Although the respirability of airborne fibers is not clearly understood, it is speculated that this characteristic is chiefly diameter dependent and fibers greater than 10 microns in diameter have little chance in reaching the deep pulmonary spaces. Trimbrell[8] suggests that fibers with densities of less than 3.5 g/cm^3 and large length to diameter ratios could be respirable if the fiber diameters were less than 3.5 microns. Fibrous glass (borosilicate glass) satisfies the density requirement and the results of the fiber distribution presented in Figure 3 show that many fibers would most likely satisfy the length to diameter ratio requirement. However, only approximately 30 percent of all fibers are less than 3.5 microns in diameter. If Trimbrell's work is accepted, only small amounts of respirable fibers are present in these operations. Although one can only speculate at this time, it would appear that such small fiber concentrations would not cause serious respiratory problems based on past studies.

Results of carbon tube and detector tube samples for acetone and styrene in the fibrous glass operations are given in Tables 4 and 5. Carbon tube samples may be considered average concentrations for the 10 minute sample period whereas detector tube samples are instantaneous samples. Highest concentrations of both acetone and styrene were found in the area of the roll-out operators. The highest 10 minute average concentrations as determined by carbon tubes were 130 ppm of acetone and 188 ppm of styrene. The highest instantaneous concentration of styrene was 400 ppm found during the roll-out of the lower portion of a mold. Higher concentrations of styrene near the floor are probable as styrene is considerably heavier than air.

Present OSHA standards for acetone and styrene are 1000 and 100 ppm respectively based on an 8-hour time weighted average exposure. No acetone sample approached the present standard; however, roll-out operators had both average and instantaneous styrene concentrations far in excess of the present standard. The 10 minute carbon tube samples appear to be good indicators of the 8-hour average exposure as samples for each operator give approximately the same concentration. These results also compare favorably with those obtained by the Liberty Mutual survey. A more restrictive standard for styrene exposure may be proposed in the near future.

The company is presently considering two solutions to the high styrene concentrations in the fibrous glass roll-out operations. One solution is the addition of costly roll-out booths using downdraft ventilation (as styrene is heavier than air). The other solution being considered is the use of dilution ventilation provided by fans placed in the roof and forcing fresh air over the roll-out operations. While the second solution is much less costly, it is unlikely that dilution ventilation will bring styrene concentrations to acceptable levels. First of all, dilution ventilation is not recommended for substances with high toxicity (substances with standards less than approximately 500 ppm). Secondly, dilution ventilation has little chance of being effective when workers are located near the point of emission as is the case with this operation. Finally, the quantity of styrene emitted at the roll-out operations is most likely too high to be diluted to any appreciable extent. In addition, expanding operations (addition of another whole line) planned for this area can only make the situation worse.

Although no samples were taken for TDI in the fibrous glass area, this problem would appear minimal as control measures are quite good. All TDI spraying is done in one well ventilated booth (entrance velocities in excess of 100 fpm) and the spray operator wears a respirator approved for organic vapors.

Vitreous China Operations

Silica sample results for the vitreous china slip mixing and casting operations are shown in Tables 6 and 7. Figure 4 shows a comparison of these sample results with present OSHA standards for silica exposure. The comparison shows that many samples are considerably in excess of present standards. The highest personal sample concentrations were found for slip batchers and slip casters. Analysis of the stationary samples shows the most out of control areas to be at the primary blungers and at the screen station. Velocity measurement at the blunger slot hoods showed very little air flow indicating plugging. Stationary samples in the hopper room show this area to be in rather good control. High concentrations for the one slip caster samples P-59 and P-73 may be attributed to the fact that the caster was doing finishing work (sanding, etc.) during the sample period.

Silica sample results in the vitreous china glaze batch and spraying operations are given in Table 8 along with a comparison of these results with present silica exposure standards in Figure 5. All samples in these areas were either equal to or greater than the present OSHA standards. Glaze spray painters apparently receive the highest exposures with large amounts of the dust being respirable. Ventilation at the batch station and spray booths is not sufficient to maintain exposures below present standards.

In addition to silica analysis in the glaze operations, three samples (MSA-115, MSA-116, and MSA-118) were analyzed for trace metals (see Table 1, Raw Material List). Insignificant amounts of these metals were found to be present.

Noise Survey

Results of the noise survey are shown in Table 9 of the Appendix. Eleven of the 14 measurements made were in excess of the present OSHA standard of 90 dBA. In the fibrous glass area, router and sander operators had excessive exposures and were not wearing hearing protection. In the vitreous china slip mixing operation levels of 97 dBA were measured during the dumping of the raw materials into the mixer (due to the vibrator used). Workers in this area wear no hearing protection. Fibrous glass laminators and glaze painters currently wear hearing protection (Swedish wool). Comparison of the "A" and "C" scale values for each measurement shows that "C" readings are higher than "A" readings indicating a prevalence of low frequency noise probably below 600 Hz.[9]

CONCLUSIONS AND RECOMMENDATIONS

From the industrial hygiene survey and the sample results the following conclusions are drawn and recommendations for improvements made:

1. Although no meaningful exposure standard has yet been established for fibrous glass, exposures in this plant would appear low based on fiber count and total dust. Addition of local exhaust ventilation at the hand finishing operations (cutting and grinding) is indicated as plastic dust exposures probably are excessive.

2. Styrene monomer exposures during roll-out in the fibrous glass operations are excessive. Addition of roll-out booths with downdraft ventilation in this area is indicated as it would appear that dilution will not bring levels below present OSHA standards.

3. Silica dust exposures in the slip mixing operations are in excess of present OSHA standards. The major problem in this area appears to be poor ventilation at the primary blungers. Apparently, transport velocities in the ducts and mains are not sufficient to prevent plugging. It appears that the system needs to be redesigned to provide appropriate transport velocities and more clean-out ports.

