

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND  
SUPPORTING DOCUMENTATION FOR

\*\*\* ISOPHORONE \*\*\*

NIOSH/OSHA Draft Technical Standard  
and Supporting Documentation for ISOPHORONE

The basic text of this document contains the draft technical standard approved by the Joint Review Committee of the NIOSH/OSHA Standards Completion Program and the supporting documentation for the substance ISOPHORONE.

The SCP draft technical standards are recommendations to the Department of Labor for its consideration in rulemaking and have no legal status until final rules have been promulgated by that agency. This draft standard is provided for your information only.

The References and Sources, Respirator Table Documentation and Use/Exposure and Control Documentation are the working documents used by the various SCP working groups during the development of the draft technical standard and serve as the technical foundation for the standard. The classification for each substance and the regulatory statements were derived following a decision logic established for the various sections of the standard.

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(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of isophorone not in excess of 25 parts per million (ppm) (140 milligrams per cubic meter (mg/M3)) averaged over an eight-hour work shift (time weighted average), as stated in § 1910.1000, Table Z-1.

(2) "Action level" means one-half of the permissible exposure for isophorone averaged over an eight-hour work shift.

(b) Initial determination and exposure measurement. (1) Each employer who has a place of employment in which isophorone is released into the workplace air shall determine if there is any possibility that any employee may be exposed to airborne concentrations of isophorone above the permissible level. The initial determination shall be made each time there is a change in production, process, or control measures which may result in an increase in airborne concentrations of isophorone.

(2) A written record of the initial determination shall be made and shall contain at least the following information:

(i) Any information, observations, or calculations which may indicate employee exposure to isophorone; dehyde; dehyde; isophorone; dehyde; dehyde;

(ii) Any measurements of isophorone taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to isophorone; and

(iv) Date of initial determination, work being performed at the time, location within work site, and employees considered.

(3) If the employer determines that any employee may be exposed to isophorone above the permissible exposure, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum eight-hour time weighted average exposure of the employee.

(4) If the exposure measurement taken pursuant to paragraph (b) (3) of this section reveals employee exposure to isophorone above the action level, the employer shall:

(i) Identify all employees who may be exposed above the permissible level; and

(ii) Measure the exposure of the employees so identified.

(5) If an employee exposure measurement reveals that an employee is exposed to isophorone above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every three months.

(6) If an employee exposure measurement reveals that an employee is exposed to isophorone above the permissible exposure, the employee shall:

(i) Measure the exposure monthly of the employee so exposed; and

(ii) Institute control measures as required by paragraph (d) of this section; and

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to isophorone above the permissible exposure. The employee shall also be notified of the results of the exposure measurements and of the corrective action being taken to reduce the exposure to below the permissible exposure.

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to isophorone below the action level, the employer may terminate measurement for the employee.

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(8) For purposes of this paragraph, employee exposure is that which would occur if the employee were not using a respirator.

(c) Methods of measurement. (1) An employee's exposure shall be obtained by any combination of long term or short term samples which represents the employee's actual exposure averaged over an eight-hour work shift (See Appendix B (IV) of this section).

(2) The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than that given in Table 1.

Table 1

| Concentration                                                  | Required Accuracy<br>(Percent of True Value) |
|----------------------------------------------------------------|----------------------------------------------|
| Above permissible exposure                                     | $\pm 25$                                     |
| At or below permissible exposure<br>and above the action level | $\pm 35$                                     |
| At or below the action level                                   | $\pm 50$                                     |

(d) Compliance. (1) No employee shall be exposed to isophorone above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of isophorone shall be controlled to at or below the permissible exposure by engineering and work practice controls.

(i) Engineering and work practice controls shall be instituted to reduce exposures to at or below the permissible exposure, except to the extent that such controls are not feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and shall be supplemented by respirators in accordance with paragraph (d)(4) of this section.

(3) Engineering controls. (i) When local exhaust is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity or static pressure shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of isophorone.

(ii) In the design of open surface tank ventilation for the purposes of § 1910.94(d), operations involving isophorone shall be classified as B-4 at 21 degrees C (70 degrees F.)

(4) Compliance with the permissible exposure shall not be achieved by the use of respirators except:

(i) During the time period necessary to install or implement engineering or work practice controls; or

(ii) In work situations in which engineering and work practice controls are not feasible; or

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(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of isophorone to at or below the permissible exposure; or

(iv) For operations which require entry into tanks or closed vessels; or

(v) In emergencies.

(5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.

