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

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 77-44-435

KELLER COLUMBUS INCORPORATED
COLUMBUS, OHIO

OCTOBER 1977

I. TOXICITY DETERMINATION

A survey team from the National Institute for Occupational Safety and Health (NIOSH) performed a health hazard evaluation at Keller Columbus Incorporated, Columbus, Ohio. The following determinations are based on environmental measurements of airborne contaminants, a review of pertinent literature, observations of employees work practices and engineering controls.

Airborne concentrations of respirable crystalline silica* were collected in the workers' breathing zone and the general work area. Eight of seventeen samples exceeded the current NIOSH recommended standard. Six of seventeen samples exceeded the current Occupational Safety and Health Administration (OSHA) Standard.

Airborne exposure to respirable and total nuisance particulates were measured in the employees' breathing zone and the general work environment. The levels of nuisance particulates measured did not exceed the accepted evaluation criteria.

Several solvents (toluene, butyl cellosolve and benzene) were monitored in the window making department. The airborne concentrations were within the accepted limits of exposure.

Airborne concentrations of fibrous glass were measured along the three assembly line operations. The airborne concentrations were within the acceptable evaluation criteria.

Carbon monoxide gas levels were monitored in bldg. 2999 on two different occasions and during two different times of the day. Carbon monoxide was generated by the fork lift trucks. Sampling results indicated that carbon monoxide gas levels exceeded the NIOSH recommended Occupational Health Standard.

*Note: The terms crystalline silica, free silica and silicon dioxide are synonymous.

I. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information 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, Publication Office at the Cincinnati address.

Copies of this report have been sent to:

a) Keller Columbus Incorporated, Columbus, Ohio
b) Authorized representatives of Local 745, International Union of Electrical Radio and Machine Workers, Columbus, Ohio
c) International Union of Electrical Radio and Machine Workers, Washington, D.C.
d) U.S. Department of Labor - Region V
e) NIOSH - Region V

For the purpose of informing the approximately 100 "affected employees", the employer shall promptly "post", for a period of thirty calendar days, this Determination Report in a prominent place(s) near where exposed employees work.

INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S. Code 669 (a)(6) authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative of employees regarding workers alleged exposures to the following particulates and vapors: (1) Employees in the mill room (bldg. 3035) are exposed to potentially toxic dusts; (2) employees in building 2999 are exposed to fork lift exhaust fumes; (3) employees in the window making department (bldg. 2999) are exposed to toxic vapors; and (4) employees are not using the correct respirators for the contaminants to which they are exposed.

IV. HEALTH HAZARD EVALUATION

A. Process Description & Evaluation Design

Keller Columbus Incorporated is a manufacturer of gas, electric and double oven stoves. The company employs about 170 persons who work in one of its two facilities, either bldg. 2999, or bldg. 3035. A majority of the employees work 10 hours a day, four days per week during the hours of 0630-1630. A small work force of twenty to thirty employees work a second shift during the hours of 1700-0330. The various production activities have been grouped into one of five categories: Fabrication, mill room operation, rack and spray operation, assembly line operation, and materials handling operation. Each category will be discussed separately.

Building 2999 incorporates about 65,000 square feet (ft^2), and it has a ceiling height of approximately 18 feet. Three exhaust fans handle the general exhaust ventilation for this building. One of the exhaust fans is a roof mounted fan, and the others are wall mounted. The combined exhaust rating for all three fans is 46,500 cubic feet of air per minute (C.F.M.). There is no makeup air unit for this building. Building 3035 is 55,000 ft^2 in size, with a ceiling height of 18 feet. The building contains two general exhaust fans whose maximum combined exhaust rate is 25,000 C.F.M. This building also has two makeup air units along the spray line operation where a ground coat and/or an enamel coat is sprayed onto the stove hardware. One makeup air unit, positioned at the ground coat station, supplies air at the rate of 77,000 C.F.M., and the other makeup air unit positioned at the enamel station supplies air at 30,100 C.F.M. The makeup air for the spray line is exhausted via a plenum system.

1. Fabrication Process and Evaluation Design

a. The fabrication operations are primarily accomplished in bldg. 2999. Only two fabrication operations were observed to be potential health hazards. The first is the sanding department. This operation is performed by one operator. The employee removes rough edges or burrs from metal panels with a pedestal mounted surface grinder. A down draft ventilation system is installed at the base of the grinder to capture total particulates. The second operation observed to be a potential health hazard is the window assembly department. This is basically a one person operation; however, two persons were observed working in this department during the survey. Window frames are dipped one at a time into a small trough (about 20 inches by 10 inches) of butyl cellosolve to thoroughly clean the frames. While the frames are air drying, the windows are cleaned with toluene to remove dirt, grease and fingerprints. Afterwards, the window is glued into the window frame using a special adhesive called RTV-Dow^R.

