Evaluation of Aerogel Insulation Particulate at a Union Training Facility

Karl D. Feldmann, MS, CIH
Kristin Musolin, DO, MS
Mark M. Methner, PhD, CIH

Report No. 2014-0026-3230
March 2015

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Contents

The employer is required to post a copy of this report for 30 days at or near the workplace(s) of affected employees. The employer must take steps to ensure that the posted report is not altered, defaced, or covered by other material.

The cover photo is a close-up image of sorbent tubes, which are used by the HHE Program to measure airborne exposures. This photo is an artistic representation that may not be related to this Health Hazard Evaluation. Photo by NIOSH.

Highlights of this Evaluation

The Health Hazard Evaluation Program received a request from a member of an insulators' union. The request concerned particulate exposure from handling aerogel insulation at their training facility in Illinois.

What We Did

- We took personal air samples for components of aerogel insulation (amorphous and crystalline silica, aluminum, iron, and titanium) while an instructor applied aerogel insulation.
- We looked at the shape, size, and size distribution of the airborne particulate released from handling aerogel insulation.
- We observed the work practices of people who handled aerogel insulation.
- We asked participants about exposure to aerogel insulation and about their use of personal protective equipment.
- We asked participants about their medical history, symptoms, and personal hygiene practices while training at this facility and at their job site.
- We reviewed aerogel insulation safety data sheets.

What We Found

- Airborne exposures for amorphous silica approached occupational exposure limits.
- Airborne exposures for crystalline silica, aluminum, iron, and titanium were below the most protective occupational exposure limits.
- Most of the particulate released during aerogel handling was respirable. This means the particles can be inhaled deep into the lungs.
- Many participants who handled aerogel insulation reported upper respiratory tract irritation, or very dry or chapped skin.

We evaluated airborne exposures from handling aerogel insulation. We collected personal air samples for amorphous and crystalline silica, aluminum, iron, and titanium, and determined the size and shape of the aerogel particles during classroom demonstrations. Airborne exposures for amorphous silica approached calculated occupational exposure limits. Most aerogel particles were respirable in size. Many interviewed participants attributed respiratory irritation and very dry skin to handling aerogel insulation. We recommended continued use of personal protective equipment per manufacturer's safety data sheets to minimize reported health effects.

What the Employer Can Do

- Educate staff and students about potential upper respiratory tract irritation and drying effects from prolonged exposure to aerogel insulation.
- Encourage staff and students to report work-related health problems to their supervisor.
- Explore alternative cleansers that are more effective than soap and water that will not contribute to skin drying.
- Provide staff and students with longer gloves that cover their wrists to minimize skin exposure to aerogel insulation.

What Employees Can Do

- Use personal protective equipment per manufacturer's safety data sheets.
- Wash exposed skin with alternative cleansers immediately after handling aerogel insulation because soap and water may not be effective.
- Report work-related health problems to your supervisor. If you experience respiratory or skin irritation, assess your work practices and seek medical attention early. Tell your healthcare provider about the materials you handle on the job.

Abbreviations

CFR	Code of Federal Regulations
NIOSH	National Institute for Occupational Safety and Health
OEL	Occupational exposure limit
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit

This page left intentionally blank

Introduction

The Health Hazard Evaluation Program received a request from an insulators union in Illinois. The request concerned exposure to particulate released during instructor demonstrations of two Aspen Aerogel® insulation products, Pyrogel® and Cryogel®. Union members were concerned that exposure to the aerogel particulate might be the cause of their reported nosebleeds, upper respiratory tract irritation, and skin dryness. They also were concerned about the size of particles generated when handling aerogel. We visited the facility in January 2014 to observe work processes, monitor exposures, and interview employees.

The union provides training for over 200 apprentices per year as part of a 5-year apprenticeship program. Every year, the union also provides supplemental training to more than 800 journeymen who have completed their apprenticeship. The union oversees a 17,000-square foot training area in their facility. Two union employees work at the training facility as instructors and administrators of the apprenticeship program. For the purpose of this report, these two full-time employees will be referred to as instructors, and apprentices receiving training during our visit will be referred to as students.

Instructors teach students how to apply insulation systems. As new types of insulation become commercially available, instructors adapt the training program to demonstrate application techniques using these new materials. Over the past few years, instructors have increased the amount of training provided on the application of aerogel insulation.

