HETA 99-0084-2807
Haverhill High School
Haverhill, Massachusetts

David C. Sylvain, CIH

PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (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 (OSHA) 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 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.

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by David C. Sylvain, CIH of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by DataChem Laboratories, and the Division of Physical Sciences and Engineering. Desktop publishing was performed by Pat Lovell. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Exposures in a High School Ceramics Classroom and Woodworking Shop

NIOSH responded to a confidential employee request for a Health Hazard Evaluation at Haverhill High School. Teaching staff was concerned about respiratory illnesses, possibly caused by exposures to materials used in classrooms.

What NIOSH Did

Tested the air for silica in the ceramics classroom.
Tested the air for wood dust in the woodworking shop.
Collected surface wipe samples.
Talked to teachers about classroom conditions.
Walked through art classrooms to observe tasks and housekeeping.

What NIOSH Found

Silica and wood dust levels were low.
Silica was found in settled dust.
Dust was found on surfaces in the ceramics classroom.
Dust collectors in the woodworking shop were not effective.

What Haverhill High School Administrators Can Do

Substitute premixed glazes or install exhaust ventilation where teachers mix powdered glaze materials.
Establish better housekeeping practices in ceramics.
Install effective exhaust ventilation at the wedging table and throughout the woodworking shop.
Implement an effective Chemical Hazard Communication Program.

What the Haverhill High School Employees Can Do

Handle powdered glaze materials carefully to minimize exposure to airborne dust.
Prohibit students from dry-sweeping dust in the ceramics classroom.
Instruct students in the hazards of crystalline silica, wood dust, and other materials in art classrooms.

CDC
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We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513/841- 4252 and ask for HETA Report # 99-0084-2807

National Institute for Occupational Safety and Health
NIOSH

Health Hazard Evaluation Report 99-0084-2807
Haverhill High School
Haverhill, Massachusetts
September 2000

David C. Sylvain, CIH

SUMMARY

On January 27, 1999, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from staff at Haverhill High School in Haverhill, Massachusetts, for an evaluation of exposures to crystalline silica and other compounds in ceramics. The request indicated that employees were concerned about developing emphysema, silicosis, and/or asthma due to exposure to ceramics materials. In addition, the request indicated that staff were concerned about exposures to various materials used in five art rooms, and the woodworking shop.

On April 27, 1999, an initial site visit was conducted which included an opening conference, informal discussions with teachers, and a walk-through inspection of the art rooms and woodworking shop. During the walk-through, activities were identified in ceramics and woodworking classrooms which could result in exposure to crystalline silica, metals, and wood dust. On May 4, 1999, a second site visit was conducted where environmental monitoring was conducted for airborne crystalline silica in the ceramics classroom, and wood dust in the woodworking shop. Surface wipe sampling for metals was conducted in ceramics.

Measured concentrations of respirable crystalline silica were below the NIOSH Recommended Exposure Limit (REL) during the monitoring period. Neither of the respirable area samples revealed detectable levels of crystalline silica. Total crystalline silica (quartz) concentrations of 0.070 milligrams per cubic meter (mg/m^3) and 0.075 mg/m^3 were quantified in bulk air samples collected at the wedging table and at the center of the classroom, respectively. A bulk sample of settled dust, collected from a shelf adjacent to the door leading to the corridor, contained 25% quartz. Cristobalite was not detected in any of the samples. Gravimetric analysis of air samples indicates that concentrations of all airborne particulates were below occupational exposure limits for particulates not otherwise regulated (PNOR). Surface wipe sampling for metals found the highest concentrations of metals in the storage closet where glazes are prepared from powdered materials. Local exhaust ventilation (LEV) is not provided at the wedging table or in the glaze preparation area.

The highest concentration of wood dust (3.4 mg/m^3 during a 50-minute period) was measured in the personal breathing zone (PBZ) sample collected on the woodworking instructor. A similar concentration (3.2 mg/m^3 during a 78-minute period) was measured in the vicinity of two students who were using hand-held orbit sanders at a "homemade" downdraft table.

The presence of crystalline silica in a settled dust sample indicates a need for LEV and appropriate housekeeping practices in the ceramics classroom. Air samples collected in the woodworking shop indicate that current LEV is not providing effective control of wood dust. Recommendations include substituting premixed glazes, installation of effective LEV systems in ceramics and woodworking classrooms, improved housekeeping practices in ceramics, and implementation of an effective Chemical Hazard Communication Program.