Once the window unit has been assembled, it is directed to the assembly line and mounted on the oven doors.

b. The sanding operator and the window assembler were each sampled for one and one-half shifts on March 23-24, 1977. Each employee was monitored using a personal breathing zone sampling train. The sanding operator was monitored for exposure to total nuisance particulates, whereas the window assembler was monitored for exposure to butyl cellosolve, toluene and benzene. Also, carbon monoxide levels were measured at the isle way adjacent to the window assembly department.

2. Mill Room Operation and Evaluation Design

The mill room operation is situated on two floors in bldg. 3035. The bottom floor houses five mixers of various sizes. Mixers number 5 and 4 are used for mixing a ground coat which is sprayed onto all stove parts except for the venturi and the grid. Mixers #3, #2, and #1 are only used for mixing enamels of different colors. The floor directly above the mixers is the chemical storage area for the mill room as well as the mixer loading area. Some of the chemicals most often used in the mixers might include: crushed glass (Frit), borax, bentonite, quartz, zinc oxide, clay, oxide, alumina, potassium carbonate, soda ash, gum and citric acid.

A separate telescoping aluminum duct is connected from the loading hopper on the second floor down to each mixer. As the mixers need loading, the telescoping duct is moved one or two feet vertically connecting to the lip of the mixer. When the mixing process is completed, the ground coat or enamel is either drained and pumped to storage tanks on the second floor, or the material is pumped into a container and transferred to the spray department where it is used immediately.

There is no local or general mechanical ventilation in the mill room department. Loading of chemicals into the mixer generates dust on both floors. The dust either escapes through a broken skylight on the second floor, or it is dispersed to other work areas by natural currents.

a. Approximately five employees and one supervisor were observed working in the mill room. Four employees were each fitted with two personal sampling trains. Sampling was performed for respirable and

total nuisance dust, and respirable silica. A high volume area sampler (Gast Pump) was used to monitor the respirable silica and total dust. Additionally, a bulk sample of quartz was obtained and subsequently analyzed to determine the percent of free silica.

3. Rack Operation and Evaluation Design

The racking operation, situtated in bldg. 3035, is performed by three workers. The racking area is about 25 feet from the mill room operation. All stove parts except for the venturi and the grids are racked onto a conveyor line and directed through a series of spray booths. During mixer loading dust generated in the mill room disperses into the racking department.

a. Two of the three rackers were monitored with personal breathing zone sampling trains. The workers were monitored for possible exposure to silica and respirable nuisance particulates generated in the mill room during mixer loading.

4. Assembly Line and Evaluation Design

Three assembly line operations are situated in bldg. 2999. The north and south lines are for the assembling of electric and gas stoves, respectively. About 12-14 employees work on each line which are similar in nature. There is also a double oven assembly line which is operated by 4-5 workers. This operation consists of assembling ovens and mounting these ovens onto the assembled stoves. As the stoves or double ovens are assembled, they are insulated with fibrous glass. In addition, the fibrous glass is pre-cut to a specified size by one of the plant workers. Consequently, a potential health exposure may occur when the fibrous glass is pre-cut or when the stoves and ovens are insulated.

a. Six employees who worked along one of the three assembly lines were sampled for potential fiber glass exposure. Each worker wore two personal breathing zone sampling trains in order to determine total airborne dust concentration in addition to dust sizing of the glass fibers. The employee responsible for cutting the fibrous glass was also monitored.

5. Material Handling and Evaluation Design

The movement of material in bldg. 2999 and bldg. 3035 is accomplished with the use of fork lifts. Nine fork lifts are used in the plant

and these include: 7 gas operated fork lifts, 1 propane operated fork lift and 1 electrically operated fork lift which is seldomly used. The majority of the fork lifts (about 6-7) are primarily used throughout bldg. 2999. Each fork lift is routinely inspected and serviced one Friday a month during production shut down.

a. The employees working in bldg. 2999 were monitored for potential carbon monoxide (CO) exposure. Area sampling was performed using gas detector tubes and a direct reading instrument (Ecolyzer^{TM}). Carbon monoxide levels were measured at the operator's breathing zone and at a distance of approximately 10 feet behind each fork lift. Also, CO levels were measured while the engine was idling and while the engine was revved.

B. Evaluation Methods

Airborne exposure to crystalline silica and nuisance particulates, fibrous glass, toluene, butyl cellosolve, benzene and carbon monoxide were measured using personal and/or work area sampling techniques, direct reading instruments and gas detector tubes. The collection and analytical techniques are described below.

