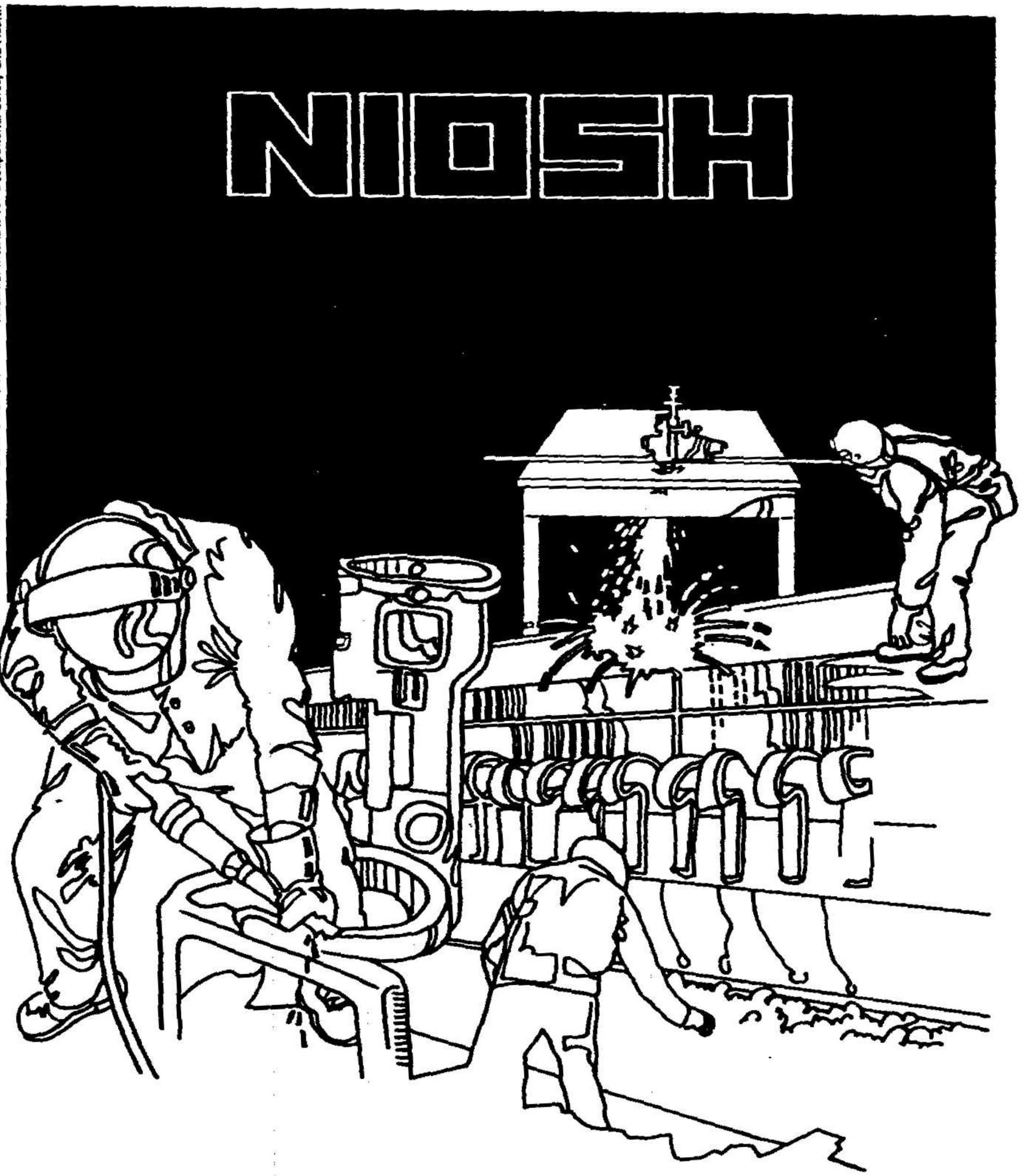
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 91-023-2096
TULLY SCULPTING
NIWOT, COLORADO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 91-023-2096
FEBRUARY 1991
TULLY SCULPTING
NIWOT, COLORADO

NIOSH INVESTIGATOR:
Charles S. McCammon, Ph.D., CIH

I. SUMMARY

On October 23, 1990, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation (HHE) to determine the hazards of exposure to crystalline silica during stone sculpting. The primary stone used for sculpting was granite and the work was typically done outside. The end products are sculptured fountains. A site visit was made on October 26, 1990, to collect personal breathing-zone samples during a typical day of working on stone. Samples were collected for total and respirable silica. Sound level measurements were taken during the operation of the various hand tools.

