

Occupational Health Guideline for Iodine

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: I_2
- Synonyms: None
- Appearance and odor: Violet solid with a sharp, characteristic odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for iodine is a ceiling level of 0.1 part of iodine per million parts of air (ppm). This may also be expressed as 1 milligram of iodine per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

• Routes of exposure

Iodine can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

• Effects of overexposure

1. Short-term Exposure: Iodine vapor is a severe irritant of the eyes, respiratory tract, and to a lesser extent, the skin. It may cause severe breathing difficulties which may be delayed in onset. Swallowing iodine may cause burning in the mouth, vomiting, abdominal pain, and diarrhea. Death may result. Crystalline iodine or strong solutions of iodine may cause severe irritation of the skin. It is not easily removed from the skin and may cause burns. An allergic skin rash may occur. It may cause irritation, brown staining, and burning of the eyes.

2. Long-term Exposure: Chronic absorption of iodine may cause insomnia, inflammation of the eyes and nose,

bronchitis, tremor, rapid heart beat, diarrhea, and weight loss.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to iodine.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to iodine at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of thyroid disorders, asthma, allergies, or known sensitization to iodine would be expected to be at increased risk from exposure. Examination of the respiratory tract, eyes, nervous system, and cardiovascular system should be stressed. The skin should be examined for evidence of chronic disorders.

—14" x 17" chest roentgenogram: Iodine causes human lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Iodine is a respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveillance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is necessary only when indicated by the results of pulmonary function testing, or when signs and symptoms of respiratory disease occur.

• Summary of toxicology

Iodine vapor is a severe irritant of the eyes, respiratory tract, and, to a lesser extent, the skin. Intratracheal administration to dogs of the vapor from 36 mg iodine/kg body weight was fatal after about 3 hours; the animals developed cough, dyspnea, and rales; autopsy findings were pulmonary edema, subpleural hemorrhage, and an increased iodine content of the thyroid

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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and urine. Workers exposed to an unspecified concentration experienced a burning sensation in the eyes, lacrimation, blepharitis, rhinitis, stomatitis, and chronic pharyngitis; after accidental exposure in a laboratory, technicians reported headache and a feeling of tightness in the chest. Iodine absorbed by the lungs is changed to iodide and eliminated mainly in the urine; iodine is an essential element in nutrition and is required by the thyroid. Accidental ingestion of 2 to 3 g may be fatal; chronic absorption of iodine causes "iodism," a disease characterized by insomnia, conjunctivitis, rhinitis, bronchitis, tremor, tachycardia, parotitis, diarrhea, and weight loss. In an experimental investigation, four human subjects tolerated 0.57 ppm iodine vapor for 5 minutes without eye irritation, but all experienced eye irritation in 2 minutes at 1.63 ppm. In patients exposed to air saturated with iodine vapor for 3 to 4 minutes for therapeutic purposes, there was brown staining of the corneal epithelium and subsequent spontaneous loss of the layer of tissue; recovery occurred within 2 to 3 days. Iodine in crystalline form or in strong solutions is a severe skin irritant; it is not easily removed from the skin, and the lesions resemble thermal burns. Hypersensitivity to iodine characterized by a skin rash has been reported. Iodine is absorbed through the skin in small amounts from a tincture or from vapor applied to the skin.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 253.8
2. Boiling point (760 mm Hg): 184 C (363 F)
3. Specific gravity (water = 1): 4.9
4. Vapor density (air = 1 at boiling point of iodine): 9
5. Melting point: 113.6 C (237 F)
6. Vapor pressure at 20 C (68 F): 0.3 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.03
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: None hazardous
2. Incompatibilities: Contact of iodine with gaseous or aqueous ammonia forms a water-insoluble solid that is very sensitive to shock when dry and which will explode, causing fires. Contact with acetylene, acetaldehyde, powdered aluminum, or other active metals may cause fires and explosions.

3. Hazardous decomposition products: None

4. Special precautions: None

• Flammability

1. Not combustible by itself, but can react vigorously with reducing materials

• Warning properties

1. Odor Threshold: No quantitative information is available concerning the odor threshold of iodine.

2. Eye Irritation Level: The AIHA *Hygienic Guide* states that "irritation rather than systemic action limits the concentrations of iodine vapor which can be tolerated. An earlier report states that 0.1 ppm is tolerable, whereas 0.3 ppm is not, but no time limits were furnished in the citation. In a recent investigation, four human subjects tolerated 0.57 ppm iodine vapor for 5 minutes without eye irritation, but all experienced eye irritation in 2 minutes at 1.63 ppm." The eye irritation threshold data reported are not consistent.