4. Silica dust exposures during finishing operations (sanding) in the slip casting operation are in excess of present OSHA standards. As this operation is intermittant, respiratory protection would appear sufficient. Slip casters should be required to wear Bureau of Mines approved respirators for pneumoconiosis producing dusts during sanding operations.

5. Glaze batch operators also are exposed to free silica in excess of present OSHA standards. The major problem in this area appears to be poor ventilation at the hand mixing station. The slot hood used at this station apparently provides poor air distribution resulting in little air being drawn at the front of the hood where most mixing takes place. This hood should be redesigned to provide better distribution of ventilation air.

6. Glaze spray operators are exposed to silica dust in excess of present OSHA standards. Air volumes through the spray hoods apparently need to be increased to provide the necessary control. Hood entrance velocities in excess of 200 fpm may be necessary to provide control of these operations.

7. Slip batch operators in the vitreous china operations and router and sander operators in the fibrous glass operations are exposed to noise levels in excess of present OSHA standards and are not wearing protection. These workers should be required to wear hearing protection during noisy operations.

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A P P E N D I X

TABLES

FIGURES

ATTACHMENTS

TABLE 1

RAW MATERIALS FOR THE KOHLER COMPANY

Spartanburg, South Carolina

I. FIBROUS GLASS REINFORCED BATH FIXTURES

	MATERIAL	*RECEIVED*
1.	Polyester Coating (Gelcoat)	Drum
2.	Polyester Resin	Drum
3.	Catalyst, 60% Methyl Ethyl Keytone in Dimethyl Phthalate	Plastic Container
4.	Polyurethane Foam (TDI)	Drum
5.	Fibrous Glass Roving	Rolls
6.	Acetone	Plastic Container
7.	Methylene Chloride	Plastic Container
8.	Nitrogen Dioxide	Cylinder
9.	Paste Wax	Can

II. VITREOUS CHINA SLIP PRODUCTION

	MATERIAL	*RECEIVED*
1.	Black Charm Ball Clay	Hopper Car
2.	C&C Ball Clay	Hopper Car
3.	Band Black Ball Clay	Hopper Car
4.	L-1 Ball Clay	Hopper Car
5.	Kaolin China Clay	Hopper Car
6.	Monarch China Clay	Hopper Car
7.	Flint	Hopper Car
8.	Feldspar	Hopper Car
9.	Spartan Sand (Flint & Feldspar)	Hopper Car
10.	Soda Ash (minor ingredient)	Bag
11.	Sodium Silicate (minor ingredient)	Bag

TABLE 1 (cont'd)

III. VITREOUS CHINA GLAZE PRODUCTION

	MATERIAL	RECEIVED
1.	Feldspar	Bag
2.	Flint	Bag
3.	Wallastonite (combined CaO and SiO_2)	Bag
4.	N.Y. Talc (minor ingredient)	Bag
5.	Zinc Oxide	Bag
6.	Zerconium Silicate	Bag
7.	Hydrated Alumina	Bag
8.	China Clay	Bag
9.	Black Charm Ball Clay	Bag
10.	Glass Frit	Bag
11.	Metal Oxides for Colors (Zirconium, Cobalt, Nickel, Iron, Vanadium)	Bag

IV. SLIP CASTING

MATERIAL	RECEIVED
Nepheline Syenite (dusting agent)	Bag

TABLE 2

RESULTS OF PERSONAL SAMPLES FOR FIBER COUNT
IN
FIBROUS GLASS-PLASTIC OPERATION

KOHLER COMPANY
Spartanburg, South Carolina

SAMPLE #	*OPERATION*	*AVERAGE FIBERS/FIELD ≤10μDIA.*	*AIR VOLUME LITERS*	*FIBER CONC. FIBERS ≤10μ IN DIAMETER PER LITER*	*SIMULTANEOU WEIGHT SAMPLE #*
M-539	Fibrous Glass Spray Operator	0.08	470	26.0	P-96
M-545	Fibrous Glass Spray Operator	0.18	210	131.0	P-95
M-549	Fibrous Glass Spray Operator	0.18	580	47.0	P-54
M-550	Fibrous Glass Spray Operator	0.10	280	55.0	P-43
M-551	Fibrous Glass Spray Operator	0.16	340	72.0	P-98
M-552	Fibrous Glass Spray Operator	0.18	320	86.0	None
M-557	Fibrous Glass Spray Operator	0.08	520	23.0	P-97
M-001	Cut and Grind	0.06	540	17.0	P-67
M-541	Cut and Grind	0.10	340	45.0	P-71
M-546	Cut and Grind	Void*	520	----	P-42

* *Too heavy a particulate concentration to allow an accurate count*

TABLE 3

RESULTS OF PERSONAL SAMPLES FOR TOTAL DUST
IN
FIBROUS GLASS-PLASTIC OPERATION

KOHLER COMPANY

Spartanburg, South Carolina

SAMPLE #	*OPERATION*	*TOTAL DUST WT., Mg*	*AIR VOLUME M^3*	*CONCENTRATION Mg/M^3*	*SIMULTANEOUS COUNT, SAMPLE*
P-43	Fibrous Glass Spray Operation	0.17	0.28	0.61	M-550
P-54	Fibrous Glass Spray Operation	3.33	0.58	5.74	M-549
P-72	Fibrous Glass Spray Operation	0.08	0.58	0.14	-----
P-95	Fibrous Glass Spray Operation	0.07	0.34	0.21	M-545
P-96	Fibrous Glass Spray Operation	0.15	0.32	0.47	M-539
P-97	Fibrous Glass Spray Operation	0.17	0.52	0.33	M-557
P-98	Fibrous Glass Spray Operation	0.15	0.34	0.44	M-551
P-42	Cut and Grind	0.64	0.52	1.23	M-546
P-67	Cut and Grind	2.67	0.54	4.94	M-001
P-71	Cut and Grind	2.06	0.46	4.48	M-541