TABLE 2 RESPIRATORY PROTECTION FOR ISOPHORONE

| CONDITION                                                            | PERMISSIBLE RESPIRATORY PROTECTION                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vapor Concentration                                                  |                                                                                                                                                                                                                                                                                                    |
| 200 ppm or less                                                      | Any supplied-air respirator.                                                                                                                                                                                                                                                                       |
|                                                                      | Any self-contained breathing apparatus.                                                                                                                                                                                                                                                            |
| 800 ppm or less                                                      | Any supplied-air respirator with a full facepiece, helmet or hood.                                                                                                                                                                                                                                 |
|                                                                      | Any self-contained breathing apparatus with a full facepiece.                                                                                                                                                                                                                                      |
| Greater than 800 ppm 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.                                                                                                                                                                                                                                          |
|                                                                      | Any escape self-contained breathing apparatus.                                                                                                                                                                                                                                                     |

(6) Respirators shall be approved by the Mining Enforcement and Safety Administration (formerly Bureau of Mines) or by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(7) The employer shall institute a respiratory protection program in accordance with § 1910.134(b), (d), (e), and (f).

(e) Fire and safety. (1) The employer shall familiarize himself with the information contained in the Substance Technical Guidelines (Appendix B of this section) for isophorone.

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(2) For the purpose of compliance with § 1910.309, locations classified as hazardous locations due to the presence of isophorone shall be Class I, Group D.

(3) For the purpose of compliance with § 1910.157, isophorone is classified as a Class B fire hazard.

(4) For the purpose of compliance with § 1910.178, locations classified as hazardous locations due to the presence of isophorone shall be Class I, Group D.

(5) For the purpose of compliance with § 1910.106, liquid isophorone is classified as a Class IIIA combustible liquid.

(6) Spray finishing operations shall be performed in accordance with §§ 1910.107 and 1910.94(c).

(7) Dip tank operations shall be performed in accordance with §§ 1910.108 and 1910.94(d).

(8) Where a fan is located in ductwork and where isophorone is present in the ductwork in concentrations greater than 2000 ppm (approximately 25% of the lower flammable limit), the fan rotating element shall be of nonsparking material or the casing shall consist of, or be lined with, nonsparking material. There shall be sufficient clearance between the fan rotating element and the fan casing so as to prevent contact.

(9) Sources of ignition such as smoking or open flames are prohibited where isophorone presents a fire or explosion hazard.

(10) Isophorone shall be stored so as not to come in contact with strong oxidizers.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use appropriate protective clothing and equipment necessary to prevent repeated or prolonged skin contact with liquid isophorone. Face shields shall comply with § 1910.133(a)(2), (a)(4), (a)(5), and (a)(6).

(2) Employers shall ensure that clothing wet with liquid isophorone is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of isophorone from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the isophorone, the employer shall inform the person performing the operation of the hazardous properties of isophorone.

(3) Employers shall ensure that non-impervious clothing which becomes wet with isophorone be removed promptly and not reworn until the isophorone is removed from the clothing.

(4) Employers shall provide and ensure that employees use splash-proof safety goggles which comply with § 1910.133(a)(2)-(a)(6) where there is any possibility of liquid isophorone contacting the eyes.

(5) Where there is any possibility that an employee's eyes may be exposed to liquid isophorone, employers shall provide an eye-wash fountain within the immediate work area for emergency use.

(g) Spills and disposal. In the event that liquid isophorone is spilled the employer shall immediately provide available ventilation and then clean up the spill.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes wet with isophorone promptly wash or shower with soap or mild detergent and water to remove any isophorone from the skin.

(2) Employers shall ensure that employees who handle isophorone wash their hands thoroughly before eating or smoking.

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(i) Training and information. (1) Each employer who has a workplace in which isophorone is present shall keep a copy of this regulation with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

(2) Each employer who has employees exposed to isophorone above the action level without regard to the use of respirators, or employees who may have repeated or prolonged skin contact, or who may have any possibility of eye contact with liquid isophorone, or employees who work where isophorone presents a fire or explosion hazard shall annually:

(i) Inform affected employees of the information contained in the Substance Safety Data Sheet for isophorone (Appendix A of this section);

(ii) Advise affected employees as to the signs and symptoms of exposure to isophorone.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of overexposure to isophorone which are listed in Appendix A of the section;

(iv) Instruct affected employees to inform the employer if they develop any of the medical conditions listed in paragraph (j)(2) of this section; and

(v) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to isophorone.