Keywords: SIC 8211 (elementary and secondary schools), ceramics, crystalline silica, metals, quartz, wood dust, woodworking.

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INTRODUCTION

On January 27, 1999, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from staff at Haverhill High School for an evaluation of exposures to crystalline silica and other compounds in ceramics. The request indicated that employees were concerned about developing emphysema, silicosis, and/or asthma due to exposures due to ceramics materials. In addition, the request indicated that staff were concerned about exposures to various materials used in five art rooms, and the woodworking shop.

On April 27, 1999, an initial site visit was conducted which included an opening conference, informal discussions with teachers, and a walk-through of the art rooms and woodworking shop. During the walk-through, activities were identified in ceramics and woodworking classrooms which could result in exposure to crystalline silica, metals, and wood dust. On May 4, 1999, a second site visit was conducted in the ceramics classroom, and the woodworking shop. During this visit, environmental monitoring was conducted for airborne crystalline silica in ceramics, and wood dust in woodworking. Surface wipe sampling for metals was conducted in ceramics.

BACKGROUND

Haverhill High School was constructed in 1963, and renovated in the 1970s. Renovations included the construction of a media center, new cafeteria, indoor swimming complex, and additional classrooms. At the time of this HHE, the facility supported approximately 1,670 students in 136 classrooms.

The art rooms and woodworking shop are located in A-wing. Activities conducted in these rooms include computer instruction (room A2), painting (A5), basic art and jewelry (A6), photography (A10), woodworking (A13), and ceramics (A11).

Six ceramics classes are conducted daily in room A11. The average ceramics class consists of 22 students, and is instructed by one of four teachers, each of whom conducts one or two ceramics classes each day. In the ceramics room, teachers instruct students in the various steps involved in making clay objects, using a potter's wheel, applying glazes, and kiln firing. The process begins with moist clay, which is received in sealed 25-pound packages, or with clay that was left over from previous projects. Leftover clay is taken from a scrap bin and is recycled through a pug mill for reuse. Next, students manually work the clay at the wedging table to smooth out the clay and remove air bubbles. Clay is then formed by hand at a work table, or thrown on one of seven potter's wheels located near the wedging table. At this point, the clay objects are allowed to dry, and may be trimmed by hand before being bisque-fired at 1800-1900°F in one of two electric kilns in the adjacent kiln room. Glazing is brushed onto the bisque-fired objects, which are then fired at 2100-2200°F (glaze firing). Firings occur overnight when no one is in the classroom. The kiln room is equipped with a ceiling exhaust fan.

Ceramics teachers spend approximately 2 to 3 hours per month preparing glazes from dry, powdered materials. The dry powders are weighed on a balance in the storage room, and are taken into the classroom where they are mixed in a blender. There is no local exhaust ventilation (LEV) where the powders are handled. Powdered materials used in glazes include flint (silica), kaolin, and colorants. Colorants contain various metals, such as manganese dioxide, nickel, and cobalt compounds. Prepared glazes are kept in sealed plastic jars.

Woodworking classes are typically conducted during 2 or 3 periods each day. Class size is approximately 18 students. The woodworking shop is located in a large interior room which measures approximately 40' x 40' x 14'. The shop is equipped with a jointer, a shaper, lathes, planers, drill presses, saws (radial arm saw, bandsaw, bench saws, jig saw), and sanders (disc, palm, spindle). A Harradee fabric filtration system, located near the teacher's desk, is used to collect particulate from several woodworking machines. Wood dust is deposited in two 55-gallon drums, and air is exhausted into the shop near the teacher's desk. The belt sander is equipped with a stand-alone fabric filtration unit. A second stand-alone unit provides downdraft exhaust ventilation through a pegboard bench top where students use powered hand sanders. In addition to the "homemade" downdraft table, a small, portable downdraft work surface is provided at the sanding bench. The nozzle of a shop vacuum cleaner is mounted at the work surface of the spindle sander to capture wood dust.

METHODS

During the initial site visit, a walk-through inspection was conducted in rooms identified on the HHE request: A2 (computer lab), A5 (art room), A6 (basic art/jewelry), A10 (photography), A11 (ceramics), and A13 (woodworking). Processes, activities, and materials were assessed in each area. Discussions with teachers, and observations during the walk-through, indicated that further environmental sampling was needed to evaluate potential workplace exposures in ceramics and woodworking; therefore, a second site visit was conducted for this purpose.

