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

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-183-303

S.W.S. SILICONE CORPORATION
DIVISION, STAUFFER CHEMICAL COMPANY
ADRIAN, MICHIGAN

JUNE 1976

I. TOXICITY DETERMINATION

Environmental and medical investigations have been conducted at the S.W.S. Silicone Corporation, Division of Stauffer Chemical Company on January 28 and 29 and April 6 and 7, 1976 to evaluate employee exposures to various dusts in the HCR compounding and RTV rubber areas of the plant. Based upon environmental concentration data gathered during these surveys, medical interviews, limited physical examinations of employees, observation of work practices, and available literature regarding the toxicity of substances used in these work areas, it has been determined that employee exposures to fumed silica powders and mica are not toxic at concentrations measured during this evaluation.

Indications of previous adverse health effects were discerned primarily by medical history. However, physical examination performed during the evaluation revealed a low incidence of positive findings. Evidence suggests that recent increased efforts by the company to improve dust conditions have been successful.

Since the substances evaluated are capable of producing drying and subsequent irritation of the skin and upper respiratory tract, recommendations pertaining to engineering control and the use of protective equipment have been included in this report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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

a) S.W.S. Silicone Corporation, Division of Stauffer Chemical Company, Adrian, Michigan
b) Authorized Representative of employees
c) U. S. Department of Labor - Region V
d) NIOSH - Region V

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

III. INTRODUCTION

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

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees of the S.W.S. Silicone Corporation to evaluate the potential health hazards associated with Cab-o-sil® and other unidentified dusts in two areas of this silicone rubber plant. The request alleged that there were "a large number of colds and other lung problems."

IV. HEALTH HAZARD EVALUATION

A. Process Description

S.W.S. Silicone Corporation manufactures silicone fluids, emulsions, defoamers, rubber, and greases. The end products are either in the form of a silicone base, to be sold to other companies for further processing, or a finished marketable product. The two areas of the plant included in this investigation were the HCR compounding room and the RTV rubber area.

1. HCR Compounding

Heat curable rubber (HCR) base and compound are mixed, milled, extruded, and packaged in this area of the plant. Silicone gum polymer is received from a separate area of the plant and is charged to a base mixer of 300-500 gallon capacity along with other silicone materials and either Aer-o-sil® or Cab-o-sil® powder. These two latter compounds are both fumed silicas which are added as filler. Charging is either manual, with an employee slitting a bag of powder and emptying it into the mixer, or automatic, in which case the employee still has to empty the bag into a hopper from which it is pumped into the mixer. The mixer is closed while the materials are physically blended together. The entire charging and mixing process may last from six to eight hours. After this time, the mixture is put on rolling mills for further blending of ingredients, then in some instances, extruded, in order to be put into a form that can be readily handled. During the milling and extrusion processes, Aer-o-sil®, Cab-o-sil®, or mica may be dusted by hand onto the rubber to keep the layers from sticking together. At this point, the material is called a "base". The base may be packaged and sold at this point or again mixed on rolling mills with a catalyst and/or pigment in very small quantities to form a "compound". Eleven persons per shift are employed in the HCR compounding area and are rotated among the different jobs - mixing, milling, or extruding.

Aer-o-sil® was the powder used most, and the greatest potential exposures occurred during charging of the mixers or during extruding and milling when powder was dusted onto the silicone rubber by hand. Employees were observed to be wearing disposable dust masks during charging, and hoods were present over the two hoppers from which fillers were pumped. There was no other local exhaust ventilation; general room ventilation was accomplished through the heating and air conditioning system.

2. RTV Rubber

The manufacturing process for RTV (room temperature vulcanization) rubber is similar to that for HCR except that the starting polymer is a low viscosity material and the final product is a liquid rather than a solid. The batches are smaller (100 gallons) and all charging is done by hand. RTV #1 contains a catalyst whereas RTV #2 does not - the customer adds the catalyst for hardening on site. There are four employees per shift in the RTV area, with one person each in charge of mixing, milling, and extruding. The fourth person operated the Kalix unit which packages caulking compound in cardboard tubes. Each mixer operator is responsible for cleaning the mixer tank between batches. This is done by hand with mineral spirits.

B. Evaluation Design

Environmental air sampling was conducted on January 28 and 29, 1976 by NIOSH industrial hygienists. Approximately 35 employees were interviewed during this visit, using non-directed medical questionnaires. More than half of those interviewed reported some health problem which they associated with the use of powders or mineral spirits. A second investigation was therefore conducted on April 6 and 7, 1976, with those employees who were symptomatic initially. They were requestioned and physical examinations were performed by a NIOSH physician. Environmental sampling also was performed on April 6.