TABLE 4

RESULTS OF CARBON TUBE SAMPLES FOR ACETONE AND STYRENE

IN

FIBROUS GLASS REINFORCED PLASTICS OPERATION

KOHLER COMPANY

Spartanburg, South Carolina

TUBE #	*OPERATOR OR AREA SAMPLED*	*ACETONE CONC.**		*STYRENE CONC.**	
		Mg/M³	*PPM*	*Mg/M³*	*PPM*
1	Fibrous Glass Laminator	5	2	96	23
2	Fibrous Glass Laminator	35	15	112	27
3	Fibrous Glass Laminator	4	1	92	22
4	Fibrous Glass Laminator	5	2	98	23
5	Polyurethane Spray Operator	11	6	34	8
6	Gelcoat Spray Operator	11	6	79	19
7	Outside Gelcoat Booth	20	8	75	18
8	Fibrous Glass Laminator	88	37	137	33
9	Fibrous Glass Laminator	62	26	131	31
10	Roll-Out Operator	313	130	788	188
11	Roll-Out Operator	244	102	593	141
12	Roll-Out Operator	186	78	730	174
13	Roll-Out Operator	123	51	358	85
14	Polyurethane Spray Operator	ND**	ND	29	7
15	Polyurethane Spray Operator	ND	ND	29	7
16	Roll-Out Operator	26	11	112	27
18	Roll-Out Operator	27	11	51	12
19	Roll-Out Operator	66	28	132	31

* *All samples were 10 minutes in duration at 1.0 lpm flow*
** *None Detected*

Present OSHA standards for styrene and acetone are 100 and 1000ppm respectively based on an 8-hour time weighted average exposure.

TABLE 5

DETECTOR TUBE SAMPLES FOR STYRENE MONOMER

KOHLER COMPANY

Spartanburg, South Carolina

SAMPLE #	*SAMPLE LOCATION*	*APPROXIMATE STYRENE CONCENTRATION, PPM*
1	Gelcoat Spray Operator	70-80
2	Gelcoat Spray Operator	100
3	Fibrous Glass Laminator	70-80
4	At Roll-Out Operator, Rolling Lower Portion of Mold	>400
5	At Roll-Out Operator, Rolling Lower Portion of Mold	300

Present OSHA standard for styrene and acetone are 100 and 1000ppm respectively based on an 8-hour time weighted average exposure.

TABLE 6

PERSONAL SILICA DUST SAMPLES

IN

SLIP MIXING AND CASTING OF VITREOUS CHINA PRODUCTS

KOHLER COMPANY

Spartanburg, South Carolina

SAMPLE #	*JOB TITLE*	*TYPE OF SAMPLE*	*TOTAL DUST WT., Mg*	*AIR VOLUME M^3*	*CONC. Mg/M^3*	*% FREE SiO_2*
P-69	Slip Batcher*	Resp.	0.42	0.59	0.71	19.0
P-49	Slip Batcher*	Total	1.64	0.70	2.34	3.7
P-46	Slip Batcher*	Resp.	1.10	0.59	1.86	13.6
P-48	Slip Batcher*	Total	7.64	0.70	10.91	18.6
P-60	Slip Pumper	Resp.	0.47	0.50	0.94	14.9
P-45	Slip Pumper	Total	2.70	0.59	4.58	7.4
P-64	Slip Pumper	Resp.	0.64	0.59	1.09	10.9
P-44	Slip Pumper	Total	3.33	0.69	4.83	23.4
P-58	Raw Material Unloader*	Resp.	0.55	0.57	0.97	20.0
P-65	Raw Material Unloader*	Total	Void	----	----	----
P-50	Scrap Reclaimer	Resp.	0.81	0.61	1.33	15.1
P-75	Scrap Reclaimer	Total	1.26	0.72	1.75	10.0
P-62	Forklift Operator	Resp.	0.32	0.58	0.55	37.5
P-51	Forklift Operator	Total	2.24	0.68	3.29	8.9
P-59	Slip Caster	Resp.	0.62	0.56	1.11	3.2
P-73	Slip Caster	Total	9.22	0.67	13.76	13.2
P-70	Slip Caster	Resp.	0.21	0.57	0.37	9.5
P-74	Slip Caster	Total	1.09	0.68	1.60	14.7

* *Worker wears a respirator*

TABLE 7

STATIONARY SILICA DUST SAMPLES
IN
SLIP MIXING AND CASTING OF VITREOUS CHINA PRODUCTS

KOHLER COMPANY

Spartanburg, South Carolina

SAMPLE #	*LOCATION*	*TYPE OF SAMPLE*	*TOTAL DUST WT., Mg*	*AIR VOLUME M^3*	*CONC. Mg/M^3*	*% FREE SiO_2*
MSA-111	Midway of Hopper Room	Resp.	0.94	4.15	0.23	33.0
Ag-26	Midway of Hopper Room	Total	2.0	2.92	0.69	17.0
MSA-112	In Hopper Room	Resp.	0.51	3.77	0.14	13.7
Ag-27	In Hopper Room	Total	1.1	2.90	0.38	10.0
MSA-113	Near Primary Blungers	Resp.	4.99	3.29	1.52	11.2
Ag-28	Near Primary Blungers	Total	9.45	2.32	4.07	10.0
MSA-114	At Screen Station	Resp.	3.94	2.96	1.33	7.4
Ag-29	At Screen Station	Total	9.50	2.28	4.17	15.0
MSA-121	In Slip Casting	Resp.	0.59	3.22	0.18	10.2
Ag-34	In Slip Casting	Total	1.55	2.48	0.63	16.0