During the second site visit, area air samples were collected using calibrated battery-operated sampling pumps with the appropriate filter media connected via Tygon® tubing. Sample concentrations were calculated based on the actual monitoring time (time-weighted average [TWA-actual] concentrations). Calibration of the air sampling pumps with the appropriate sampling media was performed before and after the monitoring period. Field blanks were collected and submitted to the laboratory.

Ceramics

Crystalline Silica

Area air sampling for respirable crystalline silica (quartz and cristobalite) was conducted using Gilian Gil-Air air sampling pumps. A flow rate of 1.7 liters per minute (lpm) was used to draw sample air through an MSA Dorr-Oliver cyclone containing a tared 37-millimeter (mm), 5-micron (μ) pore size, polyvinyl chloride (PVC) filter. The cyclone removes the non-respirable fraction of particulate so the filter will collect only that portion of the dust (<10 micrometers [μm] aerodynamic diameter particulate) that penetrates to the deeper areas of the lung. Samples were collected for the duration of ceramics activities on May 4, 1999. The respirable air samples were collected at the wedging table, and at a central location between student work tables. Analysis was conducted by the NIOSH contract laboratory (DataChem, Salt Lake City, Utah) according to NIOSH Method 7500.

Area air samples for total crystalline silica were collected adjacent to the respirable samples. A nominal flow rate of 3.0 lpm was used to draw sample air through a tared 37 mm, 5 μ pore size, PVC filter to collect all airborne silica regardless of size. Total silica samples were collected to increase the likelihood that air samples would contain sufficient free silica to exceed the analytical limit of detection (LOD) for the x-ray diffraction (XRD) analysis. One bulk sample of settled dust, obtained from a shelf in the classroom, was collected to determine the percent and type of silica present and to identify potential analytical interferences. Analysis was conducted by the NIOSH contract laboratory (DataChem, Salt Lake City, Utah) according to NIOSH Method 7500.

Particulates Not Otherwise Regulated (PNOR)

Prior to analyzing air samples for crystalline silica, the total weight of each air sample was determined gravimetrically according to NIOSH Method 0500 (modified). Total weight was determined by weighing the sample plus the filter on an electrobalance, and subtracting the tare weight of the filter.

Wipe Sampling - Elements (Metals)

Wash'n Dri™ wipes were used to collect six surface wipe samples from locations throughout the ceramics classroom for elemental analysis according to NIOSH Method 7300. Each wipe sample was collected from a 100 centimeter squared (cm^2) area using a 10 centimeter (cm) by 10 cm plastic template. Using a new pair of disposable latex gloves for each sample, a wipe was removed from its protective package, and the area within the template was wiped with firm pressure, using three or four vertical S-strokes. The exposed area of the pad was folded in, and the area was wiped using three or four horizontal strokes. The pad was folded once more, and the area was wiped with three or four vertical strokes. The folded pad was then placed in a disposable scintillation vial. A clean template and new pair of gloves were used for each sample. Care was taken to use the same technique and wiping pressure for each sample to reduce variation in collection efficiency.

Woodworking

Wood Dust

Each sample was collected using a Gil-Air sampling pump to draw air through a tared 37 mm diameter PVC membrane filter mounted in a closed-face cassette. Each pump was operated at a nominal flow rate of 2.0 lpm, and was calibrated before and after sampling to ensure that the desired flow rate was maintained throughout the sampling period. Analysis was conducted by the NIOSH contract laboratory (DataChem, Salt Lake City, Utah) according to NIOSH Method 0500.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing 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 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 potentially increases the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[1] (2) the American Conference of Governmental Industrial Hygienists' (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] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm.[4] Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A TWA exposure refers to the average airborne concentration of a substance during a normal 8-to-10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Crystalline Silica

Silica exists in several forms, but only exposure to crystalline (as opposed to amorphous) forms can produce the pulmonary condition called silicosis.[5] Silicosis is a disabling, progressive, and sometimes fatal pulmonary fibrosis characterized by the development of silica containing nodules in the lung.[6] These nodules are thought to be formed by the death of macrophages laden with fine silica. The silica particles are ingested by new macrophages which are in turn killed, thereby releasing intracellular enzymes to promote further fibrosis; thus, the process becomes progressive even if exposure is terminated.[7] The exposure conditions can affect the occurrence and/or severity of silicosis. Silicosis usually occurs after 15 or more years of exposure; however, silicosis has developed after only a few years of exposure to high concentrations.[8] Initially, silicosis may not produce symptoms. However, as the disease progresses, it is characterized by shortness of breath and a reduction in pulmonary function. Individuals with silicosis are also at increased risk of developing tuberculosis.