Only short-term (30 minute) samples were taken as this was the duration of the different operations. The total dust samples ranged from 0.2 to 1.2 mg/M^3 while the respirable dust levels ranged from <0.1 to 0.74 mg/M^3. The total quartz concentrations varied from non-detectable (detection limits of 0.015 mg/sample) to 0.6 mg/M^3. No measureable levels were found to respirable quartz, or total or respirable cristobalite. The highest exposure levels occurred during grinding of stone surfaces with no engineering controls. The short duration of the exposures did not result any any exposures over the time-weighted average standards, but could have if the duration lasted as long as 1.5 hours.

Noise levels measured near the worker's head averaged 102-104 dB(A) when the stone saw and grinder were in operation. The worker had appropriate hearing protection.

On the basis of the data collected, no health hazards were found to exist to crystalline silica, total dust, or noise. The potential for over-exposure exists to both crystalline silica and noise, so recommendations include the establishment of formal respirator and hearing conservation programs.

KEYWORDS: SIC 3281 (Cut Stone and Stone Products), cristobalite, crystalline silica, noise, quartz, and total dust.

II. INTRODUCTION

On October 23, 1990, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) to determine the hazards of exposure to silica during stone sculpting. The sculptor was concerned about the potential dust and silica exposure during the shaping of stone for granite fountains production. The stone work generally occurs outdoors and includes the use of stone saws, grinders, and drills. A site visit was conducted on October 26, 1990 to collect personal breathing-zone samples during a typical day of working on stone. Sampling was conducted while as many stone tools as possible were used. Samples were collected for total dust, total and respirable quartz, total and respirable cristobalite, and noise.

III. BACKGROUND

The primary end product made by this artist is sculptured fountains made from granite (which comes from a variety of locations around the world). Generally, the work is done outside on a lawn either at the sculptor's house or at a rented location depending on the size of stones to be worked. The stone must be shaped, drilled, and connected together to form the desired end product.

The primary tools used include stone saws, hand chisels, grinders, and drills. The various machine tools can be equipped with a water spray which reduces the dust and aids in cutting by providing some lubrication. The stone saw has a diamond-tipped cutting blade and the grinder uses diamond chips as an abrasive. When working with stone, the sculptor wears a long-sleeved shirt, leather work gloves, ear plugs, wrap-around sun glasses, and a half-face respirator equipped with a prefilter and a high efficiency particulate aerosol (HEPA) filter.

The air samples were collected while as many stone working tools as possible were used (all but the drill were used). The operation involved the use of a stone saw to first cut the granite blocks, then to hand chisel off the portion of stone which had been cut. This continued until the entire side of the block was even. Lastly, a grinder was used to further smooth the cut stone surface. The stone saw and grinder are the primary tools used in the making of stone fountains. The duration of the operations monitored (30-40 minutes) was considered to be fairly typical.

IV. EVALUATION DESIGN AND METHODS

The NIOSH evaluation consisted of observation of the stone working process, collection of breathing-zone air samples for total dust and silica dust, and the measurement of noise levels during machine operation. The specific measurements and types of samples collected in the environmental survey are detailed in the following list.

A) Air samples were collected at flow rates of 1.7 liters per minute (Lpm) for personal breathing-zone (PBZ) respirable silica samples, 2.5 Lpm for PBZ total dust samples, and 5 Lpm for area bulk air samples using Gilian Model HFS 513S high-volume sampling pumps. The samples were collected on pre-weighed polyvinyl chloride filters and analyzed gravimetrically for total dust according to NIOSH Method 0500[1]. These same samples were then analyzed for free silica (quartz and cristobalite) using X-ray diffraction according to NIOSH Method 7500[1]

B) Sound level measurements were made with a Quest Model 215 sound level meter. All measurements were made on the A-scale, with slow response. The calibration of the sound level meter was checked just prior to use.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week, for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a preexisting medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus, such contact may increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of air contamination criteria generally consulted include: (1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs); (2) the American Conference of Governmental Industrial Hygienist's (ACGIH) Threshold Limit Values (TLVs)[2]; and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs)[3]. These sources provide environmental limits based on airborne concentrations of substances to which workers may be occupationally exposed in the workplace environment for 8 to 10 hours per day, 40 hours per week for a working lifetime without adverse health effects.

A discussion of the substances evaluated in this survey is presented below. The industrial evaluation criteria for the substances evaluated in this survey are also included. A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday.