TABLE 8

PERSONAL AND STATIONARY SILICA DUST SAMPLES
IN
GLAZE MIXING AND SPRAYING

KOHLER COMPANY

Spartanburg, South Carolina

SAMPLE #	*JOB TITLE OR LOCATION***	*TYPE OF SAMPLE*	*DUST WT. Mg*	*AIR VOLUME M^3*	*CONC. Mg/M^3*	*% FREE SiO_2*
P-55	Glaze Batcher	Resp.	0.49	0.49	1.00	10.2
MSA-118	Glaze Batcher	Total	4.31	0.57	7.56	10.0*
MSA-119	Glaze Batcher	Resp.	0.16	0.50	0.32	31.3
P-63	Glaze Batcher	Total	1.60	0.59	2.71	9.4
P-53	Spray Painter, Glaze	Resp.	0.52	0.57	0.91	20.0
MSA-116	Spray Painter, Glaze	Total	4.18	0.67	6.24	15.0*
P-56	Spray Painter, Glaze	Resp.	0.27	0.57	0.47	33.3
P-68	Spray Painter, Glaze	Total	0.79	0.67	1.18	25.3
P-61	Spray Painter, Glaze	Resp.	1.20	0.58	2.07	11.7
MSA-115	Spray Painter, Glaze	Total	9.73	0.68	14.31	16.0*
P-66	Spray Painter, Glaze	Resp.	0.27	0.58	0.47	51.9
MSA-120	Spray Painter, Glaze	Total	1.24	0.68	1.82	41.7
P-57	Approx. 25' from Glaze Batch	Resp.	1.53	3.46	0.44	22.2
Ag-30	Approx. 25' from Glaze Batch	Total	5.90	2.51	2.35	115.0

* *These samples used for trace metals analysis also.*

** *Glaze batchers and spray painters wear respirators.*

TABLE 9

NOISE SURVEY RESULTS

KOHLER COMPANY

Spartanburg, South Carolina

MEASUREMENT #	*PERSON EXPOSED*	*PREDOMINANT NOISE SOURCE*	*SOUND LEVEL, DECIBELS As*	*Cs*
1	Router Operator, Fibrous Glass	Hand Router	98	--
2	Sander Operator, Fibrous Glass	Hand Sander	94	95
3	Fibrous Glass Laminator	Spray Gun	93	93+
4	Fibrous Glass Laminator	Spray Gun	93	95
5	Fibrous Glass Laminator	Spray Gun	92	94
6	Gelcoat Spray Applicator	Spray Gun	86+	83+
7	Vitreous China Mixer	Primary Blunger	82	85
8	Vitreous China Mixer	Vibrator During Cart Dump	97	92
9	Vitreous China Finisher	Bottom Grinder, Commodes	92	95
10	Glaze Painter	Hand Spray Gun	85	91
11	Commode Glaze Painter	Hand Spray Gun	95	97
12	Automatic Glaze Painter	Automatic Spray Gun	96-99	96
13	Dual Glaze Spray Painter	2 Automatic Spray Guns	96	96
14	Commode Tank Painter	Automatic Spray Gun	92*	92

* *As $\tilde{}$106 during start-up (cleaning jet)*

The present OSHA standard for noise exposure is 90 dBA based on an 8-hour time weighted average exposure