Since analyses by NIOSH of bulk samples of Aer-o-sil® and Cab-o-sil® had shown no crystalline silica in the fumed amorphous silica, it was decided that air samples would be subject only to gravimetric analysis for total particulate. During the second shift on January 28, and on the first shift on January 29 and April 6, employees' breathing zone air samples were obtained on pre-weighed VM-1 filters in 3-piece filter cassettes. Sampling was conducted over the entire workshifts at a flow rate of 1.5 liters per minute using MSA Model G personal sampling pumps. Total weight gain of the filters was determined gravimetrically by the NIOSH laboratory in Salt Lake City. On April 6, breathing zone air samples were obtained on employees spreading mica powder by hand onto the rubber during extrusion. MSA Model G personal sampling pumps pulled air at a rate of 1 liter per minute through distilled water contained in impingers worn on the employees' shirt fronts. These solutions were then subject to particle count analysis by the NIOSH laboratory in Cincinnati.

Air samples were not obtained for odorless mineral spirits because of its sporadic and infrequent usage and because the primary route of exposure was judged to be from skin contact and not inhalation.

All HCR and RTV rubber employees who wore personal sampling pumps on January 28 and 29 were interviewed. Of the 23 who gave positive responses to the questionnaires, 13 were requestioned and/or given physical examinations on the follow-up visit to document the range and severity of health problems. Some of the original group of employees questioned were not available, due to job changes, vacations, or such. The medical investigation was primarily directed toward an examination of the skin and detection of upper respiratory tract symptoms.

C. Evaluation Criteria

1. Environmental Standards

Aer-o-sil® and Cab-o-sil® are brand names for a highly dispersed pure amorphous silica produced at high temperatures in the gas phase. The product consists of extremely small (5-50 um), approximately spherically shaped particles with very high surface area and very low density.[1] Occupational health standards for amorphous silica vary considerably. The selected criterion for evaluation of the safe level of exposure is the TLV proposed by the American Conference of Governmental Industrial Hygienists (ACGIH). They recommend that no worker be exposed to time-weighted average concentrations of amorphous silica in excess of 3 mg/M^3 total particulate for up to an 8-hour workday, 40-hour workweek.

Mica is a non-fibrous silicate containing no quartz, cristobalite, or tridymite. Both the ACGIH recommended Threshold Limit Value and the federal standard promulgated by the U.S. Department of Labor (29 CFR 1910.1000) are set at 20 million particles per cubic foot of air (mppcf). Adherence to this exposure concentration should, according to the literature, prevent the development of pneumoconiosis.[2]

2. Toxicologic Effects

a) Aer-o-sil® or Cab-o-sil®

There is very little information available relating to the specific toxicities of these fumed silicas. As they contain no free silica, they would not be expected to cause silicosis. Information relating to the occupational health experience of employees of the manufacturer of Aer-o-sil® in Germany suggests that there were some non-specific lung changes associated with exposure to concentrations which ranged from 2 to 100 mg/M^3. There were no cases of silicosis diagnosed by roentgenogram in their 12 years of experience.[1]

The most important properties with respect to handling difficulties are the ease of dispersal (due to the low density) and the potent dessicant effects of the powders. These characteristics lead to mucous membrane drying and irritation while possibly increasing the incidence of respiratory infection. Contact with the skin removes moisture and irritates the skin.

b) Mica

Mica has been shown to produce pneumoconiosis both experimentally in animals[3] and in humans following several years of occupational exposure to mica dust.[4] In a 1945 study of mica workers in western North Carolina, it was determined that there was an increased incidence of pulmonary pathology. classified by X-ray diagnosis as pneumoconiosis.[4,5]

D. Evaluation Results and Discussion

1. Environmental

Breathing zone samples obtained on pre-weighed VM-1 filters were subjected to gravimetric analysis for total particulate. The results of these analyses are presented in Table 1. Particulate concentrations ranged up to 19.50 mg/M^3, but the majority of the samples were below 1.00 mg/M^3. The average concentration measured on the initial plant visit was 1.22 mg/M^3 and the median concentration was 0.41 mg/M^3. Concentrations were generally higher in the HCR area than in the RTV rubber area. This was likewise true on the follow-up survey where the average particulate concentration was 1.48 mg/M^3 with a median value of 0.35 mg/M^3. Seven of the eleven measurements which exceeded 1 mg/M^3 were obtained on personal breathing zone samples from mixer operators in the HCR compounding room, and no significant decrease was observed in exposure concentrations of operators of mixers equipped with automatic pump charging as opposed to manual charging.