A. Silica

Crystalline silica or quartz dust causes silicosis, a form of disabling, progressive, and sometimes fatal pulmonary fibrosis characterized by the presence of typical nodulation in the lungs. Conditions of exposure may affect both the occurrence and severity of silicosis. Although it usually occurs after 15 or more years of exposure, some forms with latent periods of only a few years are well recognized and are associated with intense exposures to respirable dust high in free silica[4]. Early, simple silicosis usually produces no symptoms. However, both acute and complicated silicosis (PMF) are associated with shortness of breath, intolerance for exercise, and a marked reduction in measured pulmonary function. Individuals with silicosis are also at increased risk of contracting tuberculosis. No specific treatment is available, and the disease may progress even after a worker is no longer exposed to silica.

The current OSHA PEL for crystalline quartz silica is 0.1 mg/M^3 as an 8-hour TWA for respirable dust. NIOSH considers crystalline silica to be a carcinogen and recommends that exposures be reduced to the lowest feasible limit, which is considered to be 0.05 mg/M^3 for respirable quartz dust. The ACGIH TLV is 0.1 mg/M^3 for total quartz dust. Since the cristobalite form of crystalline silica is considered to be more toxic, the corresponding OSHA PEL and NIOSH REL is 0.05 mg/M^3 as respirable dust, and the ACGIH TLV is 0.05 mg/M^3 as total dust.

B. Total Dust

Particulate aerosols which do not show a marked toxic effect and are not otherwise classified are grouped into a category of nuisance dusts. These dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control.

Excessive exposures to nuisance dusts in the workplace may reduce visibility, may cause unpleasant deposits in the eyes, ears, and nasal passages, or cause injury to the skin or mucous membranes. The current OSHA PEL for Particulates Not Otherwise Classified (PNOC) is 15 milligrams per cubic meter of air (mg/M^3) measured as total dust. The ACGIH has a TLV of 10 mg/M^3 for PNOC measured as total dust[5].

C. Noise

Exposure to high levels of noise may cause temporary or permanent hearing loss. The extent of damage depends primarily upon the intensity of the noise and the duration of the exposure. There is abundant epidemiological and laboratory evidence that protracted noise exposure above 90 dB(A) causes hearing loss in a portion of the exposed population.

The OSHA standard for noise specifies a PEL of 90 dB(A)-slow response for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship. This means that in order for a person to be exposed to noise levels of 95 dB(A), the amount of time allowed at this exposure level must be cut in half to be within the PEL.

Conversely, a person exposed to 85 dB(A) is allowed twice as much time at this level (16 hours) to remain within his daily PEL. Both NIOSH and ACGIH propose an exposure limit of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard. Both these latter two criteria also use a 5 dB time/intensity trading relationship in calculating exposure limits.

Time-weighted average (TWA) noise limits as a function of exposure duration are shown as follows:

Duration of Exposure (hrs/day)	Sound Level (dB(A)) NIOSH/ACGIH	OSHA
16	80	85
8	85	90
4	90	95
2	95	100
1	100	105
1/2	105	110
1/4	110	115*
1/8	115*	-
		**

* No exposure to continuous or intermittent noise in excess of 115 dB(A).

** Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

The OSHA regulation has an additional action level (AL) of 85 dB(A) which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the AL. The program must include monitoring, employee notification, observation, an audiometric testing program, hearing protectors, training programs, and recordkeeping requirements. All of these stipulations are included in 29 CFR 1910.95, paragraphs (c) through (o)[8].

The OSHA noise regulation also states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dB(A), feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels. Also, a continuing, effective hearing conservation program shall be implemented.

VI. RESULTS

Table 1 summarizes the dust exposures from the three sets of personal breathing-zone air samples. The samples were all about 35 minutes in duration, which was the average time to complete one phase of the stone shaping, e.g. cutting with the saw. Most of the samples were below the analytical limit of detection. The total dust levels during the sawing of stone with a dry saw, resulted in only minimal total dust levels (0.2 mg/M^3) and only a trace amount of quartz exposure. The grinding operation resulted in measureable exposures of 1.2 mg/M^3 for total dust and 0.74 mg/M^3 for respirable dust. The quartz exposure was measured to be 0.6 mg/M^3 of total quartz dust. The respirable dust sample was below the limit of detection for this 31-minute operation. Analysis of the white granite bulk air samples showed that the airborne rock dust averaged 27% free quartz and 1.8% cristobalite. If it is assumed that 27% of the respirable dust sample was free quartz, this corresponds to a respirable quartz exposure of 0.2 mg/M^3 and a respirable cristobalite exposure of 0.013 mg/M^3 during grinding operations.

Wet sawing of the red granite resulted in a very slight total dust exposure (0.42 mg/M^3) and no detectable levels of respirable, quartz or cristobalite dust.