The training facility received aerogel insulation in large rolls on a spindle. The rolls were placed in either of two cutting rooms and unrolled as needed onto a table where it is marked, cut to size, and shaped with hand tools. The cut insulation was manually wrapped around pipes, and then secured in place with fiberglass reinforced strapping tape. Instructors and students cut and handled Pyrogel in one cutting room and Cryogel in the other.

Methods

Objectives

The primary objective of this evaluation was to characterize the particulate release from the aerogel material during routine handling and application activities. The findings of this evaluation should not be considered a definitive exposure assessment. The results presented here reflect the exposure of one instructor providing hands-on aerogel handling instruction to members in a union training facility. Further evaluation of the use of aerogel materials in actual workplace settings is needed.

The objectives of this evaluation were to:

- Evaluate instructors' exposures when demonstrating installation of Aspen Aerogel products.
- Evaluate the airborne particle shape and size and determine if it has a nanoparticle fraction.
- Assess the health and safety concerns of the instructors, journeymen, and students who work with aerogel and what symptoms they associated with aerogel.

Air Sampling

We observed an instructor demonstrating how to cut and apply aerogel insulation to pipes. Our air sampling occurred over the 2 consecutive days during which aerogel was handled during a 5-day training session. We collected two full-shift personal air samples on the instructor each day. The samples were analyzed for total particulate by National Institute for Occupational Safety and Health (NIOSH) Method 0500, respirable particulate by NIOSH Method 0600, and crystalline silica by NIOSH Method 7500 [NIOSH 2015]. The respirable particulate samples were further analyzed for aluminum, iron, and titanium because they were listed as components of either Pyrogel or Cryogel.

We used a TSI Model 3330 direct reading optical particle sizer to estimate the size and size distribution of particulate in the two aerogel cutting rooms. The optical particle sizer counts particles and estimates particle size and distribution across a range of < 0.3 to 10 micrometers. We also used the optical particle sizer to collect two area air samples (one in each aerogel cutting room). The samples were photographed using scanning electron microphotography and analyzed using energy dispersive spectroscopy to determine elemental composition.

Employee Interviews

We confidentially interviewed students, journeymen, and an instructor who were present during the evaluation. We asked these participants about their exposure to aerogel insulation and about their use of personal protective equipment. Also, we asked participants about their pertinent medical history, symptoms, and personal hygiene practices.

Program and Document Review

We reviewed the written respiratory protection program with the instructors. We reviewed Aspen Aerogel safety data sheets for Pyrogel and Cryogel to identify components and create a strategy for air sampling. Occupational exposure limits and health effects for detected components of Pyrogel and Cryogel are discussed in Appendix A.

Results

Air Sampling

Personal exposures for amorphous silica approached the calculated Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) (Table 1). Personal exposures for aluminum, iron, and titanium were reported by the laboratory as not detected. The airborne particulate contained amorphous silica, but not crystalline silica, as reported in safety data sheets. Samples were not directly analyzed for amorphous silica as NIOSH Method 0500 is a gravimetric (total weight) method. The OSHA PEL for amorphous silica is calculated by dividing 80 milligrams per cubic meter by the amount of silica (in percent) in the sample [OSHA 1997]. According to the manufacturer's safety data sheet, Pyrogel and Cryogel each contain 40%–50% amorphous silica. We calculated the OSHA PEL based on a 50% amorphous silica content.

Samples were directly analyzed for crystalline silica (NIOSH Method 7500) and were reported by the laboratory as not detected. Crystalline silica is considered a more hazardous form of silica than amorphous.

Table 1. Instructor's exposures (in milligrams per cubic meter) as a time weighted average

	Particulate		Silica	
	Total	Respirable	Total amorphous	Respirable crystalline
Day 1	1.1	0.22	1.1	ND
Day 2	0.44	0.16	0.44	ND
Minimum detectable concentration	0.04	0.05	0.04	0.02
Minimum quantifiable concentration	0.15	0.22	0.15	0.22
Occupational exposure limits				
NIOSH REL	None	None	6	0.05
OSHA PEL	15	5	1.6*	5†
ACGIH TLV	10	3	None	0.025

ACGIH TLV = American Conference of Governmental Industrial Hygienists threshold limit value

ND = Not detected

NIOSH REL = NIOSH recommended exposure limit

*The OSHA PEL for amorphous silica is calculated by dividing 80 milligrams per cubic meter by the amount of silica (in percent) in the sample.