Quartz is the most common crystalline form of silica. Cristobalite and trydimite are other major forms of crystalline silica, and can be formed from quartz under certain temperature and pressure conditions. Tripoli is a naturally occurring microcrystalline form of quartz.[9]

Cristobalite and trydimite are considered to have greater fibrogenic potential than quartz, and both the ACGIH and OSHA have set the TLV/PEL for the respirable fraction of these substances at one-half the value of quartz[5,9,10] [Note: The respirable fraction is considered to be that portion of inhaled dust which penetrates to the nonciliated portions of the lung.[8] In general, particles greater than 7-10 micrometers (µm) in diameter are removed in the nasal passages and have little probability of penetrating to the lung. Particles smaller than this can reach the air-exchange regions (alveoli, respiratory bronchioles) of the lung, and are considered more hazardous.] The OSHA PEL for crystalline silica is determined according to the amount of crystalline silica in the dust; the NIOSH REL for respirable silica (all forms), is 0.05 mg/m^3.[1] The REL, TLV, and formulas for calculating the PEL are in Table 1.

The National Toxicology Program has concluded that respirable silica may reasonably be anticipated to be a carcinogen, based on laboratory animal studies which showed significant increases in the incidence of lung cancer in rats exposed to quartz via inhalation.[11,12,13] NIOSH is reviewing the data on carcinogenicity.[14]

Particulates Not Otherwise Regulated (PNOR)

Formerly referred to as nuisance dust, airborne particulate which does not have an established occupational health exposure criterion is referred to as particulates not otherwise regulated (PNOR) or particulates not otherwise classified (PNOC). These terms encompass a general category of dusts, or mixtures of dusts, which do not have substance-specific occupational exposure standards. This category includes all inert or nuisance dusts, whether mineral, inorganic, or organic, which are not listed specifically in 29 CFR 1910.1000.[15] The current exposure criteria for PNOR are presented in Table 1. NIOSH has not established a REL for PNOR.

Wood Dust

The principal effects of exposure to wood dust are eye irritation, dermatitis, and upper respiratory tract disease.[9,16] Respiratory diseases associated with wood dust include hypersensitivity, asthma, acute airway obstruction, and allergic disorders of the upper respiratory tract.[9] An increased incidence of adenocarcinoma of the nasal cavity and ethmoid sinus was discovered among woodworkers in the furniture industry of England, Belgium, France, and Denmark.[9] The woods used by these workers included oak, beech, birch, mahogany, maple, and walnut. Subsequent studies in Sweden and the United States, found a higher-than-expected incidence of nasal cancer among woodworkers in the furniture industries of these countries.[17] The most frequent complaints of workers exposed to wood dust include dryness in nose, eye irritation, nasal obstruction, prolonged colds, and frequent headaches.[9]

The NIOSH REL for all soft and hardwood dust is 1 mg/m^3 as a TWA for up to 10-hours per day during a 40-hour workweek. The OSHA PEL is an 8-hour TWA of 15 mg/m^3 for total dust, and 5 mg/m^3 for the respirable fraction. The current ACGIH TLV for “certain hardwoods such as beech and oak” is an 8-hour TWA of 1 mg/m^3 for total dust. The TLV for total softwood dust is a TWA of 5 mg/m^3, with a STEL of 10 mg/m^3. The TLVs specifically exclude red cedar dust and similar woods, which are associated with occupational asthma and related allergic respiratory responses.[9]

Metals in Ceramics

Ceramic glazes consist primarily of silica, to which metals and metal compounds are added as fluxes and colorants. The potential for exposure to metals in glaze materials depends on types and amounts of metals used, as well as the mode of handling and method of glaze-application. Metals used as fluxes include lead, barium, lithium, calcium, and sodium. Colorants are used in lesser amounts, typically about 5% by weight.[17] Various colorants may be combined to create a particular color. Metal oxides and other metal compounds used as colorants include cobalt compounds, copper compounds, lead carbonate, soluble and insoluble nickel compounds, vanadium pentoxide, and various chromates.[18]

The ceramics process typically consists of weighing dry, powdered glaze materials, and putting them into a container where they are mixed with water to make a slurry. This mixture is then brushed or sprayed onto the piece, which is fired in a kiln. Exposure to metal compounds (and silica) can occur while the powders are being manually dispensed, weighed, and transferred. Exposure may also occur if glaze is sprayed onto the workpiece.