1. Crystalline Silica[1]: Personal and work room respirable dust samples were collected using a two-stage, 10-millimeter (mm) nylon cyclone (a size selective sampler). A Mine Safety Appliance (MSA)* vacuum pump was connected to a 2-piece, 37-mm cassette containing a 37-mm, low ashing tared polyvinyl chloride (PVC) filter with a pore size of 5.0 micrometers (um). The pump operated at 1.7 liters per minute (lpm). High volume respirable work area dust samples were collected on a tared PVC filter contained in a three piece 37-mm cassette mounted in a one-half inch metal cyclone. The nonpulsating flow pump (Gast Pump) operated at 9.0 lpm with the use of a critical orifice. The filters were initially analyzed gravimetrically to determine total milligrams (mg) of dust. Sample weight analyses was accurate to 0.01 mgs. The filter was subsequently analyzed colorimetrically or by x-ray diffraction to determine total milligrams of crystalline silica. Total milligrams of free silica includes all polymorphs (quartz, cristobalite, and tridymite) of crystalline silica. The limit of detection for quartz and cristobalite, using the x-ray diffraction technique, was 30 and 40 micrograms, respectively.

2. Solvents[2]: (Toluene, Butyl Cellosolve and Benzene) The recommended sampling procedure consists of using a Sipin pump and drawing air at a rate of 200 cubic centimeters (cc) per minute through a 150 mg activated charcoal tube. The contents of the charcoal tube are desorbed with carbon disulfide, and an aliquot of the desorbed sample is analyzed with a gas chromatograph.

*Mention of commercial names or products does not constitute endorsement by NIOSH.

3. Carbon Monoxide[3]: The carbon monoxide levels were measured using certified (Certificate No. TC-84-012, Tube #CH 25601) gas detector tubes. In order for a gas detector tube to be certified, it must have ±35 percent accuracy at one-half the exposure limit and ±25 percent accuracy at 1-5 times the exposure limit. Further explanation of the regulations regarding gas detector tubes appear in the Code of Federal Regulations (CFR) as Title 42 CFR Part 84 under the authority of the Occupational Safety and Health Act of 1970. The second method used to measure CO was an Ecolyzer. This instrument was calibrated in the field with a calibration gas at a level of 48 parts of contaminant per million parts of air by volume (ppm).

4. Fibrous Glass[4]: Two sampling methods were utilized to determine whether a hazardous occupational exposure to fibrous glass existed. The first method used a 37-mm, open face, 0.8-um pore size mixed cellulose ester membrane filter in conjunction with a MSA pump operating at 1.7 lpm. The filter was transformed to an optically homogeneous gel, and the fibers were sized and counted by phase-contrast microscopy at 400-450 times magnification. The second method required collecting the total airborne material on a tared, closed face, 37-mm, 5.0-um pore size, low ashing, PVC filter (VM-1). The MSA pump operated at 1.5 lpm. The filter was analyzed gravimetrically to determine the milligrams weight increase for each filter.

5. Total Nuisance Dust[9]: The recommended sampling procedure requires collecting total dust on a tared 37-mm diameter, 5.0-um pore size, PVC filter (VM-1). The filter is connected to a MSA pump which should operate at 1.5 lpm for a minimum sampling period of 60 minutes.

C. Evaluation Criteria

1. Environmental Assessment

There are several criteria used to evaluate the toxic air contaminants of an employees work environment: (1) NIOSH Criteria Documents for a Recommended Occupational Health Standard, (2) Proposed and Recommended Threshold Limit Values (TLV's), as suggested by the American Conference of Governmental Industrial Hygienists (ACGIH), 1976. (3) the OSHA standards.

The concentration for each contaminant is based upon the current state of knowledge concerning toxicity of these substances. The concentration is designed to allow an occupational exposure for up to a 10-hour work day, 40-hour work week as a time-weighted average (TWA) over a normal lifetime without the worker experiencing discomfort. In some instances, a few employees may experience discomfort at or below the TWA.

There are some airborne contaminants for which this TWA is inappropriate; consequently, the substance may be proceeded by the letter "C". This letter indicates a ceiling value for an interval of 30 minutes or less. The ceiling value is used to identify hazardous substances which are fast acting.

The criteria mentioned above have been tabulated, footnoted, and compared to the OSHA standard listed in the Code of Federal Regulations (CFR), (1976) Title 29, Part 1910, subpart Z, Section .1000. The OSHA standard has been cited so that the reader may see which of the standards have been exceeded. However, no discussion of the OSHA standard with respect to measured airborne levels will be presented.

Substance	Time Weighted Average (TWA) 8-hour	10-hour	Ceiling Value	Minutes
Silica				
Free Silica (all polymorphs) (Respirable)[1]		0.05 mg/M^3		
Quartz (Total Dust)[2]		30.0 mg/M^3 / % Quartz + 2		
Cristobalite (Respirable)[2]		Use 1/2 (Quartz TLV equation)		
Nuisance Dust[3]				
Respirable	5 mg/M^3			
Total	10 mg/M^3			
Toluene[4]	100 ppm		200 ppm	10
Butyl Cellosolve[5]	50 ppm			
Benzene[6]	1 ppm			
Fibrous Glass[7]				
Particle Sizing		3 fibers/cc		
Total Weight		5 mg/M^3		
Carbon Monoxide[8]	35 ppm		200 ppm	