(j) Medical surveillance. (1) The employer shall provide medical procedures as required by this paragraph. All medical procedures shall be performed by or under the supervision of a physician at no cost to the employee.

(2) Each employer who has employees exposed to airborne concentrations of isophorone above the action level, without regard to the use of respirators, or employees who may have repeated or prolonged skin contact or who may have any possibility of eye contact with liquid isophorone shall obtain information as to whether such employee has a history of any of the following medical conditions:

(i) Kidney disease;

(ii) Liver disease;

(iii) Chronic lung disease; and

(iv) Skin disease.

(3) The employer shall provide a medical examination for the employee if:

(i) The employee provides a history of any of the medical conditions listed in paragraph (j)(2) of this section; or

(ii) The employee informs the employer of the development of any of the medical conditions listed in paragraph (j)(2) of this section or any of the signs or symptoms of exposure to isophorone which are listed in Appendix A which the employee suspects are caused by exposure to isophorone.

(4) The employer shall provide to the examining physician the following information:

(i) A copy of this regulation with Appendixes A, B and C for isophorone;

(ii) A description of the affected employee's duties as they relate to his exposure to isophorone;

(iii) A description of any personal protective equipment and respirators required to be used;

(iv) The results of any measurements which may indicate the affected employee's exposure;

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(v) The affected employee's anticipated exposure; and

(vi) Upon request of the physician, any available information from previous medical examinations of the affected employee.

(5) Where a medical examination is required by paragraph (j)(3) of this section, following such examination the employer shall obtain a written opinion from the examining physician which conforms with paragraph (j)(6) of this section.

(6)(i) The physician's written opinion by the examining physician shall specifically state: (A) Whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to isophorone;

(B) Any recommended limitations upon the employee's exposure to isophorone including limitations upon the use of personal protective equipment and respirators;

(C) That the employee has been informed by the physician of any detected medical conditions which require further medical examination or treatment.

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to the employee's employment.

(iii) The employer shall provide the employee with a copy of the physician's written opinion.

(7) No employee shall be exposed to isophorone in such a way as would put the employee at increased risk of material impairment of his health from such exposure. The employer shall base this decision on any information available including the physician's written opinion.

(8) The employer shall provide emergency medical treatment for any employee injured through exposure to isophorone.

(9) If an employee refuses any required medical examination, the employer shall inform the employee of the possible health consequences of such refusal and obtain a signed statement from the employee indicating that the employee understands the risk involved by refusal to be examined.

(10) No medical procedure which would be performed pursuant to this section need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(k) Recordkeeping. (1) Exposure determination. (i) The employer shall keep an accurate record of all determinations required to be made pursuant to paragraph (b)(1) of this section.

(ii) This record shall include the written determination required in paragraph (b)(2) of this section.

(iii) This record shall be maintained until replaced by a more recent record.

(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to isophorone.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to isophorone which are being monitored;

(C) Sampling and analytical method used and evidence of their accuracy;

(D) Number, duration, and results of samples taken; and

(E) Name and exposure of the employee monitored.

(iii) This record shall be maintained until replaced by a more recent record but in no event for less than one year.

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(3) Mechanical ventilation. (i) When mechanical ventilation is used as an engineering control, the employer shall maintain an accurate record of the measurements demonstrating the effectiveness of such ventilation required by paragraph (d)(3) of this section.

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

(iii) These records shall be maintained for at least one year.

(4) Employee training and information. (i) The employer shall keep an accurate record of all employee training and information required by paragraph (i) of this section.

(ii) This record shall include:

(A) Date of training;

(B) Name of employee trained;

(C) Content or scope of training provided.

(iii) This record shall be maintained until replaced by a more recent record.

(5) Medical surveillance. (i) The employer shall keep an accurate record of employee medical surveillance required by paragraph (j) of this section.

(ii) This record shall include:

(A) The name of the employee;

(B) Information concerning medical conditions obtained from the employee pursuant to paragraph (j)(2) of this section;

(C) Any employee medical complaints relative to exposure to isophorone;

(D) A copy of information provided to the physician pursuant to paragraph (j)(4)(ii), (iii), (iv), (v), and (vi) of this section.

(E) Physician's written opinion; and

(F) A signed statement of any refusal to be examined.

(iii) This record shall be maintained for the duration of and for one year after termination of the employment of the affected employee.

(6) Access to records. (i) All records required to be maintained by this section shall be made available upon request to authorized representatives of the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health.