The use of lead-containing flux poses the risk of lead exposure to the artist. In addition, certain lead-containing glazes can be a source of exposure to the user, if a lead-containing item is used for serving, storing, or preparing food. Although metal compounds in colorants are present in relatively small amounts, it should be noted that inhalation, ingestion, or skin contact with various metal compounds in sufficient concentrations or amounts is known to produce adverse health effects. Table 2 contains a summary of occupational exposure limits and health effects for selected metal compounds.

RESULTS

Crystalline Silica and PNOR

The results of the area air samples collected in the ceramics classroom are shown in Table 3. The values are TWA concentrations for the duration of the monitoring period, and include all class time spent on ceramics on the sampling date. Measured concentrations of respirable crystalline silica were below the NIOSH REL during the monitoring period. Neither of the respirable area samples revealed detectable levels of crystalline silica. Total crystalline silica concentrations of 0.070 mg/m^3 and 0.075 mg/m^3 were quantified in bulk air samples collected at the wedging table and at the center of the classroom, respectively. A bulk sample of settled dust, collected from a shelf adjacent to the door leading to the corridor, contained 25% quartz. Cristobalite was not detected in any of the samples. Gravimetric analysis of air samples indicates that concentrations of all airborne particulates were below occupational exposure limits for PNOR.

Wipe Samples

The results of surface wipe sampling for metals in the ceramics classroom are presented in Table 4; the analytical limits for these samples are listed in Table 5. With the exception of lead, the elements listed in this table were identified as constituents of the color additives used at Haverhill High School. The highest concentrations of metals were found in the storage closet where ceramics materials are stored, and glazes are prepared from powdered materials.

Wood Dust

The results of air samples collected in the woodworking shop are presented in Table 6. The values reported are TWA concentrations for the duration of the monitoring period. The highest concentration of wood dust (3.4 mg/m^3 during a 50-minute period) was measured in the personal breathing zone (PBZ) sample collected on the woodworking instructor. A similar concentration (3.2 mg/m^3 during a 78-minute period) was measured in the vicinity of two students who were using hand-held orbit sanders at the "homemade" downdraft LEV table.

DISCUSSION

Safety hazards identified during the initial walk-through consisted of an unguarded rotating shaft on a jewelry buffer in room A6, and unguarded drive belts on the Haradee dust collector in the woodworking shop. A smooth rotating shaft can cause severe injuries if hair or loose-fitting clothing becomes entangled around the rotating shaft. An unguarded drive belt and pulley create the risk of entanglement by the belt, or in an ingoing nip point between the belt and pulleys. It should be noted that mechanical safety hazards present the risk of injury even if the hazardous condition is in an out-of-the-way location ("guarded by location"). (Note: a plexiglass guard was installed on the Haradee unit prior to the second site visit.)

Ceramics

On the sampling date, airborne silica concentrations were below all applicable workplace exposure limits at the wedging table and in the vicinity of student worktables. During the sampling period, the wedging table was used periodically by one or two students to manually smooth-out clay and remove air bubbles. These activities generated dust when students struck the table with the clay. At the end of the class, a student swept the table with a brush. Even though silica concentrations measured at the wedging table were below current recommended limits on the sampling date, quantifiable amounts of silica in total silica samples indicate that the use and dry-sweeping of the wedging table may result in student and teacher exposure to airborne crystalline silica.

Silica exposure at the wedging table should be controlled by installing an effective LEV system at the table. LEV systems are designed to capture and remove air contaminants which would otherwise enter a person's breathing zone. The release of silica-containing dust during dry-sweeping should be reduced by using wet-methods to clean the table, or by cleaning the table with a vacuum cleaner equipped with a high-efficiency particulate air (HEPA) filter. HEPA filtration will capture respirable dust which would otherwise be released into the room in the exhaust stream emitted from the vacuum cleaner.

Since glaze was not mixed at the time of the sampling visit, this source of potentially significant exposure to airborne silica remains unevaluated. According to teaching staff, teachers spend approximately two to three hours per month preparing glazes from dry powders. Weighing and mixing of glazes occurs in a storage closet where there is no LEV, or other means to control exposure to silica and other glaze components. According to "Conrad glaze formula G210," flint (silica) comprises 32 percent of glazes used at Haverhill High School.

The presence of crystalline silica in the bulk sample of settled dust in Room A 11 indicates the need for good housekeeping. A thin film of settled dust was observed on horizontal surfaces throughout the room. Dust and dirt had accumulated beneath the television stand near student work tables. Teaching staff reported that housekeeping is inadequate, and that a film of dust is left on the floor even after mopping. Footprints were visible where dust had been tracked from the ceramics classroom into the adjacent photography room.