†The OSHA PEL for respirable dust containing 1% or more of quartz is calculated by dividing 10 milligrams per cubic meter by the percent quartz in the sample, plus two. In this evaluation the percent quartz was 0% [10/(0% quartz +2) = 5].

The instructor's 8-hour time weighted averages were calculated based on sample times of 353 and 355 minutes with the balance of the exposure period (127 and 125 minutes) calculated as a zero exposure level. Our observations confirm that the instructor was not engaged in activities involving aerogel for these time periods.

When comparing the total particulate samples to the respirable particulate samples using gravimetric analytical methods, results show that for total particulate samples, particles larger than 4 micrometers account for nearly three times the total mass per sample than the respirable samples (e.g., 1.1 milligrams per cubic meter versus 0.22 milligrams per cubic meter). In short, a few large particles contribute the majority of the mass of the total samples whereas in the respirable samples, the majority of the mass is divided between many small particles.

Most of the airborne particles collected with the TSI Model 3330 were in the respirable (< 4 micrometers in diameter) size fraction. Scanning electron microphotographs of airborne particles collected during Pyrogel (Figure 1) and Cryogel (Figure 2) cutting and handling showed that most were singular, angular, and ranged from 2 to 10 micrometers in diameter. The microscopist reported seven or less nanoparticles per sample. Energy dispersive spectroscopy of these samples showed that the components of the particulate agreed with the safety data sheets.

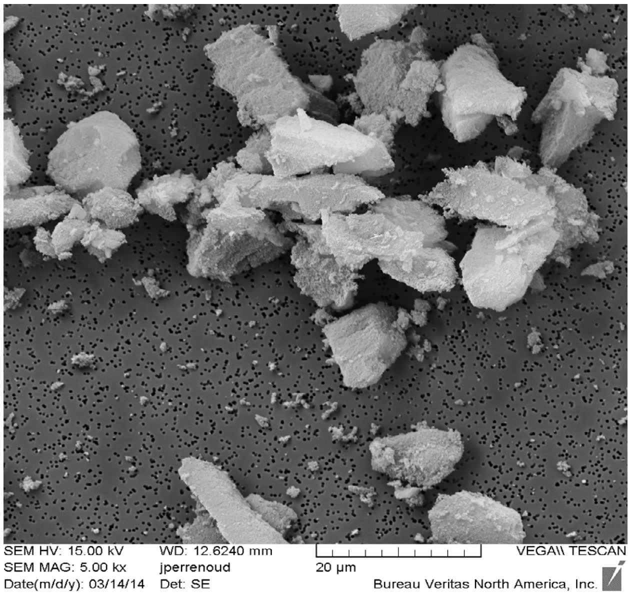

Figure 1. Scanning electron photomicrograph of Pyrogel particles released during cutting and handling. Photo by Bureau Veritas North America, Inc.

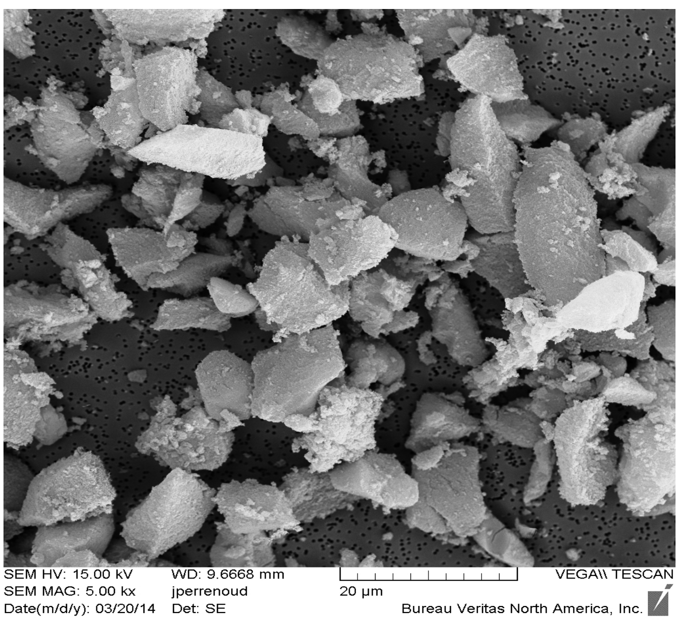

Figure 2. Scanning electron photomicrograph of Cryogel particles released during cutting and handling. Photo by Bureau Veritas North America, Inc.

