

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CALCIUM SILICATE

INTRODUCTION

This guideline summarizes pertinent information about calcium silicate for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

• Formula



• Synonyms

Calcium metasilicate, wollastonite, calcium hydrosilicate, calcium monosilicate, calcium salt of silicic acid, Calflo E, Calsil, CS Lafarge, Micro-Cel, Silene EF

• Identifiers

1. CAS No.: 1344-95-2
2. RTECS No.: VV9150000
3. DOT UN: None
4. DOT label: None

• Appearance and odor

Calcium silicate is a noncombustible, white or cream-colored, free-flowing powder that is prepared commercially from lime and diatomaceous earth; many different calcium silicates occur in nature in mineral form (e.g., wollastonite, afwillite, grammitite).

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 116.16
2. Boiling point (760 mm Hg): Data not available
3. Specific gravity (water = 1): 2.9 at 20°C (68°F)
4. Vapor density: Data not available
5. Melting point: 1,540°C (2,804°F)
6. Vapor pressure at 20°C (68°F): Data not available
7. Solubility: Insoluble in water; forms a siliceous gel with mineral acids
8. Evaporation rate: Not applicable

• Reactivity

1. Conditions contributing to instability: None reported
2. Incompatibilities: None reported

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

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

3. Hazardous decomposition products: None reported

4. Special precautions: None reported

Flammability

The National Fire Protection Association has not assigned a flammability rating to calcium silicate; this substance is not combustible.

1. Flash point: Not applicable

2. Autoignition temperature: Not applicable

3. Flammable limits in air: Not applicable

4. Extinguishant: Use an extinguishant that is suitable for the materials involved in the surrounding fire.

Fires involving calcium silicate should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving calcium silicate.

EXPOSURE LIMITS

• OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for calcium silicate is 15 mg/m³ of air (total dust) and 5 mg/m³ (respirable fraction) as 8-hr time-weighted average (TWA) concentrations [29 CFR 1910.1000, Table Z-1].

• NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 15 mg/m³ (total dust) and 5 mg/m³ (respirable dust) for up to a 10-hr workday and a 40-hr workweek [NIOSH 1992].

• ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned calcium silicate a threshold limit value (TLV) of 10 mg/m³ (total dust) as a TWA for a normal 8-hr workday and a 40-hr workweek [ACGIH 1993].

• Rationale for limits

The OSHA and ACGIH limits are based on calcium silicate's local irritant properties.

HEALTH HAZARD INFORMATION

• Routes of exposure

Exposure to calcium silicate can occur through inhalation, eye or skin contact, and ingestion.

• Summary of toxicology

1. *Effects on Animals:* The toxicity of calcium silicate depends on the silica content and amount of respirable fiber in the particular calcium silicate preparation; studies in animals should be interpreted with this information in mind. Rats exposed to 10 mg/m³ concentrations of various calcium silicate preparations, measured as respirable dust (approximately 19 to 25 mg/m³ total dust), for 7 hr/day, 5 days/week for 224 days in a 12-month period showed no pulmonary lesions except for a few nodules in the animals exposed to the calcium silicate preparation that contained about 1% crystalline silica [ACGIH 1991]. No mesotheliomas were seen in groups of rats injected intraperitoneally with three different calcium silicate preparations [ACGIH 1991]. One experiment in rats showed a significant increase in the incidence of pleural sarcomas after wollastonite (naturally occurring calcium silicate) fibers were implanted intrapleurally [IARC 1987]. Rats, guinea pigs, and hamsters exposed for as long as 36 months to synthetic calcium silicate containing 15% asbestos at concentrations ranging from 100 to 125 million particles per cubic foot (mppcf) developed fibrosis; the authors of this study attributed the fibrosis to the asbestos in the product [ACGIH 1991].