34

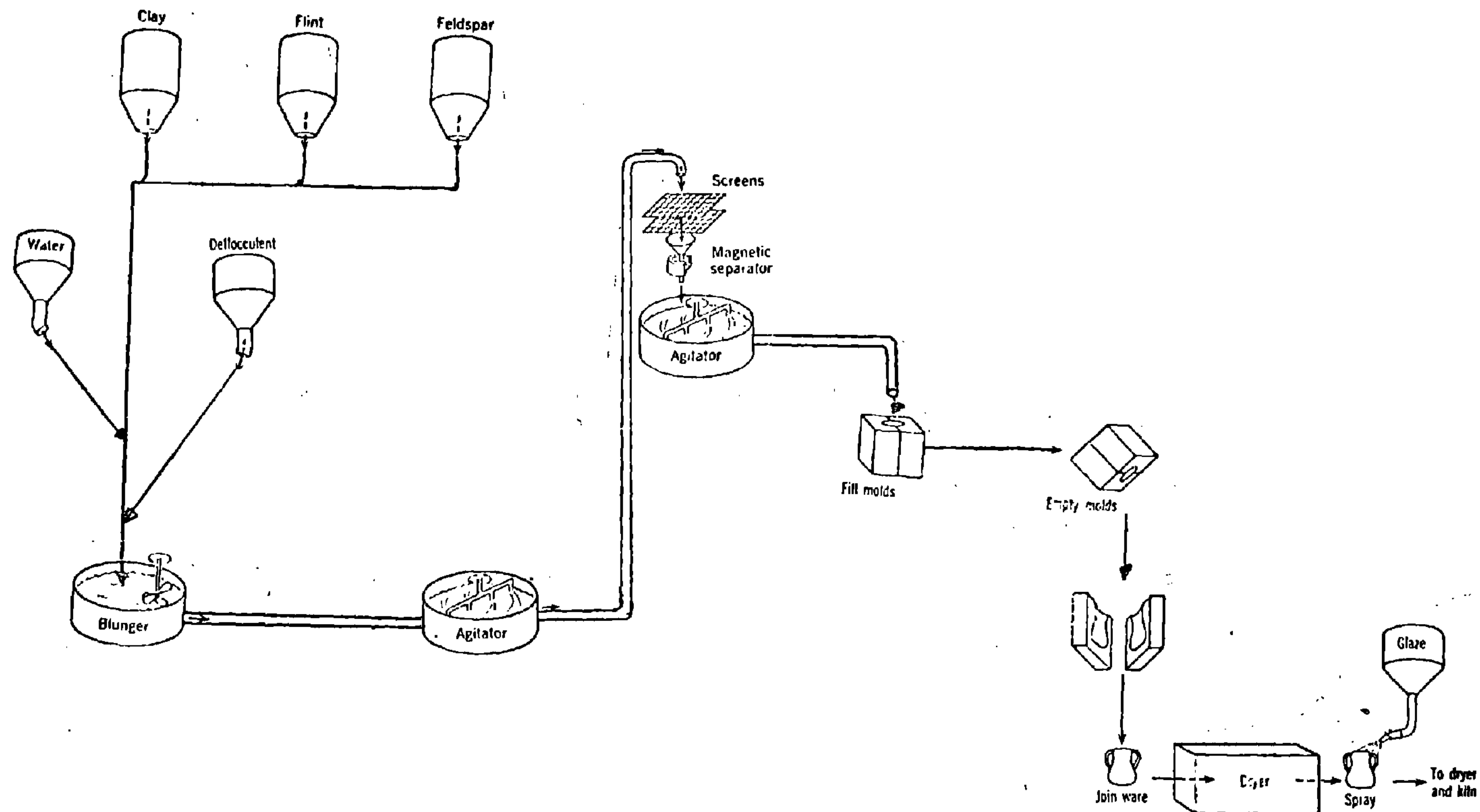


FIGURE: 1

SCHEMATIC DIAGRAM OF MIXING & CASTING VITREOUS CHINA OPERATIONS

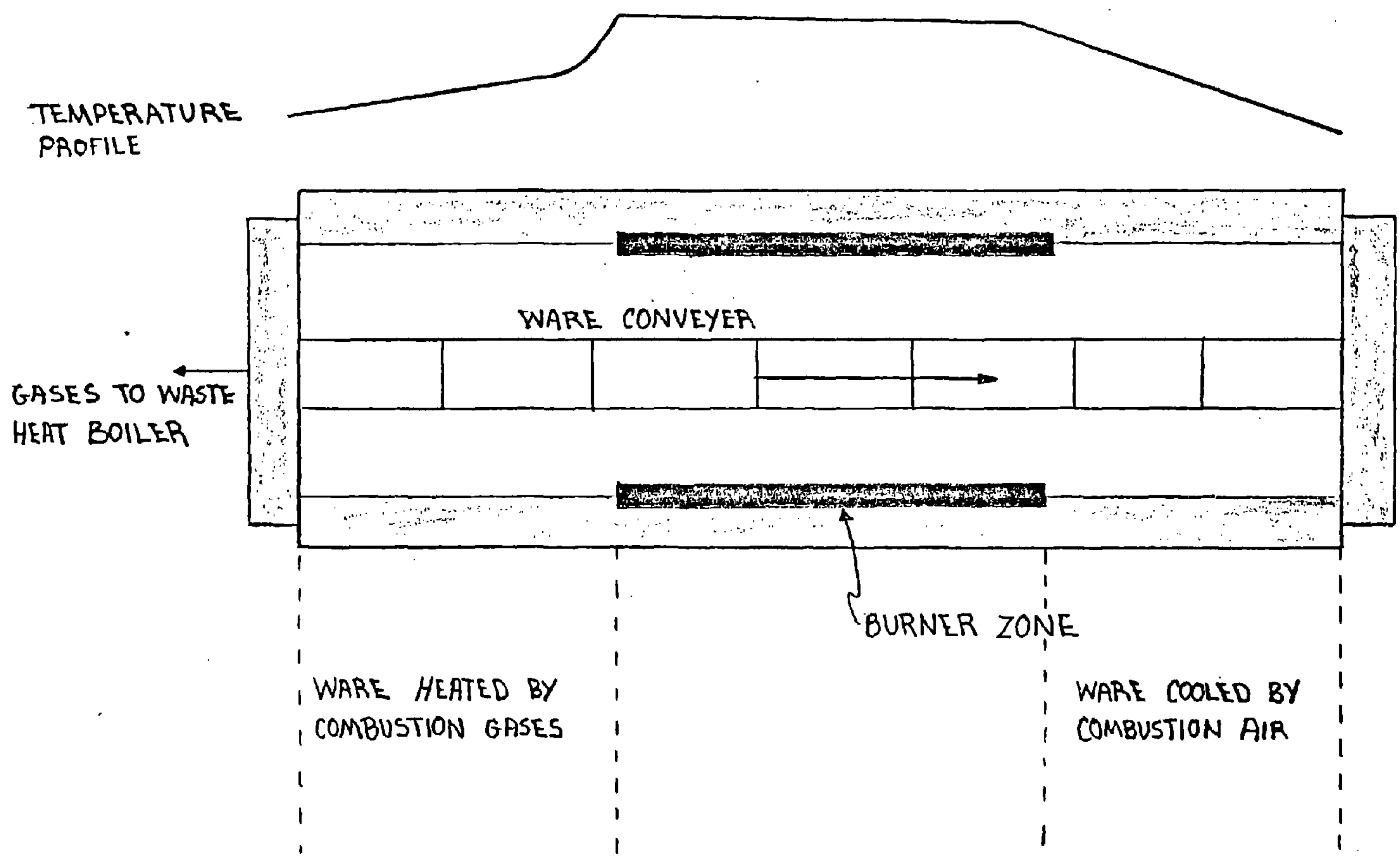