Employee Interviews

We confidentially interviewed 16 participants (13 students, 2 journeymen, and 1 instructor) during our site visit. The average age was 36 years (range: 24–50 years). The average time worked in the trade was 8 years (range: 4 months–28 years), and average time worked on their current job site was 4 months. All participants were male.

The week we visited the facility coincided with the first time the students received training on aerogel insulation. The journeymen had never received training with aerogel insulation because these materials are relatively new to the marketplace. Eight of the interviewed students were in the first year of their 5-year program, one was in the second year, and four were in the third year. Ten interviewed participants had previously worked with aerogel insulation on a job site, while six had never worked with it prior to this training class. Of those who had worked with aerogel insulation on a job site, the time spent working with it ranged from 3–60 days.

When asked if they had ever used or been exposed to materials containing crystalline silica or asbestos at work, 11 of 16 interviewed participants reported exposure to crystalline silica, and 12 reported exposure to asbestos, another fibrous insulating material. All interviewed participants reported working in or around a construction site and other dusty jobs, 14 reported working in or around a refinery, and three reported working in or around a shipyard. We asked about these prior jobs because it provides an understanding of the potential for other exposures to cause adverse health effects. When handling any insulating material during training, all interviewed participants were required to wear half-mask elastomeric air purifying respirators with P100 filters, nitrile inner gloves and cut-resistant outer gloves, Tyvek® coveralls, goggles, and steel-toed boots. The most common respiratory protective equipment reportedly used on a job site for handling aerogel insulation was either full facepiece or half-mask respirators. Two interviewed participants reported wearing a "dust mask" on a job site while handling aerogel insulation. It was not clear if that was a filtering facepiece respirator or non-respirator facemask. Other personal protective equipment used on a job site was similar to that used during training.

Of the 14 training participants, 11 reported getting aerogel insulation on their clothes or exposed skin or hair while training. All 10 interviewed participants who worked with aerogel insulation on a job site noticed the material getting on their clothes or exposed skin or hair. We asked interviewed participants about personal hygiene practices at work and how they usually cleaned their hands after handling aerogel insulation. Most interviewed participants reported usually cleaning their hands with soap and water. We also asked how many times they washed their hands after handling aerogel insulation. The average number of times was five while training and three times when on a job site.

Respiratory Conditions

Of 16 interviewed participants, 10 reported currently experiencing irritation of eyes, nose, or throat that they believed was related to working with aerogel insulation. Other reported symptoms included nosebleeds (2 of 16) and nasal congestion (2 of 16). Some interviewed participants reported more than one symptom.

When asked about ever having continuous or repeated trouble breathing, 5 of 16 interviewed participants responded yes and of those, three reported having pre-existing asthma. Five of 16 interviewed participants responded yes to experiencing an episode of shortness of breath following strenuous activity in the last 12 months, and 4 of 16 reported wheezing. Seven of 16 interviewed participants reported having environmental allergies, and 11 of 16 reported either being a former or current smoker. Environmental allergies and smoking can contribute to the types of respiratory symptoms reported during interviews.

Skin Conditions

We asked if interviewed participants had experienced specific skin conditions (Table 2) after handling aerogel insulation. The most common skin condition related to working with aerogel insulation either while training or on a job site was excessive dryness or chapping (Table 2).

Table 2. Prevalence of skin conditions related to working with aerogel insulation while training or on a job site reported by interviewed participants (n = 11–14)

Skin conditions	During training No. (%)	On job site No. (%)
Excessive dryness or chapping	10 (71)	10 (91)
Irritant contact dermatitis	6 (43)	2 (18)
Heat rash	3 (21)	2 (18)
Allergic eczema or atopic dermatitis	1 (7)	1 (9)
Individual fluid-filled blisters	0 (0)	1 (9)

Note: Some participants reported more than one symptom.