3. Evaluation of Warning Properties: Since the *Hygienic Guide* states that "the warning properties of iodine vapor are not adequate to prevent excessive inhalation exposure," iodine has been treated as a material with poor warning properties. The ILO also notes that the warning properties of iodine vapor cannot be depended upon to prevent excessive exposure. In addition, a recent investigation has shown that a 5-minute exposure to 0.57 ppm iodine vapor did not produce eye irritation in human subjects.

MONITORING AND MEASUREMENT PROCEDURES

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of iodine. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method

At the time of publication of this guideline, no measurement method for iodine had been published by NIOSH.

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which

includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with solid iodine or liquids containing more than 7% iodine by weight.

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquids containing 7% or less of iodine by weight.

- If employees' clothing has had any possibility of being contaminated with solid iodine, employees should change into uncontaminated clothing before leaving the work premises.

- Clothing contaminated with iodine should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of iodine from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the iodine, the person performing the operation should be informed of iodine's hazardous properties.

- Where there is any possibility of exposure of an employee's body to solid iodine or liquids containing more than 7% iodine by weight, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

- Non-impervious clothing which becomes contaminated with iodine should be removed immediately and not reworn until the iodine is removed from the clothing.

- Non-impervious clothing which becomes wet with liquids containing 7% or less of iodine by weight should be removed promptly and not reworn until the iodine is removed from the clothing.

- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of solid iodine or liquids containing more than 7% iodine by weight contacting the eyes.

- Employees should be provided with and required to use splash-proof safety goggles where liquids containing 7% or less of iodine by weight may contact the eyes.

- Where there is any possibility that employees' eyes may be exposed to solid iodine or liquids containing more than 7% iodine by weight, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with solid iodine or liquids containing more than 7% iodine by weight should be immediately washed or showered with soap or mild detergent and water to remove any iodine.

- Skin that becomes wet with solutions containing 7% or less of iodine by weight should be promptly washed or showered with soap or mild detergent and water to remove any iodine.

- Eating and smoking should not be permitted in areas where solid iodine is handled, processed, or stored.

- Employees who handle solid iodine or liquids containing iodine should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to iodine may occur and control methods which may be effective in each case:

Operation	Controls
Use in synthesis of chemical intermediates, pharmaceuticals, photographic chemicals, antiseptics, disinfectants, detergent sanitizers, and organic and inorganic compounds	Process enclosure; local exhaust ventilation; personal protective equipment
Use as a reagent in analytical chemistry; as catalyst in organic synthesis; synthesis of dyes, food additives, and coloring agents	Process enclosure; local exhaust ventilation; personal protective equipment
Use in production of intermediates in purification of metals; use as a catalyst in the modification of selenium during manufacture of photoelectric cells and rectifiers	Process enclosure; local exhaust ventilation; personal protective equipment
Use during manufacture of specialty lubricants and in production of stereospecific polymers	Process enclosure; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If iodine, liquids containing iodine, or strong concentrations of iodine vapor get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If iodine or liquids containing iodine get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If iodine or liquids containing iodine penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation or burns are present after washing, get medical attention.

• Breathing

If a person breathes in large amounts of iodine, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

When iodine or liquids containing iodine have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately. (If milk is immediately available, give the person milk instead of water).

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If iodine is spilled, the following steps should be taken:

1. Ventilate area of spill.

2. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing iodine should be absorbed in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Iodine may be disposed of in sealed containers in a secured sanitary landfill.

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RESPIRATORY PROTECTION FOR IODINE

Condition	Minimum Respiratory Protection* Required Above 0.1 ppm
Vapor or Particulate Concentration	
1 ppm or 10 mg/m ³ or less	Any supplied-air respirator. Any self-contained breathing apparatus.
5 ppm or 50 mg/m ³ or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
10 ppm or 100 mg/m ³ or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 10 ppm or 100 mg/m ³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors, acid gases, and particulates. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