Impinger solutions were submitted for particle count analysis. All counts were made using light field microscopy at 100X magnification. Particle counts ranged from 0.55 to 4.16 mppcf (million particles per cubic foot of air sampled). The lowest count was an area sample at extruder 702 and the two highest counts were breathing zone samples on the operator for this same extruder. All levels measured were below the recommended criterion of 20 mppcf for mica. Data from particle count analyses are presented in Table 2.

2. Medical

A total of 13 workers, 6 females and 7 males, were evaluated by use of questionnaire and physical examination. The mean age was 25.8 years with a range of 20-40 years. The mean work duration was 1.8 years with a range of 2 weeks to 4.0 years. Eleven of those interviewed believed they had had symptoms related to their work. Forty-six percent (6 of 13) reported skin rash mostly associated with use of odorless mineral spirits and Aer-o-sil®. Sixty-nine percent (9 of 13) reported upper respiratory irritation and/or congestion due primarily to Aer-o-sil®. Fifteen percent (2 of 13) had increased incidence of colds and 23% (3 of 13) stated they had nose bleeds or nasal sores related to Aer-o-sil®. Thirty-one percent (4 of 13) reported cough, 8% (1 of 13) wheezing and 8% (1 of 13) had shortness of breath, again mostly related to Aer-o-sil®. Table 3 presents the data on symptoms by history.

Physical examination of the workers revealed a low number of positive findings. The three cases of skin rash discovered were primarily red dry areas of the hands and forearms and one case of folliculitis. No atopic appearing rashes were observed. Mucous membrane irritation was observed in two workers, and wheezing was found in one worker who had had a past history of asthma since childhood. This data is shown in Table 4.

Irritancy testing on animals conducted by the Experimental Toxicology Branch of NIOSH, revealed that Aer-o-sil® and mineral spirits were very minor irritants, even on abraded skin.

F. Conclusions and Recommendations

Based upon the environmental and medical data, it has been determined that no serious health hazard exists at S.W.S. Silicone Corporation from exposures to Aer-o-sil®, Cab-o-sil®, or mica powders. The high incidence of past symptoms by medical history and the lack of current physical findings suggest that higher exposure probably existed in the past. This is supported by reports that the company had been improving their housekeeping practices.

Concentrations of total particulate measured in the breathing zones of workers were normally quite low and are not expected to cause any serious health effects. The two values which were above the recommended standard of 3 mg/M^3 for amorphous silica are not believed to be typical or representative of actual employee exposures (45 of the 47 samples were below 2 mg/M^3). Moreover, on both instances the mixer operators wore respiratory protective equipment during charging, therefore the measured values would not represent the employees' true exposures.

In order to reduce the incidence of upper respiratory tract irritation and congestion, it is recommended that all mixer operators wear respiratory protection during the short time that they are slitting bags and emptying them into the mixers. A twin cartridge respirator equipped with a high efficiency particulate filter designed to protect against extremely finely divided particles is recommended. Employees should be given instruction on the use of respirators, cleaning of respirators, and how to test for leakage. It is further suggested that automatic pumps be used for charging of all mixers and that local exhaust ventilation be provided where the bags are slit and dumped into the hopper.

The use of protective clothing would reduce the drying effects of the powders on the skin. It is recommended that loose fitting coveralls be provided and that workers shower and change clothes prior to leaving the plant. Additionally, since the powders seem to be capable of permeating through clothing, rubber or plastic aprons are recommended, especially for extruder and mixer operators.

Gloves which are impervious and resistant to mineral spirits, such as Neoprene®, are suggested for use during the cleaning of mixers with mineral spirits. Persons who develop rashes while using these precautions should be evaluated by a dermatologist. If skin testing is required, NIOSH would be available to assist in this endeavor.