Of 16 interviewed participants, five reported current dermatitis (defined as skin irritation or rash with red, dry skin that can have tiny bumps or blisters, flaking, cracks, or crusts; skin often itches, burns, or stings). Six interviewed participants reported a history of dermatitis in the last 12 months on their hands or fingers, four reported it on their wrists or forearms, and three reported it on their face or neck. Of those interviewed participants who reported current dermatitis, three reported their dermatitis improved when away from work for more than 5 days. Most thought their rash was caused by handling aerogel insulation. None of the interviewed participants who reported dermatitis in the last 12 months had seen a doctor.

Program and Document Review

The written respiratory protection program included union instructors and students in the apprenticeship program. All students are required by the union to be medically evaluated and cleared for respirator use before beginning the apprenticeship program. The union provides the medical evaluations and training and maintains the records for instructors and students. We observed instructors providing training to students on respirator use, maintenance, and cleaning. We were impressed with the overall quality and thoroughness of this training.

The manufacturer reported small variations of titanium, aluminum and iron content in different versions of insulation. However, in each version the metal content was reported to be less than 5%. The remaining components listed in the safety data sheets were 40%–50% amorphous silica (reported as synthetic amorphous silica) and 40%–50% textile-grade fibrous glass.

Discussion

Air Sampling

We analyzed airborne particulate released from handling aerogel insulation two ways. One was gravimetrically, meaning that we obtained the weight of total and respirable particulate without regard to the number of particles or their size distribution. We also used an optical particle sizer to estimate the number of airborne particles based on their size, and their distribution across a size range without regard to particle mass. Gravimetrically (by mass), most of the airborne particulate we collected was total particulate, and not respirable particulate. However, by counting particles in a specific size range but not measuring their mass there were more respirable particles than non-respirable particles, and most of these respirable particles were within a range of 2 to 10 micrometers in diameter. These apparently contradictory results can be explained by the fact that smaller particles, although more numerous than larger particles, do not weigh as much.

Employee Interviews

Many participants who handled aerogel insulation reported irritation of their upper respiratory tract or excessively dry or chapped skin. The reports of dry or chapped skin may be the result of excessive skin cleaning with soap and water to remove the water-repelling aerogel particulate. Additionally, the small size and angular shape of the particles could result in increased mechanical irritation to skin and the respiratory tract.

The manufacturer's safety data sheets mentioned potential respiratory health effects from mechanical irritation of the upper respiratory tract and a drying sensation from inhaling airborne particulate. These safety data sheets noted that inhaling particulate may aggravate pre-existing lung conditions. When assessing the health effects of synthetic amorphous silica it is important to know if crystalline silica is also present. Crystalline is a much more hazardous form of silica that can cause silicosis, a serious lung disease [Merget et al. 2002]. We detected no crystalline silica in our air samples. Although studies on the health effects of synthetic amorphous silica are limited there is no evidence of a fibrogenic effect in human lungs [Merget et al. 2002]. Acute inhalation injury is dictated by the characteristics of particulates that contribute to toxicity (e.g., particle size, density, and shape) [Miller and Chang 2003]. The principal contributor to airway penetration is particle size; particles that are 3–10 microns in size are deposited in the conducting airways, whereas particles of 0.5–3 microns are deposited deeper into the lungs [Miller and Chang 2003]. The particles we sampled were mostly singular and angular and ranged in size from 2–10 micrometers in diameter. Most of the airborne particles were in the respirable size fraction. Laboratory analysis showed the chemical composition of the particulate was consistent with the manufacturer's safety data sheets. Because health effect information related to human exposure is insufficient, the potential risk of occupational lung disease or respiratory irritation related to aerogel particulate exposure cannot be dismissed.

Some interviewed participants reported a history of dermatitis on their hands, fingers, wrists, forearms, face, or neck. Skin conditions are often located at the site of contact, but airborne particles trapped under clothing may also result in skin conditions [Goossens and Hulst 2011]. Synthetic amorphous silica is known to cause drying and cracking of the unprotected skin following repeated exposure [ECETOC 2006]. The safety data sheets for the aerogel products stated that skin contact can produce a drying sensation and mechanical irritation of the skin and mucous membranes and may aggravate existing dermatitis.

Program and Document Review

Although the respirator training was thorough, we observed instructors using the irritant smoke tube protocol to qualitatively fit test students. NIOSH does not recommend performing qualitative fit testing with irritant smoke [NIOSH 1999]. The isoamyl acetate, saccharin solution aerosol, and denatonium benzoate (Bitrex™) solution aerosol protocols are acceptable substitutes. Qualitative fit testing should be performed according to the OSHA respiratory protection standard [29 CFR 1910.134], whichever protocol is chosen [OSHA 2011].