(ii) Each employee or former employee shall have access to the exposure determination and exposure measurement records required to be maintained by this section which indicate his own exposure to isophorone.

(iii) Employee medical records required to be maintained by this section shall be made available upon written request to a physician designated by the employee or former employee.

(1) Employee observation of measurement. (1) The employer shall give each employee or his representative an opportunity to observe any measurement of his exposure to isophorone which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to isophorone requires entry into an area where the use of personal protective devices, including respirators, is required, the observer shall be provided with and required to use such equipment and comply with all other applicable safety procedures.

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(3) Without interfering with the measurement, observers shall be entitled to:

- (i) Receive an explanation of the measurement procedure.
- (ii) Visually observe all steps related to the measurement of the airborne concentration of isophorone that are being performed at the place of exposure; and
- (iii) Record the results obtained.

NOTE: The information contained in the following appendix for isophorone is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligations. To the extent that the information supplements this regulation for isophorone, it is advisory in nature.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET  
FOR ISOPHORONE

I. SUBSTANCE IDENTIFICATION

- A. Substance: Isophorone
- B. Permissible Exposure: 25 parts of isophorone per million parts of air (ppm) (140 milligrams of isophorone per cubic meter of air (mg/M3)) averaged over an eight-hour work shift.
- C. Appearance and Odor: Colorless or pale yellow liquid with an odor like camphor

II. HEALTH HAZARD DATA

- A. Ways in which the chemical affects your body: Isophorone can affect your body if you inhale it or if it comes in contact with your eyes or skin. It may also affect your body if you swallow it.
- B. Effects of Overexposure:
  - 1. Short-term Exposure: Isophorone may cause irritation of the eyes, nose and throat. It may also cause headache, dizziness, faintness and drunkenness.
  - 2. Long-term Exposure: Repeated or prolonged exposure to liquid isophorone may cause irritation of the skin.
  - 3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to isophorone.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If liquid isophorone gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation

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persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

- B. Skin Exposure: If liquid isophorone gets on your skin, promptly wash the contaminated skin using soap or mild detergent and water. If liquid isophorone soaks through your clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation is present after washing, get medical attention.
- C. Breathing: If you or any other person breathes in large amounts of isophorone 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.
- D. Swallowing: When isophorone has 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.
- E. Rescue: Move 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 yourself. Understand your emergency rescue procedures and know the locations of the emergency rescue equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators: Respirators are not the best way to control exposure to isophorone. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where there use is required. If you can smell isophorone while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.
- B. Protective Clothing: You must wear appropriate protective clothing and equipment to prevent repeated or prolonged skin contact with liquid isophorone. Replace or repair impervious clothing that has developed leaks.
- C. Eye Protection: You must wear splash-proof safety goggles where there is any possibility of liquid isophorone contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

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- A. Isophorone is a combustible liquid. Its vapors can form explosive mixtures with air at elevated temperatures.
- B. Isophorone must be stored in tightly closed containers in a cool, well ventilated area away from strong oxidizers.
- C. Sources of ignition such as smoking and open flames are prohibited wherever isophorone is handled, used or stored in a manner that could create a potential fire or explosion hazard.
- D. You must promptly remove any non-impervious clothing that becomes wet with isophorone and this clothing must not be re worn until the isophorone is removed from the clothing.
- E. If your skin becomes wet with isophorone, you must promptly wash or shower with soap or mild detergent and water to remove any isophorone from your skin.
- F. Fire extinguishers and eye flushing facilities, where provided, must be readily available and you should know where they are and how to operate them.
- G. Ask your supervisor where isophorone is used in your work area and for any additional safety and health rules.

VI. ACCESS TO INFORMATION

- A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for isophorone. In addition, your employer must instruct you in the safe use of isophorone, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to isophorone. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure data for at least one year and to keep medical data during your employment, and for a period of one year following your termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.
- D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

NOTE: The information contained in the following appendix for isophorone is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligations. To the extent that the information supplements this regulation for isophorone, it is advisory in nature.