2. *Effects on Humans:* The toxicity of calcium silicate depends on the particle size, amount of silica, the aspect ratio, and the amount of respirable fiber in the particular calcium silicate product being used; studies in humans should be interpreted with this in mind. Calcium silicate causes physical irritation when in contact with the eyes, skin, or upper respiratory tract of exposed workers. In vitro toxicity studies of calcium silicate insulation materials demonstrated equivocal hemolysis potential (one greater versus one less)

but less cytotoxicity than asbestos [ACGIH 1991]. A 23-year-old warehouse worker developed a skin reaction to calcium silicate after 3 days of exposure to an atmosphere described only as permeated with the silicate. The skin condition was characterized by patches of itchy, erythematous papular eruptions that cleared after work [Lachapelle 1984]. A study of 104 U.S. wollastonite workers with more than 1 year of exposure (mean duration of exposure approximately 9.2 years) showed no relationship between the prevalence of chronic bronchitis, airflow obstruction, or abnormal diffusing capacity in workers with increasing exposure to wollastonite [Rom 1983].

• Signs and symptoms of exposure

1. *Acute exposure:* The signs and symptoms of acute overexposure to calcium silicate include pain and redness of the eyes; itching, redness, and eruptions of the skin; and scratchiness of the throat.
2. *Chronic exposure:* Synthetic or natural materials that have calcium silicate as a base may cause dermal irritation after prolonged contact and possible induction of altered pulmonary function and lesions when silica or asbestos are also present.

• Emergency procedures

WARNING!

Seek immediate medical attention for severely affected victims or for victims with signs and symptoms of toxicity or irritation!

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* Irritation may result. **Immediately and thoroughly** flush the eyes with large amounts of water, occasionally lifting the upper and lower eyelids.
2. *Skin exposure:* Irritation may result. **Immediately and thoroughly** wash contaminated skin with soap and water.
3. *Inhalation exposure:* Move the victim to fresh air **immediately**. Have victim blow his or her nose, or use a soft tissue to remove particulates or residues from the nostrils.

If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Take the following steps if calcium silicate or any material containing it is ingested:

—Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.

—Have the victim drink a glass (8 oz) of fluid such as water.

—Induce vomiting by giving syrup of ipecac as directed on the package. If ipecac is unavailable, have the victim touch the back of the throat with a finger until productive vomiting ceases.

—Do *not* force an unconscious or convulsing person to drink fluid or to vomit.

5. *Rescue:* Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

EXPOSURE SOURCES AND CONTROL METHODS

The following uses may involve calcium silicate and may result in worker exposures to this substance:

—Use as a substitute for materials containing silica in ceramics and as a substitute for asbestos in wallboard, insulation, and brake linings

—Use as a constituent of lime glass and Portland cement

—Use as a reinforcing filler in elastomers and plastics, paints, ceramics, paper, and wallboard

—Use as an anticaking ingredient in table salt, baking powder, foods, powdered pharmaceuticals, and cosmetics

—Use as an aggregate in road construction

—Use as a binder in refractory material, as a thermal insulator, and as a paper coating in chromatography

- Use as a veterinary antacid and absorbent
- Use as a carrier in the formulation of triazine herbicides and to provide free-flowing dust for toxic powders such as ground sulfur

The following methods are effective in controlling worker exposures to calcium silicate, depending on the feasibility of implementation:

- Process enclosure
- Local exhaust ventilation
- General dilution ventilation
- Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. *Industrial ventilation—a manual of recommended practice*. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
2. Burton DJ [1986]. *Industrial ventilation—a self study companion*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
3. Alden JL, Kane JM [1982]. *Design of industrial ventilation systems*. New York, NY: Industrial Press, Inc.
4. Wadden RA, Scheff PA [1987]. *Engineering design for control of workplace hazards*. New York, NY: McGraw-Hill.
5. Plog BA [1988]. *Fundamentals of industrial hygiene*. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring

program is intended to supplement, not replace, such measures. To detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

• Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to calcium silicate, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, and respiratory system. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society [ATS 1987].

A preplacement medical evaluation is recommended to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to calcium silicate at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with diseases of the eyes, skin, or respiratory system.

• Periodic medical examinations and biological monitoring

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to calcium silicate exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of calcium silicate on the eyes, skin, and respiratory tract. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for calcium silicate.