1) NIOSH Criteria Document (1974), OSHA standard for respirable silica is calculated by dividing 10 mg/M^3 by the percent quartz + 2.
2) The ACGIH TLV Document (1976) and the OSHA Standard (1976) both use this formula.
3) ACGIH TLV Document (1976). The OSHA Standard for respirable and total dust is 5 and 15 mg/M^3, respectively.
4) NIOSH Criteria Document (1973). The OSHA Standard (1976) is 200 ppm with a maximum ceiling concentration of 500 ppm for 10 minutes.
5) The ACGIH TLV Document (1976) and the OSHA Standard (1976) both use the same value.
6) NIOSH Update Criteria and Recommended Standard (1976). The OSHA Standard (1976) is 10 ppm.
7) NIOSH Criteria Document (1977).
8) NIOSH Criteria Document (1972). The OSHA Standard (1976) is 50 ppm.

2. Toxicological Effects

a. Crystalline Silica[1,5]: The primary health effects associated with inhalation of free silica is a form of pneumoconiosis termed silicosis. Onset of this malady may vary from several years to twenty years or more. The percent of free silica present in the environment generally determines the course of this disease. As the silicon dioxide is deposited in the lungs, the silica stimulates production of fibrotic nodules. The nodules in turn compress the alveoli (air sacs) thereby decreasing the lung function and producing restrictive type pulmonary disease.

Early silicosis termed "simple silicosis" is normally diagnosed by chest x-ray examination. Individuals with this disease are usually asymptomatic, and lung function impairment is non-existent. As the severity of silicosis increases, the symptoms become prevalent and these are marked by intolerance to exertion, episodes of coughing, and production of a thick sputum. Silicosis of this severity is diagnosed as "conglomerate silicosis" which is irreversible. Conglomerate silicosis incapacitates the affected worker regardless of termination of exposure.

b. Toluene[5,6]: Intoxication may occur via inhalation and/or absorption of the liquid through skin contact. Toluene is irritating to the skin and eyes. High toluene vapor concentrations are irritating to the respiratory tract. Toluene is a central nervous system depressant, and exposure to this solvent may be manifested by dizziness, weakness, confusion, or a sense of euphoria.

c. Butyl Cellosolve[5,7]: The cellosolves in general are irritating to the skin and mucous membranes. Exposure may occur by absorption via the skin, lungs, or gastrointestinal tract. Acute poisoning usually affects the central nervous system and the kidneys. Symptomatology associated with central nervous system depression includes stuttering, staggering gait, tremor and blurred vision.

d. Benzene[5,7]: Benzene is a central nervous system depressant at high concentrations and it may cause acute narcotic reactions. Exposure to either the vapor or liquid may produce irritation of skin, eyes and mucous membranes of the upper respiratory tract. Symptoms of mild benzene exposure are nonspecific and might include lightheadedness, headache, and excitement. Acute high level exposure to benzene could cause respiratory paralysis and death with or without convulsions. Benzene is considered a leukemogenic because it produces a malignant disease of the blood forming organs.

e. Fibrous Glass[4,5]: Fibrous glass may affect the skin, eyes or mucous membranes. While inhalation of fibrous glass does not cause an identified pneumoconiosis, its sharp spicules are troblesome to those exposed. Some of the real problems of exposure are warts due to implanted splinters of fibrous glass, irritation of conjunctivae and irritation of the skin. Inhalation of fibrous glass may cause cough, a nose bleed and sore throat.

f. Carbon Monoxide[3,5,7]: Carbon monoxide gas is a colorless, odorless, tasteless, non-irritating asphyxiant. The central nervous system is the most vulnerable to the effect of CO. Symptoms of the first stage exposure may include a feeling of weakness, a bandlike construction or throbbing of the head, mental confusion, headache, roaring in the ears or nausea. The second stage is characterized by increasing weakness and confusion, dizziness, and an inability to think clearly or act with energy. Additionally, in acute cases of CO intoxication, the victim may have pink lips and cheeks.

D. Results and Discussion

The results of personal and work area respirable samples for crystalline silica, analyzed by x-ray diffraction, are presented in Table I. It should be noted that a bulk sample of quartz was analyzed and reported to contain 99 percent free silica. The limit of detection for quartz and cristobalite based upon NIOSH physical and chemical analytical method (P&CAM) number 109 was 0.03 milligrams and 0.04 milligrams, respectively. The quartz concentrations exceeded the NIOSH recommended standard on eight occasions, and the respirable quartz concentration exceeded the OSHA standard on six occasions. In addition, cristobolite, a polymorph of free silica, was identified on one filter, and it exceeded the OSHA standard. Two of the area samples were analyzed colorimetrically (see Table II). Both of these samples exceeded the NIOSH recommended standard and the OSHA standard.

It should be noted that there is no recommended silica standard for area samples; however, area samples are a good indication of general environmental conditions in addition to the evaluation of environmental engineering controls.