Students' work aprons (not worn during the HHE), were encrusted with dry clay. The aprons were reportedly washed once each semester: it appeared that they would benefit from more frequent cleaning, especially since dry clay is a likely source of airborne silica.

Surface wipe samples revealed only low levels of metals on surfaces throughout the classroom. Higher surface concentrations were found in the closet where glazes are stored and prepared. Surface contamination resulting from airborne dust, released during glaze-preparation, should be controlled by substituting premixed glaze for the dry powders; or by installing an effective LEV system if powdered glazes continue to be used.

Material safety data sheets (MSDSs) were not available for materials used in ceramics. The only available information was found on the glaze formulation sheet, labels on some containers, and handwritten notices in the storage closet. Colorants were stored in coffee cans with no hazard warnings. The label on sacks of Zircopax Glaze (the manufacturer's packaging) displayed a confusing label stating that the product was of "low toxicity," yet contained silica. It inaccurately stated that the health consequence of exposure to silica is "possible lung irritation."

Woodworking

The types of wood used in the shop were identified as oak, poplar, pine, cherry, black walnut, black willow, aromatic cedar, and ash. LEV in the woodworking shop consists of a Haradee dust collector and several stand-alone dust collectors at woodworking equipment. Some equipment, such as the bandsaw and radial arm saw, is not equipped with LEV. The Haradee is a fabric collector system ("baghouse") which serves several pieces of woodworking equipment. The Haradee is located in a corner of the shop and, like the stand-alone dust collectors, discharges filtered air into the shop. While recirculating dust collectors may be fairly effective, the area air sample collected near the Haradee indicates that some dust is being exhausted into the shop by this system.

LEV at the "homemade"downdraft table was not operating during much of the sample period; however, during the period when it was used, it was found to be ineffective at collecting dust from hand-held sanders. This LEV system consisted of a stand-alone Wood-Tek dust collector which pulled air from beneath a pegboard table top. The maximum air velocity, measured one-inch above the surface of the table, was 25 feet per minute; most readings showed no air movement at the surface of the table. During sanding, the pegboard holes were blocked by the students' flat workpieces; thus, dust was generated at the upper surface of the workpieces, while the pegboard holes beneath each workpiece were blocked by the workpieces.

Noise levels greater than 85 decibels (dBA) were measured at several workstations. A hand-held sound level meter indicated 98-100 dBA near the planer, 92 dBA at the spindle sander, and 88 dBA at the sanding table during operation of the Wood-Tek collector (no sanding was occurring at this time). Although exposure to noise in the woodworking shop is of limited duration, hearing protection should be used to help prevent a gradual loss of hearing from repeated exposure to excessive, continuous noise.

CONCLUSIONS

Although all measured air concentrations of silica were below recommended limits during the monitoring period, the presence of crystalline silica in a settled dust sample indicates a need for local exhaust ventilation and appropriate housekeeping practices to control the release of airborne silica. It should be noted that glaze mixing was not performed during the sampling visit; thus, this potentially significant source of silica exposure was not evaluated.

Although wood dust concentrations measured during the HHE did not exceed current exposure criteria when averaged over 8-hours (assuming no additional exposure for the day), air samples collected during the HHE indicate that current LEV in the wood working shop is not providing effective control of wood dust.

RECOMMENDATIONS

The following recommendations are based on observations made during the survey and are intended to help ensure the safety and health of staff and students in the ceramics classroom and woodworking shop.

1. Exposure to airborne silica and other compounds during glaze mixing should be controlled by substituting premixed glazes for glazes that require mixing of dry powders. If substitution is not feasible, a properly designed LEV system should be installed to capture airborne contaminants at the point of generation.

2. Although measured silica concentrations did not exceed recommended limits on the sampling date, it appeared likely that higher airborne levels would be generated during periods of greater use of the wedging table. The relatively low silica concentrations measured on this date should not be interpreted as an indication of the absence of airborne silica exposure: the settled dust sample, which consisted of 25% quartz, revealed the presence of crystalline silica in the classroom. Installing an effective LEV system at the wedging table would reduce the potential for silica exposure. The release of silica-containing dust during dry-sweeping should be reduced by using wet-methods to clean the table, or by cleaning the table with a vacuum cleaner equipped with a HEPA filter.