Conclusions

Airborne exposures for amorphous silica approached calculated occupational exposure limits. However, our sample results are from one instructor providing hands-on aerogel instruction to students in a classroom. Therefore, our results may not be generalizable to other workplace settings. Many interviewed participants who handled aerogel insulation reported irritation of their upper respiratory tract and excessively dry or chapped skin. The small size and angular shape of the airborne particles could result in increased mechanical irritation to skin and the respiratory tract. Because aerogel is manufactured to be water-repellant, the particulate may be difficult to remove from skin with soap and water.

Recommendations

Our recommendations are based on an approach known as the hierarchy of controls (Appendix A). This approach groups actions by their likely effectiveness in reducing or removing hazards. In most cases, the preferred approach is to eliminate hazardous materials or processes and install engineering controls to reduce exposure or shield employees.

Administrative Controls

The term administrative control refers to employer-dictated work practices and policies to reduce or prevent hazardous exposures. Their effectiveness depends on employer commitment and employee acceptance. Regular monitoring and reinforcement are necessary to ensure that policies and procedures are followed consistently.

1. Explore alternative cleansers that are more effective than soap and water and will not contribute to skin drying.

2. Encourage students, journeymen, and instructors to report health or safety concerns associated with job tasks to a supervisor. Those with possible work-related symptoms should promptly seek medical attention from their healthcare provider.
3. Refer students, journeymen, and instructors with persistent dermatitis to a dermatologist for diagnosis and to determine work-relatedness. Refer those with persistent respiratory problems that may be work-related to a pulmonologist familiar with occupational respiratory disorders.

Personal Protective Equipment

Personal protective equipment is the least effective means for controlling hazardous exposures. Proper use of personal protective equipment requires a comprehensive program and a high level of employee involvement and commitment. The right personal protective equipment must be chosen for each hazard. Supporting programs such as training, change-out schedules, and medical assessment may be needed. Personal protective equipment should not be the sole method for controlling hazardous exposures. Rather, personal protective equipment should be used until effective engineering and administrative controls are in place.

1. We recommended the continued use of personal protection equipment in accordance with the manufacturer's safety data sheets. Any respirator use should comply with the OSHA respiratory protection standard [29 CFR 1910.134].
2. Do not use irritant smoke for qualitative respirator fit testing, on the basis of NIOSH respiratory policy [NIOSH 2006]. OSHA does allow the use of irritant smoke as a qualitative fit-testing method.
3. Provide students, journeymen, and instructors gloves with longer cuffs to prevent skin exposure to aerogel insulation.

Appendix A: Occupational Exposure Limits and Health Effects

NIOSH investigators refer to mandatory (legally enforceable) and recommended occupational exposure limits (OELs) for chemical, physical, and biological agents when evaluating workplace hazards. OELs have been developed by federal agencies and safety and health organizations to prevent adverse health effects from workplace exposures. Generally, OELs suggest levels of exposure that most employees may be exposed to for up to 10 hours per day, 40 hours per week, for a working lifetime, without experiencing adverse health effects. However, not all employees will be protected if their exposures are maintained below these levels. Some may have adverse health effects because of individual susceptibility, a pre-existing medical condition, or a hypersensitivity (allergy). In addition, some hazardous substances act in combination with other exposures, with the general environment, or with medications or personal habits of the employee to produce adverse health effects. Most OELs address airborne exposures, but some substances can be absorbed directly through the skin and mucous membranes.

Most OELs are expressed as a time-weighted average exposure. A time-weighted average refers to the average exposure during a normal 8- to 10-hour workday. Some chemical substances and physical agents have recommended short-term exposure limit or ceiling values. Unless otherwise noted, the short-term exposure limit is a 15-minute time-weighted average exposure. It should not be exceeded at any time during a workday. The ceiling limit should not be exceeded at any time.

In the United States, OELs have been established by federal agencies, professional organizations, state and local governments, and other entities. Some OELs are legally enforceable limits; others are recommendations.

The U.S. Department of Labor OSHA permissible exposure limits (29 CFR 1910 [general industry]; 29 CFR 1926 [construction industry]; and 29 CFR 1917 [maritime industry]) are legal limits. These limits are enforceable in workplaces covered under the Occupational Safety and Health Act of 1970.