The personal samples for total airborne nuisance particulates are listed in Table III. All of the levels were below the OSHA standard except for one sample (#V3027). The level of dust on this filter far exceeded the levels of dust measured in the same area. It is believed that this filter was inadvertently contaminated; consequently, this filter was excluded from the evaluation of the data.

Sampling for fibrous glass was performed by two methods. The first method determines the weight increase of each filter (see Table IV). The second method consists of particle sizing (see Table V). Both sampling and analytical procedures indicated that the NIOSH recommended standard was not exceeded.

Personal samples were collected in the window making department for exposure to toluene, butyl cellosolve and benzene. The limit of detection for each of these analytes was 0.01 mg. The concentrations for each solvent (see Table VI) were below the NIOSH recommended standard and the OSHA standard.

The carbon monoxide levels are recorded in Tables VII and VIII. Although an 8-hour time-weighted average was not obtained, short-term sampling was performed during both surveys of the facility. Results indicate that the NIOSH recommended ceiling concentration of 200 ppm was exceeded.

A few of the employees were interviewed to determine their health status. Several workers complained of noxious odors emanating from the fork lifts. Also, a few workers complained of slight headaches on occasion.

V. RECOMMENDATIONS

Whenever possible, engineering controls are the preferred method for controlling environmental exposure to toxic substances. Some of the recommendations listed below are temporary type changes which may be implemented immediately until effective engineering controls can be provided. These recommendations are contained in the NIOSH criteria documents.[1,3]

A. Medical Recommendations Regarding CO Exposure[3]

1. Because employees with overt cardiovascular disease cannot be protected by the NIOSH recommended standard, a medical program should be initiated consisting of preplacement and periodic examinations emphasizing the conditions exacerbated by CO exposure. Also, an anti-smoking program for high-risk employees should be conducted.

B. Medical Recommendations Regarding Crystalline Silica Exposure[1]

1. Employees subject to free silica exposure should receive a pre-placement medical examination, and a medical examination at least once every three years thereafter. Examinations should include:

   a. A work history to indicate free silica exposure in addition to signs and symptoms of respiratory disease.

   b. A chest x-ray should be administered and classified according to the 1971 International Classification of Radiographs of Pneumoconiosis.

   c. Pulmonary function tests should be administered to provide a base-line for evaluation of pulmonary function, and to determine the advisability of the workers using negative or positive pressure respirators.

   d. Initial medical examinations for presently employed workers should be offered within six months of the initiation of a standard incorporating these changes.

C. Respirator Protection for CO and/or Crystalline Silica Exposure

1. A respirator program shall be established according to the requirements of 29 CFR 1910.134 published in the Federal Register, volume 39, dated June 27, 1974, as ammended.

2. The employer shall provide a NIOSH approved or Bureau of Mines approved respirator as outlined in Part II of Title 30, Code of Federal Regulations.

3. The employer shall supply respirators in accordance with Table VIII, extracted from the criteria document for crystalline silica, page 8.

4. Employees shall be given instructions on the use, cleaning requirements and leakage tests of respirators.

D. The rubber boot connecting the telescoping duct to the lip of the mixer in the mill room is a source of dust contamination on the bottom floor during loading. The boot should have a tight fit in order to prevent escape of dust particles.

E. The "caution" logo printed on the oxide containers in the mill room suggests that prolonged contact of skin with the oxide should not be permitted. It is recommended that gloves be made available to workers handling the oxide.

F. Exhaust ventilation is recommended in the mill room department. Some of the air cleaning devices available are fabric collectors, wet collectors, dry centrifugal collectors, and settling chambers.

G. The exhaust system for the sanding operation was not operating properly. Some dust accumulated in the ducting, and some dust not filtered by the screen was recirculated in the immediate area.

The duct should be cleaned periodically and repaired whenever required. The dust screen should be replaced with a more efficient filter which will not recirculate the small particulates.

H. The fork lifts should be inspected on a more frequent basis in order to assure proper operation. Several of the lifts were observed to be emitting strong odors of unburned hydrocarbons.

I. The fork lift operators should be instructed not to let the vehicles idle needlessly along the isleways when they are not transporting material.

J. The only make-up air available to Building 2999, is from open doors and windows. It is recommended that a make-up air unit be installed in bldg. 2999 in order to properly circulate and exhaust the air. The make-up air unit may help reduce employee exposure to carbon monoxide and unburned hydrocarbons emanating from the fork lifts.

K. It is recommended that employees who handle fibrous glass be issued gloves to help prevent skin contact.

VI. AUTHORSHIP AND ACKNOWLEDGEMENTS

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VII. REFERENCE

1. Criteria for a Recommended Standard ... Occupational Exposure to Crystalline Silica, (1974), HEW Publication No. (NIOSH) 75-120.