FIG. 2 SCHEMATIC OF CERAMIC TUNNEL KILN VITREOUS CHINA OPERATIONS

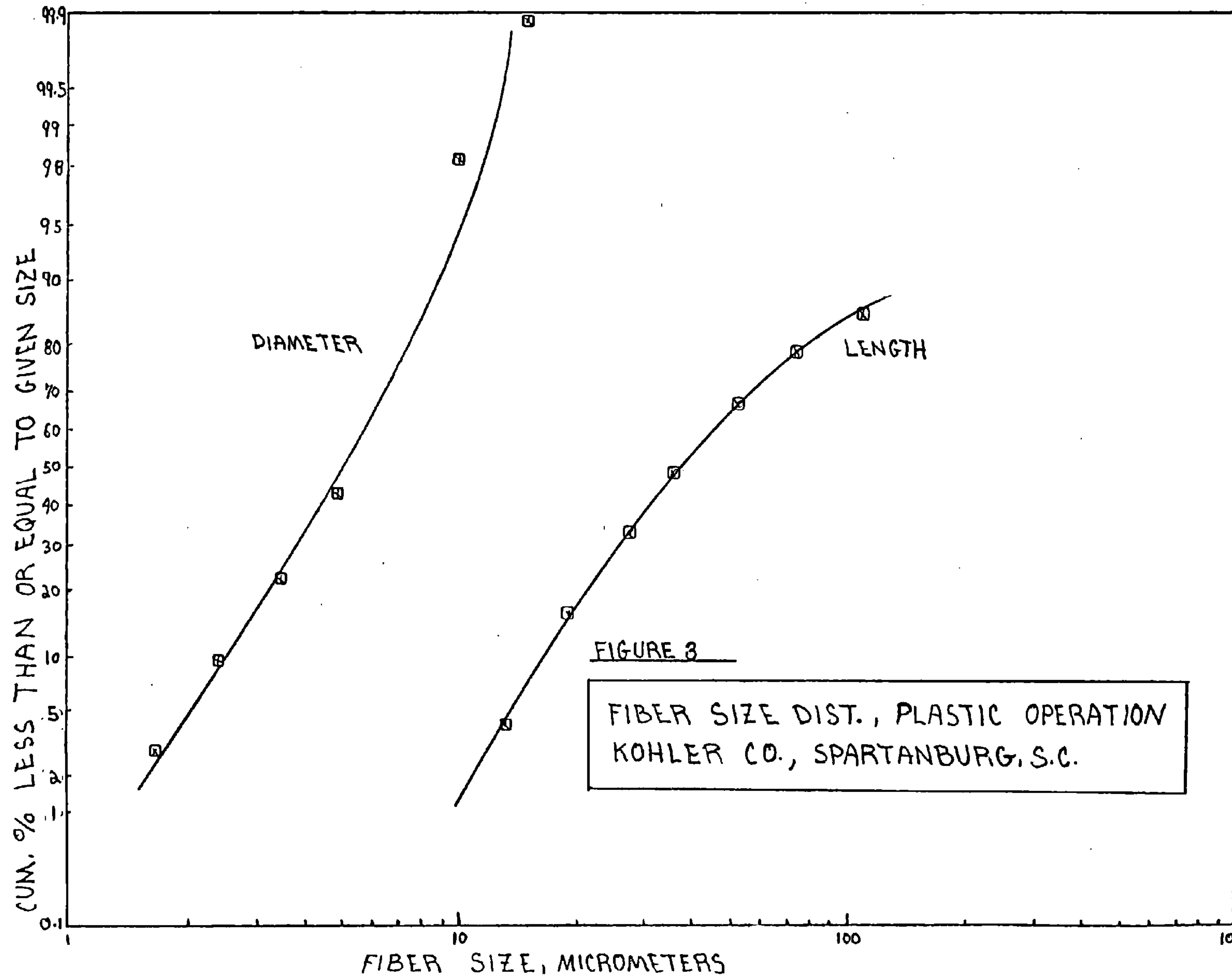


FIGURE 3

FIBER SIZE DIST., PLASTIC OPERATION
KOHLER CO., SPARTANBURG, S.C.

