OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CALCIUM OXIDE

INTRODUCTION

This guideline summarizes pertinent information about calcium oxide 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 Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether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**

  CaO

- **Synonyms**

  Lime, burnt lime, calcia, calx, quicklime, pebble lime, unslaked lime

- **Identifiers**

  1. CAS No.: 1305-78-8
  2. RTECS No.: EW3100000
  3. DOT UN: 1910 60
  4. DOT label: None

- **Appearance and odor**

  Calcium oxide may take the form of odorless crystals, white or grayish-white lumps, or granular powder. The commercial material may have a yellowish or brownish tint because of its iron content.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

  1. Molecular weight: 56.08
  2. Boiling point (760 mm Hg): 2,850°C (5,162°F)
  3. Specific gravity (water = 1): 3.32 to 3.35 at 20°C (68°F)
  4. Vapor density: Not applicable
  5. Melting point: 2,572°C (4,662°F)
  6. Vapor pressure at 20°C (68°F): 0 mm Hg
  7. Solubility: Soluble in water (forms slaked lime and generates a large quantity of heat); soluble in acids, glycerol, and sugar solution; practically insoluble in alcohol.
  8. Evaporation rate: Not applicable

- **Reactivity**

  1. Conditions contributing to instability: Moisture

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

2. Incompatibilities: Contact of calcium oxide with water causes a violent reaction, and the heat liberated during this reaction may cause the ignition of combustible substances. Calcium oxide reacts violently with ethanol, liquid hydrogen fluoride, some acids, some halogens, some metal halides, some metals, and some oxides, boron trifluoride, liquid hydrofluoric acid, phosphorus pentoxide, boric oxide and calcium chloride mixtures, fluorine, chlorine trifluoride, and carbon dioxide.

3. Hazardous decomposition products: Toxic particulates (such as particles of calcium hydroxide) may be released in a fire involving calcium oxide.

4. Special precautions: When exposed to air, this substance will react with the moisture and the carbon dioxide in the air. Calcium oxide swells when moist and may burst its containers.

Flammability

The National Fire Protection Association has assigned a flammability rating of 0 (no fire hazard) for calcium oxide; this substance is not combustible.

1. Flash point: Not applicable

2. Autoignition temperature: Not applicable

3. Flammable limits in air: Not applicable

4. Extinguishant: Calcium oxide will not burn. Because water reacts violently with calcium oxide, it should NOT be used as an extinguishant. Use an extinguishant that is suitable for the materials involved in the surrounding fire.

Fires involving calcium oxide should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Containers of calcium oxide may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Do NOT allow water to come into contact with the contents of containers. Stay away from the ends of containers. Dikes should be used to contain fire-control water for later disposal. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving calcium oxide. Structural firefighters' protective clothing may provide limited protection against fires involving calcium oxide.

EXPOSURE LIMITS

- **OSHA PEL**

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for calcium oxide is 5 mg/m^3 as an 8-hr time-weighted average (TWA) concentration [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 2 mg/m^3 as a TWA 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 oxide a threshold limit value (TLV) of 2 mg/m^3 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 the risk of eye, skin, and respiratory tract irritation associated with exposure to calcium oxide.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

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

- **Summary of toxicology**

1. *Effects on Animals:* No published data on the effects of calcium oxide exposure in animals were available for review.

2. *Effects on Humans:* Calcium oxide causes marked irritation and corrosion of contacted tissues. The irritant and corrosive effects of exposure to calcium oxide dust are primarily a result of its alkalinity and

its heat-generating reaction when in contact with moisture [Clayton and Clayton 1981]. Addition of water to calcium oxide has generated temperatures as high as 800°C (1,472°F) [NLM 1991]. In contact with the eyes, calcium oxide causes severe burns and may cause corneal ulceration [Grant 1986; Sittig 1985]. In contact with the skin, calcium oxide causes dermatitis or corrosive burns, with desquamation and a vesicular rash [Sittig 1985]. Inhalation of the dust at a concentration of 25 mg/m^3 caused marked nasal irritation in exposed workers; however, at a concentration of 9 or 10 mg/m^3, this effect disappeared [Clayton and Clayton 1981]. Exposure to calcium oxide at unspecified concentrations causes inflammation of the respiratory passages and ulceration and perforation of the nasal septum [ACGIH 1991].