2. P&CAM Method No. 127, NIOSH Manual of Analytical Methods, HEW Publication No. (NIOSH), 75-121, 1974.

3. Criteria for a Recommended Standard ... Occupational Exposure to Carbon Monoxide, (1972), HSM 73-11000.

4. Criteria for a Recommended Standard ... Occupational Exposure to Fibrous Glass, (1977), HEW (NIOSH) Publication No. 77-152.

5. Hamilton, A. and Harriet L. Hardy, Industrial Toxicology, Third Ed., Publishing Sciences Group, Inc., 1974.

6. Criteria for a Recommended Standard ... Occupational Exposure to Toluene, (1973), HSM 73-11023.

7. U.S. Department of Health, Education and Welfare, Occupational Diseases, A Guide to Their Recognition, Public Health Service Publication No. 1097, June, 1966.

8. Documentation of Threshold Limit Values (TLV's), ACGIH, 3rd Ed., Cincinnati, Ohio, 1971.

9. NIOSH Manual of Sampling Data Sheets, (1977), DHEW (NIOSH) Publication No. 77-159.

Table I

Summary of Respirable Silica Concentration Data*
Keller Columbus Inc.
Columbus, Ohio

March 23 and 24, 1977

Date	Sample Number	Job or Area Description	Period(Hrs)	Volume(M^3)[1]	Quartz(mg/m^3)[2]	Cristobalite(mg/m^3)	% SiO_2[3]	Respirable Particulate(mg/m^3)	OSHA Standard(mg/m^3)	Type sampl
3/23/77	PV955	Mill Room	5.1	0.53	0.11	N.D.[4]	26.0	0.44	0.36	P[5]
3/23/77	FB278	Mill Room	5.8	0.59	0.45	N.D.	22.0	2.25	0.42	P
3/23/77	PV877	Mill Room	5.7	0.58	0.26	N.D.	25.0	1.03	0.37	P
3/23/77	PV968	Mill Room Storage	3.5	1.87	0.25	0.03	22.0	1.13	0.42	A[6]
3/23/77	PV1066	Dept. Adjacent to Mill Room	5.9	0.60	0.05	N.D.	14.0	0.35	0.63	P
3/23/77	PV1045	Dept. Adjacent to Mill Room	5.9	0.60	0.07	N.D.	5.0	1.23	1.43	P
3/23/77	PV882	Mill Room	5.7	0.58	0.40	N.D.	27.0	1.45	0.34	P
3/23/77	PV951	Mill Room	1.7	0.90	0.67	N.D.	33.0	2.02	0.29	A
3/24/77	PV1059	Mill Room	3.1	0.31	N.D.	N.D.	N.D.	0.61[7]	5.0[8]	P
3/24/77	FB263	Blank	Ø	Ø	N.D.	N.D.	N.D.	1.14[7]	N.A.[8]	-
3/24/77	PV1064	Mill Room	1.1	0.11	N.D.	N.D.	N.D.	1.09	5.0	P
3/24/77	PV1048	Mill Room (storage)	3.1	1.64	0.04	N.D.	11.0	0.40	0.77	P
3/24/77	PV962	Mill Room (storage	3.1	1.68	0.06	N.D.	12.0	0.51	0.71	P
3/24/77	PV954	Dept. Adjacent to Mill Room	3.3	0.34	N.D.	N.D.	N.D.	0.09	5.0	P
3/24/77	PV949	Dept. Adjacent to Mill Room	3.3	0.34	N.D.	N.D.	N.D.	0.03	5.0	P
3/24/77	PV965	Mill Room	3.2	0.33	N.D.	N.D.	N.D.	0.42	5.0	P
3/24/77	PV969	Blank	Ø	Ø	N.D.	N.D.	N.D.	N.D.	N.A.	-
3/24/77	PV1055	Blank	Ø	Ø	N.D.	N.D.	N.D.	N.D.	N.A.	-

*NIOSH Evaluation Criteria is 0.05 mg/M^3.

1) m^3 - Volume of air is measured in units of cubic meters.
2) mg/m^3 - Milligrams of contaminant per cubic meter of air by volume.
3) SiO_2 - Formula used to represent free silica.
4) N.D. - Not Detected.
5) P - Personal Sample.
6) A - Area Sample.
7) Filter is believed to have been contaminated.
8) N.A. - Not applicable.

Table II

Crystalline Silica Data Record for Area Sampling
Keller Columbus Inc.
Columbus, Ohio

March 23, 1977

Sample Number	Area Description	Period(Hrs)	Volume(M^3)[1]	SiO_2[2] (mg/M^3)[3]	Percent SiO_2	Total Particulate(mg/M^3)	OSHA Standard(mg/M^3)
PV 1053	Second Floor of Mill Room Operation	3.5	1.91	1.05	24.0	4.31	1.11
FB 227	Second Floor of Mill Room Operation	1.7	0.91	3.51	43.0	8.19	0.65

1) M^3 - Volume of air is measured in units of cubic meters.
2) SiO_2 - Symbol used to represent free silica.
3) mg/M^3 - Milligrams of contaminant per cubic meter of air by volume.