NIOSH recommended exposure limits are recommendations based on a critical review of the scientific and technical information and the adequacy of methods to identify and control the hazard. NIOSH recommended exposure limits are published in the *NIOSH Pocket Guide to Chemical Hazards* [NIOSH 2010]. NIOSH also recommends risk management practices (e.g., engineering controls, safe work practices, employee education/training, personal protective equipment, and exposure and medical monitoring) to minimize the risk of exposure and adverse health effects.

Other OELs commonly used and cited in the United States include the threshold limit values, which are recommended by the American Conference of Governmental Industrial Hygienists, a professional organization, and the workplace environmental exposure levels, which are recommended by the American Industrial Hygiene Association, another professional organization. The threshold limit values and workplace environmental exposure levels are developed by committee members of these associations from a review of the published, peer-reviewed literature. These OELs are not consensus standards. Threshold limit values are considered voluntary exposure guidelines for use by industrial hygienists and others trained in this discipline “to assist in the control of health hazards” [ACGIH 2014]. Workplace environmental exposure levels have been established for some chemicals “when no other legal or authoritative limits exist” [AIHA 2014].

Outside the United States, OELs have been established by various agencies and organizations and include legal and recommended limits. The Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (Institute for Occupational Safety and Health of the German Social Accident Insurance) maintains a database of international OELs from European Union member states, Canada (Québec), Japan, Switzerland, and the United States. The database, available at http://www.dguv.de/ifa/Gefahrstoffdatenbanken/GESTIS-Internationale-Grenzwerte-für-chemische-Substanzen-limit-values-for-chemical-agents/index-2.jsp, contains international limits for more than 1,500 hazardous substances and is updated periodically.

OSHA requires an employer to furnish employees a place of employment free from recognized hazards that cause or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970 (Public Law 91-596, sec. 5(a)(1))]. This is true in the absence of a specific OEL. It also is important to keep in mind that OELs may not reflect current health-based information.

When multiple OELs exist for a substance or agent, NIOSH investigators generally encourage employers to use the lowest OEL when making risk assessment and risk management decisions. NIOSH investigators also encourage use of the hierarchy of controls approach to eliminate or minimize workplace hazards. This includes, in order of preference, the use of (1) substitution or elimination of the hazardous agent, (2) engineering controls (e.g., local exhaust ventilation, process enclosure, dilution ventilation), (3) administrative controls (e.g., limiting time of exposure, employee training, work practice changes, medical surveillance), and (4) personal protective equipment (e.g., respiratory protection, gloves, eye protection, hearing protection). Control banding, a qualitative risk assessment and risk management tool, is a complementary approach to protecting employee health. Control banding focuses on how broad categories of risk should be managed. Information on control banding is available at http://www.cdc.gov/niosh/topics/ctrlbanding/. This approach can be applied in situations where OELs have not been established or can be used to supplement existing OELs.

Amorphous Silica

Amorphous silica can affect the body if it is inhaled or if it comes in contact with the eyes. Prolonged inhalation of amorphous silica may produce x-ray changes in the lungs without disability and is usually considered to be of low toxicity. However, pure amorphous silica is rarely found, and diatomaceous earth usually contains some amount of crystalline silica. When converted partially to crystalline form by calcination, the dust of diatomaceous earth produces pulmonary fibrosis [NIOSH 1978]. The OSHA PEL for amorphous silica is calculated by dividing 80 milligrams per cubic meter by the amount of silica (in percent) in the sample. [OSHA 1997]. The NIOSH recommended exposure limit is 6 milligrams per cubic meter of air [NIOSH 2010].

References

ACGIH [2014]. 2014 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

AIHA [2014]. AIHA 2014 Emergency response planning guidelines (ERPG) & workplace environmental exposure levels (WEEL) handbook. Fairfax, VA: American Industrial Hygiene Association.

CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

ECETOC [2006]. Synthetic amorphous silica (CAS No. 7631-86-9) – JACC REPORT No. 51. European Centre for Ecotoxicology and Toxicology of Chemicals, Brussels. [http://members.ecetoc.org/Documents/Document/JACC%20051.pdf]. Date accessed: March 2015.

Goossens A, Hulst KV [2011]. Occupational contact dermatitis in the pharmaceutical industry. Clin Dermatol *29*(6):662–668.