- **Signs and symptoms of exposure**

1. *Acute exposure:* Calcium oxide can produce spasmodic blinking, tears, and adhesion of calcium oxide particles to the eyeball and the conjunctival sac; dermatitis with desquamation and a vesicular rash, ulceration, and corrosive burns; and coughing, sneezing, and inflammation of the nose and throat, bronchitis, and pneumonia.

2. *Chronic exposure:* Calcium oxide has caused ulceration and perforation of the nasal septum and severe recurrent dermatitis.

- **Emergency procedures**

> **WARNING!**
>
> **Transport victims immediately to emergency medical facility!**

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. ***Immediately*** initiate the following emergency procedures, continuing them as appropriate en route to the emergency medical facility:

1. *Eye exposure:* Tissue destruction and blindness may result! ***Immediately but gently*** flush the eyes with large amounts of water for at least 15 min, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Severe burns and skin corrosion may result! ***Immediately*** remove all contaminated clothing! ***Immediately, continuously, and gently*** wash skin for at least 15 min. Use soap and water if skin is intact; use only water if skin is not intact.

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 oxide or any material containing it is ingested:

   —Do ***not*** induce vomiting.

   —Have the victim rinse the contaminated mouth cavity several times with a fluid such as water. Immediately after rinsing, have the victim drink one cup (8 oz) of fluid and ***no more***.

   —Do ***not*** permit the victim to drink milk or carbonated beverages!

   —Do ***not*** permit the victim to drink any fluid if more than 60 min have passed since initial ingestion.

NOTE: These instructions must be followed exactly. Drinking a carbonated beverage or more than one cup of fluid could create enough pressure to perforate already damaged stomach tissue. The tissue-coating action of milk can sometimes impede medical assessment of tissue damage. Ingestion of any fluid more than 60 min after initial exposure could further weaken damaged tissue and result in perforation.

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 operations may involve calcium oxide and may result in worker exposures to this substance:

—Use as raw material in the preparation of chlorinated lime, bleaching powder, and calcium salts and as a binding agent in the manufacture of Portland cement, mortar, stucco, plaster, bricks, refractory material, and glass

—Use as a softening, purifying, coagulating, and suspending compound in water treatment and purification; as a neutralizer of acid waste effluents; to remove sulfur dioxide from stack gases; to treat sewage and waste from steel fabrication and chemical, pharmaceutical, and explosives manufacturing facilities; and to remove sulfur from process streams in petroleum refining

—Use in wire-drawing operation in the manufacture of iron and steel; as a promoter of iron catalysts in ammonia synthesis; in flotation of nonferrous ores and in the refining of ores to remove silica; and as a flux during metal refining and smelting

—Manufacture of aluminum, magnesium, calcium carbide, and sodium carbonate and in the synthesis of chemical and dye intermediates, paint pigments, pharmaceuticals, drilling fluids, and lubricants

—Use in Kraft pulp processing of paper, to clarify cane and beet sugar juices, and as a nutrient and/or dietary supplement and food additive

—Use in dehairing of hides in leather manufacture; in manufacture of pesticides, insecticides, and fungicides; and in cleaning operations as bleach, disinfectant, and deodorizer

The following methods are effective in controlling worker exposures to calcium oxide, 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 place workers effectively and 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 oxide, the 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 aggra-

vated or may result in increased risk when a worker is exposed to calcium oxide 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 eye, skin, or respiratory system diseases.

- **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 oxide exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of calcium oxide on the eyes (especially the cornea and conjunctiva), skin, and respiratory tract. The mucosa of the nose and mouth and the nasal septum should be examined for evidence of ulceration or perforation. 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 oxide.