Table III

Summary of Personal Total Dust Concentration*
Keller Columbus Inc.
Columbus, Ohio

March 23 & 24, 1977

Date	Sample Number	Area or Job Description	Sampling Period(Hrs)	Sampling Volume(M^3)[1]	Particulate Conc.(mg/m^3)[2]
3/23/77	V351	Mill Room	5.1	0.46	6.55
3/23/77	V3027	Mill Room	5.8	0.52	23.89*
3/23/77	V3047	Mill Room	5.7	0.51	3.98
3/23/77	V3056	Mill Room	5.7	0.51	2.87
3/23/77	V3041	Sanding Operation	6.6	0.59	0.39
3/24/77	V3030	Mill Room	3.1	0.28	8.95
3/24/77	V3053	Mill Room	1.1	0.10	2.68
3/24/77	V3070	Mill Room	1.1	0.10	1.75
3/24/77	V3068	Sanding Operation	3.9	0.35	0.48
3/24/77	V3018	Mill Room	3.2	0.30	1.43
3/24/77	V3006	Blank	Ø	Ø	0.01
3/24/77	V3069	Blank	Ø	Ø	0.01

* ACGIH EVALUATION CRITERIA is 10.0 mg/m^3

1) M^3 - Volume of air is expressed in units of cubic meters.
2) mg/m^3 - Milligrams of contaminant per cubic meter of air by volume.

Table IV

Summary Record for Airborne Concentration*
of Total Fibrous Glass
Keller Columbus Inc.
Columbus, Ohio

March 23 & 24, 1977

Date	Sample Number	Area or Job Description	Sampling Period(Hrs)	Sampling Volume(M^3)[1]	Total Fibrous Glass Conc.(mg/m^3)[2]
3/23/77	V3004	South Assy. Line	7.0	0.63	0.57
3/23/77	V2986	North Assy. Line	6.6	0.60	1.04
3/23/77	V3058	South Assy. Line	6.8	0.61	0.57
3/23/77	V3048	North Assy. Line	6.5	0.58	0.82
3/23/77	V3051	DBL Oven Assy. Line	7.0	0.63	0.79
3/24/77	V3022	DBL Oven Assy. Line	3.7	0.34	0.50
3/24/77	V2953	Cutting Fibrous Glass	3.7	0.33	1.20
[illegible]4/77	V3050	South Assy. Line	3.8	0.34	0.67
[illegible]4/77	V3049	North Assy. Line	3.8	0.34	0.70
3/24/77	V3039	South Assy. Line	3.9	0.35	0.48
3/24/77	V3060	North Assy. Line	3.8	0.34	0.58
3/24/77	V3063	Blank	Ø	Ø	N.D.[3]

*NIOSH EVALUATION CRITERIA is 5.0 mg/m^3

1) M^3 - Volume of air is expressed in units of cubic meters.
2) mg/m^3- Milligrams of contaminant per cubic meter of air by volume.
3) N.D. - Not detected.

Table V

Summary of Fibrous Glass Data*
Keller Columbus Inc.
Columbus, Ohio

March 23 and 24, 1977

Date	Filter Number	Area or Job Description	Sampling Period(Hrs)	Sampling Volume(M^3)[1]	Concentration Fibrous Glass (Fibers/cc)[2]
3/23/77	1	South Assy. Line	7.0	.71	0.05
3/23/77	2	North Assy. Line	6.6	.68	0.05
3/23/77	3	South Assy. Line	6.8	.70	0.05
3/23/77	4	North Assy. Line	6.5	.66	0.09
3/23/77	5	Double Oven Assy.	7.0	.71	0.03
3/24/77	14	Double Oven Assy.	3.7	.38	0.02
3/24/77	15	Cutting Fiber Glass	3.7	.37	0.03
3/24/77	11	South Assy. Line	3.8	.39	0.15
3/24/77	12	North Assy. Line	3.8	.39	0.04
3/24/77	16	South Assy. Line	3.9	.40	N.D.[3]
3/24/77	13	North Assy. Line	3.8	.34	N.D.
3/24/77	6	Blank	Ø	Ø	N.D.
3/24/77	17	Blank	Ø	Ø	0.04

*NIOSH Evaluation Criteria is 3.0 fibers/cc.

1) M^3 - volume of air is expressed in units of cubic meters
2) fiber/cc - fibers of glass per cubic centimeter of air
3) N.D. - Not Detected

Table VI

Summary of Breathing Zone Data for Toluene, Butyl Cellosolve, and Benzene*
Keller Columbus Inc.
Columbus, Ohio

March 23 and 24, 1977

Date	Sample Number	Area Description	Period(Hrs)	Volume(M^3)[1]	Airborne Contaminant - ppm[2]		
					Toluene	Butyl Cellosolve	Benzene
3/23/77	1	Window making area	7.0	0.05	4.0	0.3	N.D.
3/24/77	2	Window making area	4.0	0.01	4.0	2.6	N.D.
3/24/77	3	Blank	Ø	Ø	N.D.[3]	N.D.	N.D.