FIG. 4 COMPARISON OF SILICA RESULTS IN SLIP MIXING & CASTING WITH PRESENT OSHA STANDARDS

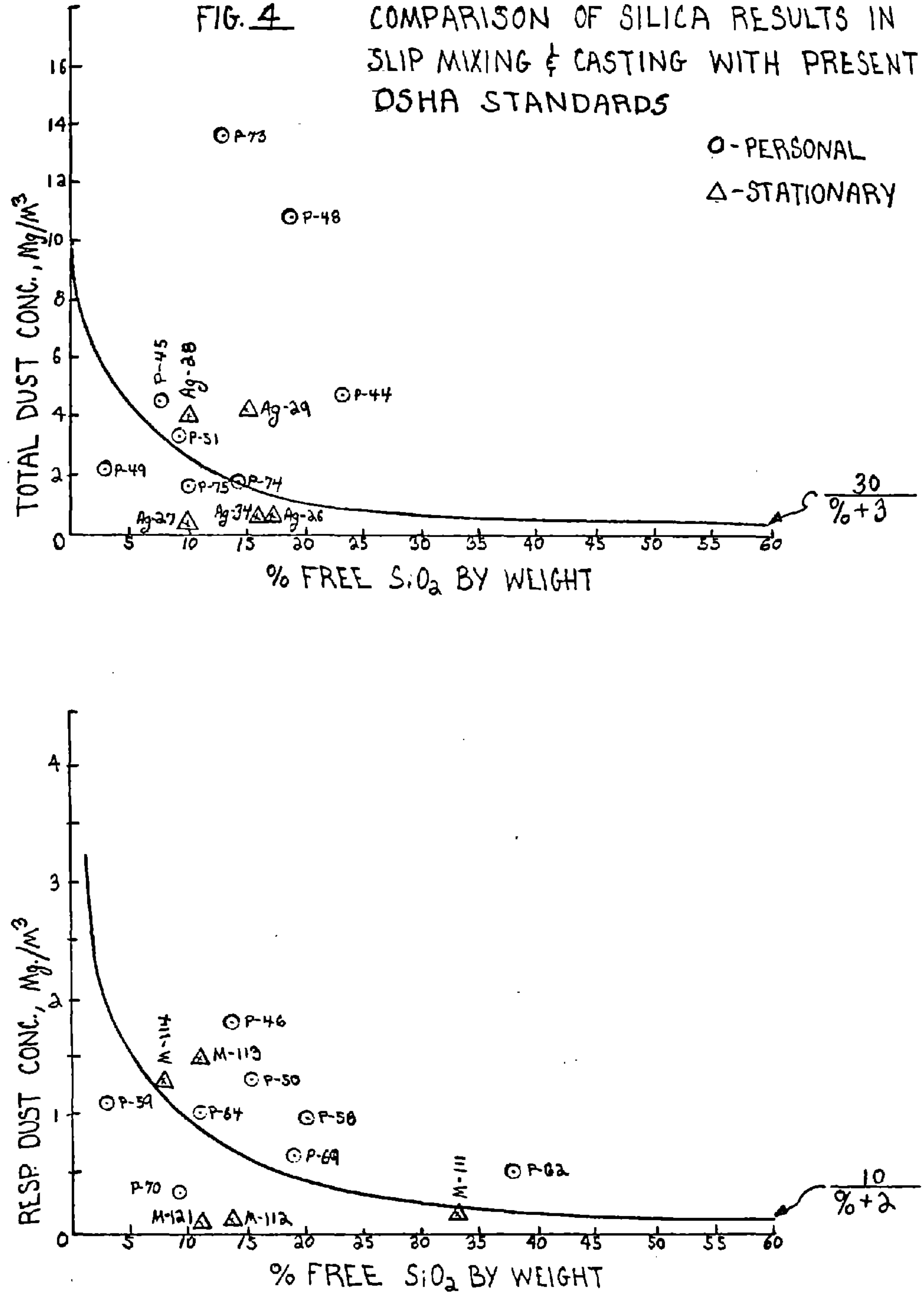
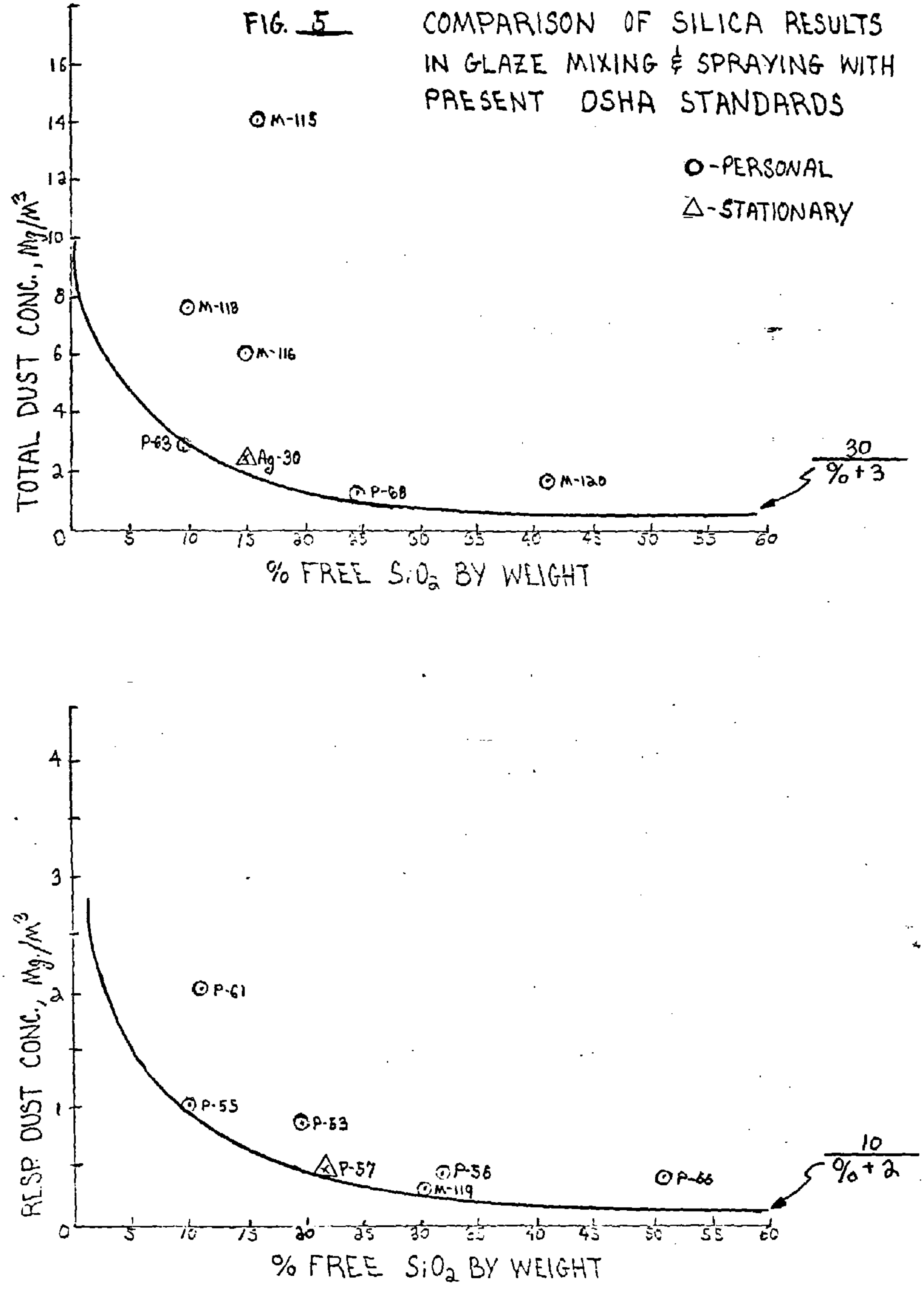


FIG. 5 COMPARISON OF SILICA RESULTS IN GLAZE MIXING & SPRAYING WITH PRESENT OSHA STANDARDS



ADDITIONAL HISTORY AND REMARKS

Date	Doctor	

E-179 Rev.

PHYSICAL EXAMINATION RECORD

Kohler Co.

NAME ____ S. S. NO ____ S. M. W. D. ____ M. F. ____ X-RAY NO. ____
ADDRESS ____ DATE OF BIRTH ____ BRANCH OFFICE OR PLANT ____
CHANGE TO ____
PLACE OF BIRTH ____
OCCUPATION ____ DEPT. ____

APPLICANT TO ANSWER ALL QUESTIONS IN THIS SPACE ONLY
HAVE YOU NOW OR HAVE YOU EVER HAD.