- **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 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 calcium oxide is determined by using a 0.8-micron mixed cellulose ester filter (MCEF). Samples are collected at a maximum flow rate of 2 liters/min until a maximum air volume of 400 liters is collected. The samples are ashed with nitric and hydrochloric acids. Ionization interferences are controlled with 1,000 µg/ml potassium. Analysis is conducted by atomic absorption spectroscopy with a nitrous oxide/acetylene flame. The limit of detection for this procedure is 0.03 µg/ml. This method is described in OSHA Method No. ID-121 in the *OSHA Analytical Methods Manual* [OSHA 1985]. A similar method is described in NIOSH Method 7020 of the *NIOSH Manual of Analytical Methods* [NIOSH 1984].

PERSONAL HYGIENE

If calcium oxide contacts the skin, particles should be removed with oil or grease before they are flushed with flooding amounts of water.

Clothing contaminated with calcium oxide should be removed immediately, and provisions should be made for safely removing this chemical from these articles. Persons laundering contaminated clothing should be informed of the hazardous properties of calcium oxide, particularly its potential to cause eye, skin, and upper respiratory tract irritation and burns.

A worker who handles calcium oxide 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 oxide or a solution containing calcium oxide is handled, processed, or stored.

STORAGE

Calcium oxide should be stored in a cool, dry, well-ventilated area in tightly sealed, airtight containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of calcium

oxide should be protected from physical damage and should be stored separately from water and other sources of moisture, acids, oxidizers, organic materials, other combustibles, heat, and open flame. Because containers that formerly contained calcium oxide may still hold product residues, they should be handled appropriately.

SPILLS

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

1. Do not touch the spilled material.
2. Notify safety personnel.
3. Remove all sources of moisture.
4. Ventilate the area of the spill.
5. Do NOT use water on the spilled material; collect the spilled material and gently place it in a clean, dry container creating as little dust as possible. 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 hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

- **Emergency planning requirements**

  Calcium oxide 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 oxide; 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 oxide 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 oxide 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 oxide 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 (gloves, boots, aprons, gauntlets, and coveralls) should be worn to prevent any skin contact with calcium oxide. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. No reports have been published on the resistance of various protective clothing materials to calcium oxide permeation; however, natural rubber, neoprene, and nitrile rubber have been tested against chemically similar materials (calcium hydroxide) and may provide protection for more than 8 hr. Since specific data are not available for calcium oxide, the information provided here should be considered as a guideline only. If permeability data are not readily 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 oxide.

Goggles or face shields should be worn during operations in which calcium oxide 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 oxide. Contact lenses should not be worn if the potential exists for calcium oxide exposure.

REFERENCES CITED

ACGIH [1991]. Documentation of the threshold limit values and biological exposure indices. 6th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

ACGIH [1993]. 1993-1994 Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

ATS [1987]. Standardization of spirometry—1987 update. American Thoracic Society. Am Rev Respir Dis 136:1285-1296.

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

Clayton G, Clayton F [1981]. Patty's industrial hygiene and toxicology. 3rd rev. ed. New York, NY: John Wiley & Sons.

Grant WM [1986]. Toxicology of the eye. 3rd ed. Springfield, IL: Charles C. Thomas.

NIOSH [1984]. Calcium oxide: Method 7020. In: Eller PM, ed. NIOSH manual of analytical methods. 3rd rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-100.

NIOSH [1987a]. NIOSH guide to industrial respiratory protection. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-116.

NIOSH [1987b]. NIOSH respirator decision logic. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-108.

NIOSH [1992]. NIOSH recommendations for occupational safety and health: compendium of policy documents and statements. Cincinnati, OH: U.S. Department of

Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.

NLM [1991]. The hazardous substances data bank: calcium oxide. Bethesda, MD: National Library of Medicine.

OSHA [1985]. Calcium oxide: Method ID 121. OSHA analytical methods manual. U.S. Department of Labor, Occupational Safety and Health Administration, OSHA Analytical Laboratory.

Sittig M [1985]. Handbook of toxic and hazardous chemicals. 2nd ed. Park Ridge, NJ: Noyes Publications.