3. Visible dust on the floor and other horizontal surfaces in the ceramics classroom indicates a need for more rigorous housekeeping practices. Floors, tables, and other surfaces should be cleaned thoroughly and regularly to reduce potential exposure to crystalline silica. Use of wet-methods and/or a HEPA vacuum cleaner will help prevent dust from becoming airborne, where it may be inhaled or settle on horizontal surfaces.

4. Student aprons should be laundered frequently to remove dry clay, which is a likely source of airborne crystalline silica.

5. An effective Chemical Hazard Communication Program (Right-to-Know Program) should be implemented to ensure that teachers and students are aware of the hazards of materials that they are using, and appropriate methods for reducing these hazards. MSDSs should be obtained from material suppliers.

6. An effective LEV system should be provided in the woodworking shop to control teacher and student exposures to airborne wood dust.

7. Although exposure to noise in the woodworking shop is of limited duration, hearing protection should be worn when woodworking machinery is in use.

Routine use of hearing protection will help prevent gradual loss of hearing resulting from repeated exposure to excessive, continuous noise. Staff and students should be instructed in the proper selection, use, and limitations of hearing protection.

8. Art classrooms and the woodworking shop should be inspected at least weekly to ensure that guards are installed on all equipment, machinery, moving mechanical parts, and drive belts where there is *any* chance that a student or teacher could inadvertently contact moving mechanical parts. Equipment with unguarded components should be taken out of service until effective guards are installed.

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Table 1 Exposure Criteria: Crystalline Silica (Quartz) and PNOR[1] Haverhill High School (HETA 99-0084-2807) May 4, 1999			
Contaminant	Exposure Criteria (mg/m^3)		
	NIOSH REL	OSHA PEL[1]	ACGIH TLV
Crystalline Silica (respirable)	0.05	0.37	0.05
Crystalline Silica (total)	none	1.1	none
PNOR (respirable)	none	5	3
PNOR (total)	none	15	10[2]

mg/m^3 = Milligrams of contaminant per cubic meter of air.
PNOR = Particulates not otherwise regulated.

1. The OSHA PEL for crystalline silica is determined according to the amount of crystalline silica in the dust. The PEL for the respirable fraction and total particulate is calculated as follows:
   PEL(respirable) = 10/[(%quartz) + (%cristobalite x 2) + (%tridymite x 2) +2]
   PEL(total) = 30/[(%quartz) + (%cristobalite x 2) + (%tridymite x 2) +2]
   The PEL for this sample set is based on a settled dust sample containing 25% quartz.
2. Inhalable fraction.

Table 2 Summary of Occupational Exposure Limits and Health Effects for Selected Metal Compounds Haverhill High School (HETA 99-0084-2807) May 4, 1999				
Substance	NIOSH REL (mg/m^3)	OSHA PEL (mg/m^3)	ACGIH TLV (mg/m^3)	Primary Health Effects*
Chromium (IIII) oxide	0.5	0.5	0.5	Chromium exists in a variety of chemical forms and toxicity varies among the different forms. Chromium (III) compounds may cause skin irritation, sensitization, and dermatitis.
Chromium (VI) compounds	0.001	C 0.1	0.05[1] 0.01[2]	Hexavalent chromium (Cr(VI)) compounds are potential occupational carcinogens. Also, liver, kidney damage; leukocytosis (increased blood leukocytes), leukopenia (reduced blood leukocytes), monocytosis (increased blood monocytes), eosinophilia; eye injury, conjunctivitis; skin ulcerationr, primary irritant dermatitis, and sensitization dermatitis.
Cobalt	0.05	0.1	0.02	Lung disease (fibrosis, pneumonitis, obstructive airways syndrome), respiratory hypersensitivity, asthma cardiomyopathy, and allergic dermatitis.
Copper carbonate	--	--	--	Toxic by ingestion.
Copper oxide Red	--	--	--	Toxic by ingestion.
Iron oxide	5	10	5	Benign pneumoconiosis (siderosis).
Iron chromate	0.001	C 0.1	0.01	See Chromium (VI) above.
Lead (inorganic)	0.1	0.05	0.05	Weakness, irritability, gastrointestinal disturbances, reproductive and developmental effects, neuromuscular disfunction, neuropathy, kidney damage, and anemia.
Manganese	1 ST 3	C 5	0.2	Chronic manganese poisoning (manganism) due to effects on the central nervous system, dyspnea (breathing difficulty), and kidney damage.
Nickel compounds	0.015	1	0.1[1] 0.2[2] [Inhalable fraction]	Sensitization dermatitis (nickel itch), asthma, and potential occupational carcinogen (NIOSH).
Titanium dioxide	--	15	10	Mild pulmonary irritant; lung fibrosis, potential occupational carcinogen (NIOSH).
Vanadium pentoxide	C 0.05 [15-min] [respirable]	C 0.5 [respirable]	0.05 [respirable]	Eczema bronchitis, dyspnea (breathing difficulty).