Merget R, Bauer T, Kupper HU, Philippou S, Bauer HD, Breitstadt R, Bruening T [2002]. Health hazards due to the inhalation of amorphous silica. Arch Toxicol *75*(11–12):625–634.

Miller K, Chang A [2003]. Acute inhalation injury. Emerg Med Clin North Am *21*(2):533–557.

NIOSH [1978]. Occupational health guideline for amorphous silica. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 81-123. [http://www.cdc.gov/niosh/docs/81-123/pdfs/0552.pdf]. Date accessed: March 2015.

NIOSH [1999]. NIOSH respirator policy statement, January 1998. In: NIOSH policy statements. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

NIOSH [2006]. Respirator selection logic. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-100. [http://www.cdc.gov/niosh/docs/2005-100/]. Date accessed: March 2015.

NIOSH [2010]. NIOSH pocket guide to chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2010-168c. [http://www.cdc.gov/niosh/npg/]. Date accessed: March 2015.

NIOSH [2015]. NIOSH manual of analytical methods (NMAM®). 4th ed. Schlecht PC, O'Connor PF, eds. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 94-113 (August 1994); 1st Supplement Publication 96-135;

2nd Supplement Publication 98-119; 3rd Supplement 2003-154. [http://www.cdc.gov/niosh/docs/2003-154/]. Date accessed: March 2015.

OSHA [1997]. Occupational safety and health standards, subpart Z, toxic and hazardous substances, 1910.1000 table Z-3, mineral dusts. [https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9994]. Date accessed: March 2015.

OSHA [2011]. OSHA respiratory protection program. Office of Publications, Room N 3101, 200 Constitution Avenue, NW, Washington, DC. U.S. Department of Labor, Occupational Safety and Health Administration. [https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=12716]. Date accessed: March 2015.

Keywords: North American Industry Classification System 611513 (Apprenticeship Training), Illinois, apprentice training, aerogel, union training facility, insulation, dry skin, upper respiratory tract irritation

The Health Hazard Evaluation Program investigates possible health hazards in the workplace under the authority of the Occupational Safety and Health Act of 1970 (29 U.S.C. § 669(a)(6)). The Health Hazard Evaluation Program also provides, upon request, technical assistance to federal, state, and local agencies to investigate occupational health hazards and to prevent occupational disease or injury. Regulations guiding the Program can be found in Title 42, Code of Federal Regulations, Part 85; Requests for Health Hazard Evaluations (42 CFR Part 85).

Disclaimer

The recommendations in this report are made on the basis of the findings at the workplace evaluated and may not be applicable to other workplaces.

Mention of any company or product in this report does not constitute endorsement by NIOSH.

Citations to Web sites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. NIOSH is not responsible for the content of these Web sites. All Web addresses referenced in this document were accessible as of the publication date.

Acknowledgments

Analytical Support: Chuck Neumeister, Rosa Key-Schwartz, Joe Fernback, Bureau Veritas North America
Desktop Publisher: Shawna Watts
Editor: Ellen Galloway
Industrial Hygiene Field Assistance: Kendra Broadwater
Logistics: Donnie Booher, Kevin Moore

Availability of Report

Copies of this report have been sent to the employer and employees at the facility. The state and local health department and the Occupational Safety and Health Administration Regional Office have also received a copy. This report is not copyrighted and may be freely reproduced.

This report is available at http://www.cdc.gov/niosh/hhe/reports/pdfs/2014-0026-3230.pdf.

Recommended citation for this report:
NIOSH [2015]. Health hazard evaluation report: evaluation of aerogel insulation particulate at a union training facility. By Feldmann K, Musolin K, Methner M. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HHE Report No. 2014-0026-3230.

Delivering on the Nation's promise:
Safety and health at work for all people through research and prevention

To receive NIOSH documents or more information about occupational safety and health topics, please contact NIOSH:

Telephone: 1–800–CDC–INFO (1–800–232–4636)

TTY: 1–888–232–6348

CDC INFO: www.cdc.gov/info

or visit the NIOSH Web site at www.cdc.gov/niosh

For a monthly update on news at NIOSH, subscribe to NIOSH eNews by visiting www.cdc.gov/niosh/eNews.

SAFER • HEALTHIER • PEOPLE™