	Yes	No
Broken Bone	☐	☐
Head Injury	☐	☐
Serious Injury	☐	☐
Industrial Injury	☐	☐
Were You Paid Compensation	☐	☐
Painful Back, Sacroiliac Sprain, or Ruptured Disc	☐	☐
Hernia (Rupture)	☐	☐
Bone Infection	☐	☐
Cancer	☐	☐
Foot Trouble	☐	☐
Surgical Operation	☐	☐

	Yes	No
Asthma	☐	☐
Hay Fever	☐	☐
Allergy	☐	☐
Skin Disease (Rash)	☐	☐
Ear Disease or Injury	☐	☐
Loss of Hearing	☐	☐
Sinus Disease	☐	☐
Eye Disease	☐	☐
Impaired Vision	☐	☐
Heart Disease	☐	☐
High Blood Pressure	☐	☐
Tuberculosis	☐	☐
Other Lung Disease	☐	☐

	Yes	No
Stomach Trouble	☐	☐
Kidney Trouble	☐	☐
Diabetes	☐	☐
Epilepsy (Convulsions or Fits)	☐	☐
Migraine Headaches	☐	☐
Fainting or Dizzy Spells	☐	☐
Arthritis or Rheumatism	☐	☐
Nervous Breakdown	☐	☐
Are you now taking medicine of any kind	☐	☐

	Yes	No
Have you ever been rejected for military service	☐	☐
Were you discharged from service for medical reasons	☐	☐
Have you ever drawn disability pension from any source	☐	☐
Were you hospitalized while in military service	☐	☐
Have you ever had trouble getting life or health insurance	☐	☐
Were you ever hospitalized for illness or operation	☐	☐
What hospital ____		
Name of doctor ____		
Were you ever treated for alcoholism or drug addiction	☐	☐
Is there any kind of work that you are unwilling to do. If "Yes," specify.	☐	☐

FEMALES ONLY:

	Yes	No
Are menstrual periods regular	☐	☐
Accompanied by cramps	☐	☐
Longer than 5 days	☐	☐
Are you pregnant	☐	☐
Date of last menstrual period ____		
Number of children ____		

The above information is true and complete to the best of my knowledge

____ Signature ____ Date

REMARKS — If yes to any of above questions, please explain: ____

	First Exam. Date ____ 19__	Re-exam. Date ____ 19__	Re-exam. Date ____ 19__	Re-exam. Date ____ 19__	Re-exam. Date ____ 19__
New Empl. / Re-hire / Prev. Empl.					
Height—Weight / Temp.					
Marks—Scars					
Skin—Glands					
Eyes—Pupils / Cornea					
Vision 20 ft.	R. ___ L. ___ Glasses R. ___ L. ___	R. ___ L. ___ Glasses R. ___ L. ___	R. ___ L. ___ Glasses R. ___ L. ___	R. ___ L. ___ Glasses R. ___ L. ___	R. ___ L. ___ Glasses R. ___ L. ___
Vision 14 in.	R. ___ L. ___ R. ___ L. ___	R. ___ L. ___ R. ___ L. ___	R. ___ L. ___ R. ___ L. ___	R. ___ L. ___ R. ___ L. ___	R. ___ L. ___ R. ___ L. ___
Hearing R. / L. (250, 500, 1000, 2000, 3000, 4000, 8000)					
Ears					
Teeth					
Throat-Tonsils / Thyroid					
Heart-Rate and Findings					
Lungs					
Blood Pres.					
Abdomen					
Hernia					
Genitalia					
Back					
Extremities					
Varicose Veins					
Rectal					
Reflexes					
Breasts					
Nervous System					
URINALYSIS: Color / Sp. G. / Sug. / Alb. / Micro.					
Blood - Serology					
Other Laboratory Tests					
Chest X Ray					
Physical Classification Code					
Recommendations or Other Comments					
Medical Examiner					

ADDITIONAL HISTORY AND REMARKS

Date	Doctor	

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IMMUNIZATION HISTORY

NAME ____________________ TODAY'S DATE __________
BUILDING OR PLANT LOCATION ____________________ BIRTHDATE __________
HOME ADDRESS ____________________ CITY __________
COUNTY ____________________ STATE __________
OFFICE OR HOME PHONE NUMBER ____________________ DATE DEPARTURE __________
DESTINATION (S) ____________________

1. Have you ever received the following immunizations:

   a. Tetanus toxoid(lockjaw) __________ When? __________
   b. Diphtheria __________ When? __________
   c. Typhoid-paratyphoid A&B __________ When? __________
   d. Smallpox vaccination __________ When? __________
   e. Yellow Fever __________ When? __________
   f. Polio ______ Number of shots __________ When? __________
      Number of oral doses __________ When? __________
   g. Typhus __________ When? __________
   h. Influenza __________ When? __________
   i. Cholera __________ When? __________
   j. Measles __________ When? __________

2. Did you ever receive the series of childhood immunizations?

   ____

3. Have you ever served in any branch of the armed forces?

   ____

4. Does anyone in your household have eczema or skin rashes?

   ____

5. Are you allergic to: Eggs? __________ Penicillin? __________
   any other food or drug? __________
6. WOMEN ONLY: Are you pregnant? __________ What month? __________

DO NOT FILL OUT BELOW THIS LINE

Smallpox ______	Typhus (1st) ______	Triple Typhoid (1st) ______
Tetanus (1st) ______	Typhus (2nd) ______	Triple Typhoid (2nd) ______
Tetanus (2nd) ______	Booster ______	Triple Typhoid (3rd) ______
Tetanus (3rd) ______	Cholera (1st) ______	Booster ______
Booster ______	Cholera (2nd) ______	Polio (1st) ______
Diphtheria ______	Booster ______	Polio (2nd) ______
Measles (1st) ______	Influenza (1st) ______	Polio (3rd) ______
Measles (2nd) ______	Influenza (2nd) ______	Polio (4th) ______
Booster ______	Booster ______	Polio (5th) ______
		Polio ( ) ______

Yellow Fever ______

X - REQUIRED
O - Recommended