V. REFERENCES

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Table 1

TOTAL PARTICULATE CONCENTRATIONS

S.W.S. SILICONE CORPORATION
ADRIAN, MICHIGAN

January 28 and 29, 1976

Job - Location	Sample Time	Concentration (mg/M^3)
Greaser - RTV	16:08 - 23:00	0.11
Clean-up - RTV	16:10 - 23:03	0.27
Packaging - RTV	16:11 - 22:59	0.10
Packaging - RTV	16:13 - 23:02	1.19
Mixing - M-704 - HCR	16:17 - 23:13	1.68
Mixing - M-703 - HCR	16:20 - 23:15	19.50*
Mixing - M-701 - HCR	16:21 - 23:12	1.80
Extruding - 704 - HCR	16:28 - 23:11	0.45
Extruding - 704 - HCR	16:32 - 23:11	0.57
Extruding - 706 - HCR	16:33 - 23:08	0.30
Extruding - 706 - HCR	16:34 - 23:08	0.32
Extruding - 602 - HCR	16:37 - 23:15	0.27
Milling - 710 - HCR	16:40 - 23:09	0.41
Extruding - 602 - HCR	16:42 - 23:07	0.28
Milling - 702 & 704 - HCR	16:48 - 23:12	0.35
Kalix - RTV	8:14 - 14:57	0.27
Kalix - RTV	8:15 - 14:58	0.29
Mixing - M-908 - RTV	8:17 - 15:01	0.41
Mixing - M-917 - RTV	8:19 - 15:00	0.30
Packaging catalyst - RTV	8:25 - 15:02	0.18
Mixing - M-701 - HCR	8:31 - 15:11	0.47
Milling - 702 - HCR	8:33 - 15:09	0.44
Milling - 704 - HCR	8:35 - 15:10	0.58
Milling - 708 - HCR	8:36 - 15:11	1.33
Extruding - 702 - HCR	8:41 - 15:05	0.96
Clean-up - HCR	8:43 - 15:03	0.55
Extruding - 703 - HCR	8:46 - 15:08	0.28
Milling - 710 - HCR	8:51 - 15:19	0.39
Extruding - 704 - HCR	8:55 - 15:04	0.75
Extruding - 704 - HCR	8:56 - 15:03	1.90
Extruding - 701 - HCR	9:00 - 15:07	0.83
Mixing - M-704 - HCR	9:10 - 15:09	1.48

Table 1 (contd)

TOTAL PARTICULATE CONCENTRATIONS

S.W.S. SILICONE CORPORATION
ADRIAN, MICHIGAN

April 6, 1976

Job - Location	Sample Time	Concentration (mg/M^3)
Milling - 703 - HCR	11:47 - 15:52	0.35
Milling - 704, 708 - HCR	11:06 - 15:55	0.62
Milling - 709, 710 - HCR	10:58 - 15:57	0.29
Mixing - 701 - HCR	11:45 - 15:53	1.94
Mixing - 704 - HCR	11:02 - 15:53	0.92
Mixing - 703 - HCR	11:04 - 15:52	1.30
Mixing - 702 - HCR	11:00 - 15:55	0.56
Mixing - 701 - HCR	11:40 - 15:54	14.02*
Extruding - 703 - HCR	11:10 - 15:53	1.34
Packaging - RTV	12:00 - 15:46	0.12
Warehouse - RTV	12:00 - 15:47	0.23
Mixing & Milling - RTV	12:15 - 15:50	0.28
Kalix - RTV	12:17 - 15:47	0.13
Kalix - RTV	12:24 - 16:00	N.D.
Milling & Packaging - Redroom - RTV	12:47 - 15:45	0.04

* These higher values are believed to be due to errors in sampling or analyses, or to inadvertent contamination of the filters.

Table 2

MICA CONCENTRATIONS

S.W.S. SILICONE CORPORATION
ADRIAN, MICHIGAN

April 6, 1976

Job/Location	Sample Time	Concentration* (mppcf)
Extruding - 702 - HCR	12:40 - 13:30	4.16
Extruding - 702 - HCR	14:18 - 15:59	3.69
Extruding - 703 - HCR	12:31 - 15:55	0.69
Area - Extruder 702 - HCR	12:41 - 15:59	0.55

$$*\text{mppcf} = \frac{(\text{Average \# particles/field})(\text{Impinger dilution vol in cc} \times 10^3)}{(\text{Air vol in ft}^3)\ (\text{Area of counting cell})\ (10^6)}$$

Table 3

SYMPTOMS BY HISTORY

S.W.S. SILICONE CORPORATION
ADRIAN, MICHIGAN

1.	Skin rash	6 of 13	46%
2.	Upper respiratory irritation and/or congestion	9 of 13	69%
3.	Increased incidence of colds	2 of 13	15%
4.	Nose bleeds and/or sores in nose	3 of 13	23%
5.	Coughing	4 of 13	31%
6.	Wheezing	1 of 13	8%
7.	Shortness of breath	1 of 13	8%

Table 4

PHYSICAL EXAMINATION FINDINGS

S.W.S. SILICONE CORPORATION
ADRIAN, MICHIGAN

April 6, 1976

1.	Skin rash or erythema	3 of 13	23%
2.	Nose and throat mucous membrane irritation	2 of 13	15%
3.	Lungs (wheezing)	1 of 13	8%