* = Source: *Proctor and Hughes' Chemical Hazards of the Workplace, 4th ed.*, and *NIOSH Pocket Guide to Chemical Hazards*, DHHS (NIOSH) Publication No. 97-140.
ST = 15-minute short-term exposure limit.
C = Ceiling limit. A ceiling value should not be exceeded at any time.
1. Water-soluble compounds.
2. Insoluble compounds.

Table 3
Air Sampling Results: Crystalline Silica (Quartz) and PNOR
Haverhill High School (HETA 99-0084-2807)
May 4, 1999

Sample #	Sample Description	Sample Time (min)	Crystalline Silica (mg/m³)		PNOR (mg/m³)	
			Respirable	Total	Respirable	Total
99-1044	Respirable Area Sample collected at Wedging Table	11:25-13:47 (142)	<0.04	N/A	<0.08	N/A
99-1046	Total Silica Area Sample collected at Wedging Table	11:25-13:46 (141)	N/A	0.070	N/A	0.36
99-1038	Respirable Area Sample: Center of Classroom	11:32-13:44 (132)	<0.04	N/A	0.09	N/A
99-1053	Total Silica Area Sample: Center of Classroom	11:32-13:45 (133)	N/A	0.075	N/A	0.27

Notes: All results are time-weighted average concentrations for the duration of the monitoring period.
PNOR = Particulates not otherwise regulated.
N/A = Not applicable.
mg/m^3 = Milligrams of contaminant per cubic meter of air sampled.
< = Value is less than the minimum detectable concentration (MDC). The MDC is determined by the analytical limit of detection, and the volume of the air sample.

Table 4
Wipe Sampling Results: Metals
Haverhill High School (HETA 99-0084-2807)
May 4, 1999

Contaminant (µg/100 cm²)	Location					
	Table Top	Table Top	Kiln Room	Countertop	Teacher's Desk	Closet Shelf
Cobalt	(2)	nd	7.6	(3)	nd	73
Chromium	nd	nd	nd	nd	nd	nd
Copper	2	3.2	9	2.7	3.2	750
Iron	120	77	340	48	17	360
Lead	nd	nd	nd	nd	nd	(20)
Manganese	1.3	2.9	19	1.3	nd	410
Nickel	nd	nd	7.1	(2)	nd	13
Titanium	12	nd	5.6	nd	nd	2.7
Vanadium	2	(1)	(1)	(0.9)	nd	130

µg/100 cm^2 = Micrograms of contaminant per 100 square centimeters (approximately 16 square inches) of sampled surface.
nd = Not detected (see limit of detection in Table 5).

Table 5 Wipe Sample Analytical Limits Haverhill High School (HETA 99-0084-2807) May 4, 1999		
Contaminant	Limit of Detection (µg/sample)	Limit of Quantitation (µg/sample)
Cobalt	1	4
Chromium	5	20
Copper	0.4	1
Iron	4	10
Lead	5	20
Manganese	0.1	0.4
Nickel	2	6
Titanium	0.5	2
Vanadium	0.6	2

µg = microgram.

Table 6 Air Sampling Results: Wood Dust Haverhill High School (HETA 99-0084) May 4, 1999			
Sample #	Sample Description	Sample Time (minutes)	Wood Dust (mg/m^3)
99-1003	Area Sample: Two students using orbit sanders	08:46-10:03 (78)	3.2
99-1012	Area Sample: Near planer/molder	08:49-10:02 (74)	0.96
99-1014	Area Sample: At Haradee dust collector	08:51-10:01 (70)	2.4
99-1016	Personal Sample: Woodworking Teacher	09:00-09:11 09:21-10:00 (50)	3.4

Notes: All results are time-weighted average concentrations for the duration of the monitoring period.
mg/m^3 = Milligrams of contaminant per cubic meter of air sampled.

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Occupational Safety and Health Concerns

Call NIOSH at:
1–800–35–NIOSH (356–4674)
or visit the NIOSH Web site at:
www.cdc.gov/niosh

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