*NIOSH Evaluation Criteria: Toluene - 100 ppm
Butyl Cellosolve - 500 ppm
Benzene - 1 ppm

1) M^3 - Volume of air is expressed in units of cubic meters.
2) ppm - Parts of contaminant per million parts of air.
3) N.D. - Not Detected

Table VII

Summary Record of CO Levels Measured Using Chemical Indicator Tubes
Keller Columbus, Inc.
Columbus, Ohio

February 24 and March 24, 1977

Date	Time	Location	Type Sample	Concentrations(ppm)[3]
2/24/77	0750	Checkers station in shipping area	B.Z.[1]	55
3/24/77	13:05	Window Department isleway	A[2]	40
24/77	13:10	South Assembly line (Station #1)	A	20
3/24/77	13:15	Checkers station in shipping area	B.Z.	40

1) B.Z. - breathing zone sample of worker.
2) A - Area sample
3) ppm - parts of a contaminant per million parts of air by volume

Table VIII

Summary Record of CO Levels Measured Using an Ecolyzer*
Keller Columbus Inc.
Columbus, Ohio

February 24 and March 24, 1977

Date	Approximate Time	Location & Description	Concentration(ppm[3])
2/24/77	0815	10 feet aft F.L.[1] #5 while idling	450
2/24/77	0815	" " " " " " revved	>500
2/24/77	0820	F.L. #5 while idling, operators B.Z.[2]	140
2/24/77	0830	10 feet aft F.L. #13 while idling	>500
2/24/77	0830	F.L. #13 while idling, operators B.Z.	125
2/24/77	0835	Area sample taken at isleway next to tube bending department	85
2/24/77	0835	Area sample taken at conveyor shut off switch on isleway next to tube bending department	75
2/24/77	0840	Shipping dept., appxt. 20 feet east of checkers station	90
2/24/77	0840	Shipping dept., appxt. 20 feet west of checkers station	120
2/24/77	0845	Shipping Dept., checkers station	35
2/24/77	0845	F.L. #1 while idling, operators B.Z.	120
2/24/77	0850	East shipping doors while closed	40
2/24/77	0855	Shipping dept., checkers station while the westerly doors were open for loading	35
3/24/77	1325	Window making dept.	35
3/24/77	1330	Press operator-spot welder	38
3/24/77	1335	10 feet aft F.L. #6 while idling	80
3/24/77	1335	" " " " " " revved	300
3/24/77	1340	Press area isleway	40
3/24/77	1340	Sheet metal storage area (isleway)	22
3/24/77	1345	Area sample taken at conveyor shut off switch on isleway next to tube bending department	18
3/24/77	1350	Doorway from tube bend area to shipping department	28
3/24/77	1350	Final check point for S. Stove Assy. line	45
3/24/77	1355	10 feet aft F.L. #1 while idling	65
3/24/77	1355	" " " " " " revved	190
3/24/77	1400	" " " " #3 " idling	110
3/24/77	1400	" " " " #4 " "	95
3/24/77	1405	" " " " " " revved	75
3/24/77	1410	Press #19	32
3/24/77	1415	10 feet aft F.L. #9 while idling	88
3/24/77	1415	" " " " " " revved	200
3/24/77	1420	" " " " #12 " idling	>450
3/24/77	1420	" " " " " " revved	>500
3/24/77	1425	" " " " #6 " idling	120
3/24/77	1425	" " " " " " revved	>500

*NIOSH Evaluation Criteria: 35 ppm - 8-hour TWA, 200 ppm - Ceiling Value.

1) F.L. - Fork Lift
2) B.Z. - Breathing Zone
3) p.p.m. - parts of a contaminant per million parts of air by volume.

Table IX

Requirements for Respirator Usage at Concentrations above the Standard

Concentrations of Free Silica in Multiples of the Standard	Respirator Type*
Less than or equal to 5x	Single use (valveless type) dust respirators.
Less than or equal to 10x	Quarter or half mask respirator with replaceable dust filter or single use (with valve) dust respirator.
	Type C, demand type (negative pressure), with quarter or half mask facepiece.
Less than or equal to 100x	Full facepiece respirator with replaceable dust filter.
	Type C, supplied air respirator, demand type (negative pressure), with full facepiece.
'ess than or equal to 200x	Powered air-purifying (positive pressure) respirator, with replaceable applicable filter.**
Greater than 200x	Type C, supplied air respirator, continuous flow type (positive pressure), with full facepiece, hood, or helmet.

*Where a variance has been obtained for abrasive blasting with silica sand, use only Type C continuous flow, supplied air respirator with hood or helmet.

**An alternative is to select the standard high efficiency filter which must be at least 99.97% efficient against 0.3 μm dioctyl phthalate (DOP).