Noise levels measured about 1.5 feet from the machine tools, about where the worker's head was located, measured 104-108 dB(A) when the saw was used (use of the water spray seemed to have little effect on noise levels). The grinder levels were very similar, varying between 100 and 108 dB(A) and averaging 102 dB(A). In the two hours of monitoring, it is estimated that the noise level averaged 104 dB(A) for 47 minutes (while either the saw or grinder was being operated).

VII. DISCUSSION AND CONCLUSIONS

Use of the grinder resulted in higher levels of dust exposure than use of the saw. Generally, most of the exposures were quite low and of short duration. While some of the short-term samples were in excess of the respective evaluation criteria, the time-weighted averages for this job were well below the respective standards. If the duration of exposure for the grinding operation had continued for a total of 2 hours during that day, then the NIOSH recommended TWA for respirable quartz would have been exceeded.

Exposures to crystalline silica (quartz) did not exceed the applicable standards during the day monitored. Exposures may vary with the type of work, weather conditions, and stone being worked. The personal protective equipment used was appropriate for the work being performed, with the exception of the sun glasses for which goggles should be substituted. Also, a complete respirator program should be instituted which includes periodic fit testing, cleaning of respirators, etc. Currently, the user has had one qualitative fit test done and has been trained by the respirator supplier on how to use a respirator.

The use of the water spray seemed to be visually effective in reducing dust emissions even though the total dust levels measured were higher for the one PBZ sample. Since the total dust air samples collected were fairly low and a limited number were collected, it was impossible to determine the effectiveness of the control based on the air samples.

VIII. RECOMMENDATIONS

1. Full respirator and hearing conservation programs should be implemented. These programs should meet all the requirements of the the specific OSHA standards (29 CFR 1910.95 for Hearing Conservation and 29 CFR 1910.134 for the Respiratory Protection).

2. Goggles should be used instead of sun glasses for eye protection. Although wrap-around sun glasses were worn, goggles would offer better eye protection against rock fragments.

3. It was difficult to fully assess the effectiveness of the water controls on dust generation due to the short duration of the samples and the few numbers of samples. It appeared that the water sprays were reducing dust levels. These controls should be more fully evaluated.

IX. REFERENCES

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4. Ziskind M., Kones RN, Weill H. Silicosis, State of the Art. Am Rev Respir Dis. 1976;113:643.

5. Occupational Health Guidelines for Chemical Hazards. National Institute for Occupational Safety and Health and Occupational Safety and Health Administration. January 1981. DHHS (NIOSH) Publication No. 81-123.

6. 29 CFR 1910.95 (March 1989). Code of federal regulations. Washington, DC: U.S. Government Printing Office of the Federal Register.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared and Typed by:	Charles S. McCammon Regional Consultant for Occupational Health Denver Regional Office
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations and Field Studies

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Tully Sculpting, Niwot, Colorado
2. OSHA Region VIII
3. NIOSH Denver Region

TABLE 1
SUMMARY OF PERSONAL SAMPLES FOR FREE SILICA
TULLY SCULPTING
NIWOT, COLORADO
OCTOBER 1990

Job/Machine Used	Sample Time(min)	Flow Rate (Lpm)	Granite Type	Dust Conc.* (mg/M3)	Quartz Conc. (mg/M3)	Cristobalite Conc. (mg/M3)
Sawing stone blocks	39	2.5	white	0.2	(0.3)#	ND
	39	1.7		ND-R	ND-R	ND-R
Grinding stone blocks	31	2.5	white	1.2	0.6	ND
	31	1.7		0.74-R	ND-R	ND-R
Sawing stone, saw had	38	2.5	red	0.42	ND	ND
water spray 38	1.7		ND-R	ND-R	ND-R	

*R denotes respirable sample collected with 10-mm nylon cyclone.
#()indicates analysis above limit of detection (0.015 mg/sample for both quartz and cristobalite) but below the limit of quantitation (0.03 mg/sample for both analytes).
ND denotes the sample was below the limit of detection

NOTE: Two samples were collected during each job, one for total dust and one for respirable dust. Both samples were analyzed for total weight, quartz, and cristobalite. Bulk analysis indicated that the white granite contained an average of 27% quartz and 1.8% cristobalite, and the red granite contained 15% quartz and 1% cristobalite.

EVALUATION CRITERIA: NIOSH REL = 0.05 mg/M^3 respirable quartz and cristobalite; OSHA PEL = 0.1 mg/M^3 as respirable dust for quartz and 0.05 mg/M^3 as respirable dust for cristobalite; ACGIH TLV = 0.1 mg/M^3 as total dust for quartz and 0.05 mg/M^3 as total dust for cristobalite.