- **Medical examinations recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of job placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT

A worker's exposure to airborne concentrations of calcium silicate (total dust) is determined by using a tared, low-ash polyvinyl chloride filter with a 5-micron pore size; the filter is contained in a 37-mm cassette. Samples are collected at a maximum flow rate of 2.0 liters/min until a maximum air volume of 960 liters is collected. Analysis is conducted by gravimetric measurement (weighing) of the filters. This method has a sampling and analytical error of 0.10 and is included in the OSHA Computerized Information System under Dust (total) [OSHA 1989]. NIOSH has a similar method (Method 0500) that also involves gravimetric analysis [NIOSH 1984a]. The sample flow rate in the NIOSH method is between 1.5 and 2.0 liters/min. The minimum volume for an airborne concentration of 15 mg/m³ is 15 liters, and the maximum sample volume at 15 mg/m³ is 133 liters. The overall precision of the NIOSH method is 0.056.

A worker's exposure to airborne concentrations of calcium silicate (respirable fraction) is determined by using a tared, low-ash polyvinyl chloride filter with a 5-micron pore size; the filter is contained in a 37-mm cassette. Air is drawn through the filter cassette, which is held in a 10-mm nylon cyclone, at a flow rate of 1.7 liter per minute until a maximum air volume of 800 liters is collected. Analysis is conducted by gravimetric measurement (weighing) of the filters. This method has a sampling and analytical error of 0.10 and is included in the OSHA Computerized Information System under Dust (Respirable Nuisance) [OSHA 1989]. NIOSH has a similar method (Method 0600) that also involves gravimetric analysis [NIOSH 1984b]. The sample flow rate in the NIOSH method is 1.7 liter/min. The minimum volume for an airborne concen-

tration of 5 mg/m³ is 75 liters and the maximum sample volume at 5 mg/m³ is 1,000 liters. The overall precision of the NIOSH method ranges from 0.043 on laboratory tests and from 0.144 to 0.227 in field tests.

PERSONAL HYGIENE

If calcium silicate contacts the skin, workers should immediately wash the affected areas with soap and water.

Clothing contaminated with calcium silicate should be removed, and provisions should be made for safely removing this chemical from these articles.

A worker who handles calcium silicate should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, or applying cosmetics.

Workers should not eat, drink, use tobacco products, or apply cosmetics in areas where calcium silicate is handled, processed, or stored.

STORAGE

Calcium silicate should be stored in a cool, dry, well-ventilated area in tightly sealed containers. Containers of calcium silicate should be protected from physical damage. Because containers that formerly contained calcium silicate may still hold product residues, they should be handled appropriately.

SPILLS

In the event of a spill involving calcium silicate, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a spill:

1. Use a wet method, a scoop, or a vacuum to clean up this material.
2. Place the material into a clean, dry container.
3. Cover and remove the container from the spill area.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and haz-

ardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

- **Emergency planning requirements**

Calcium silicate is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

- **Reportable quantity requirements for hazardous releases**

Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the National Response Center of an accidental release of calcium silicate; there is no reportable quantity for this substance.

- **Community right-to-know requirements**

Employers are not required by Section 313 of SARA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of calcium silicate emitted or released from their facility annually.

- **Hazardous waste management requirements**

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although calcium silicate is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 CFR 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

- **Conditions for respirator use**

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of calcium silicate exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

- **Respiratory protection program**

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, respirator fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information about the selection and use of respirators and about the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective clothing should be worn to prevent prolonged or repeated skin contact with calcium silicate. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions for use. No reports have been published on the resistance of various protective clothing materials to calcium

silicate permeation. If permeability data are not available, protective clothing manufacturers should be requested to provide information on the best chemical protective clothing for workers to wear when they are exposed to calcium silicate.

If calcium silicate is dissolved in an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which calcium silicate might contact the eyes (e.g., through dust particles). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with calcium silicate. Contact lenses should not be worn if the potential exists for calcium silicate exposure.

REFERENCES CITED

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