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APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES  
FOR ISOPHORONE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: 3,5,5-Trimethyl-2-cyclohexene-1-one
2. Formula: C9H14O
3. Molecular weight: 138.2

B. Physical Data

1. Boiling point (760 mm Hg): 215 C (419 F)
2. Specific gravity (water = 1): 0.93
3. Vapor density (air = 1 at boiling point of isophorone): 4.77
4. Melting point: -8.1 C (17 F)
5. Vapor pressure at 20 C (68 F): 0.2 mm Hg
6. Solubility in water, grams of isophorone per 100 grams of water (68 F): 1.2
7. Evaporation rate (butyl acetate = 1): 0.03
8. Appearance and odor: Colorless or pale yellow liquid with an odor like camphor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: 84.4 C (184 F) (closed cup)
2. Autoignition temperature: 460 C (860 F)
3. Flammable limits in air, % by volume: Lower: 0.8; Upper: 3.8
4. Extinguishing media: Carbon dioxide, dry chemical, alcohol foam
5. Special fire-fighting procedures: Do not use a solid stream of water since a stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.
6. Unusual fire and explosion hazards: Isophorone is a combustible liquid. At elevated temperatures its vapors can form explosive mixtures with air. All ignition sources must be controlled where isophorone is used, handled or stored in a manner that could create a potential fire or explosion hazard.
7. For purposes of complying with the requirements of 29 CFR 1910.106, isophorone is classified as a Class IIIA combustible liquid. For example, 2000 ppm, approximately one-fourth of the lower flammable limit, is one situation in which isophorone is considered to be a potential fire and explosion hazard.
8. For purposes of complying with 29 CFR 1910.309, the classification of hazardous locations as described in

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Article 500 of the National Electrical Code for isophorone shall be Class I, Group D.

B. Reactivity

1. Conditions contributing to instability: None hazardous.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving isophorone.
4. Special precautions: Isophorone will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If isophorone is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. For small quantities, absorb on paper towels. Remove to a safe place (such as a fume hood) and burn the paper. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber.

B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until cleanup has been completed.

C. Waste disposal methods: Isophorone may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.
2. By atomizing in a suitable combustion chamber.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the eight-hour exposure may be determined from a single eight-hour sample or two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or gas and vapor adsorption tubes with subsequent chemical analysis. The method of measurement must determine the concentration of isophorone to plus or minus 35%.

B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described under paragraph IV. A. Laboratories performing chemical analyses should be accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association. The method of measurement must determine the concentration of isophorone to plus or minus 25%.

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C. METHODS: Methods meeting these accuracy requirements are available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161 under the title "NIOSH Analytical Methods for Set V" (Order number XXXXXXXXXXXX).

D. QUALIFIED PERSONS: Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. MISCELLANEOUS PRECAUTIONS

A. Store isophorone in tightly closed containers in a cool, well ventilated area.

B. Employers should advise employees of all areas and operations where their exposure to isophorone could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to isophorone is likely to occur are: During its production and its use as a solvent for resins, adhesives, inks; and in the vicinity of baking ovens where resins dissolved in isophorone are used to coat metals; and in organic synthesis.

NOTE: The information contained in the following appendix for isophorone is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligations. To the extent the information supplements this regulation for isophorone, it is advisory in nature.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Isophorone vapor is an irritant of the eyes and mucous membranes. Human subjects exposed briefly to 25 ppm experienced irritation of the eyes, nose, and throat. Workers exposed to 5 to 8 ppm for one month complained of fatigue and malaise which disappeared when air levels were reduced to 1 to 4 ppm. Repeated or prolonged skin contact with the liquid may cause dermatitis due to its defatting action.

III. SIGNS AND SYMPTOMS

Eye, nose, throat irritation; signs and symptoms of narcosis; dermatitis.

IV. SPECIAL TESTS

None in common usage.

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V. TREATMENT

Remove from exposure. Flush eyes with water and wash skin with soap or mild detergent and water. If swallowed and the person is conscious, induce vomiting. Give artificial resuscitation and administer oxygen if indicated. Recovery is usually rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Most reported effects of isophorone are caused by its irritant and narcotic properties. It is important that the physician become familiar with plant operating conditions in which exposure to isophorone occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. PREPLACEMENT

Routine medical histories and physical examinations are not required. However, the employer must screen employees for history of certain medical conditions (listed below) which might place the employee at increased risk from isophorone exposure. Only those giving a positive history of these conditions must be referred for further medical examinations.

1. Chronic respiratory disease -- In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of isophorone might cause exacerbation of symptoms due to its irritant properties.
2. Liver disease -- Although isophorone is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.
3. Kidney disease -- Although isophorone is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.
4. Skin disease -- Isophorone is a defatting agent and can cause dermatitis on prolonged exposure. Persons with preexisting skin disorders may be more susceptible to the effects of this agent.

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C. PERIODIC EXAMINATIONS

Routine periodic examinations are not required. However, if the employer becomes aware of an employee with the above-listed conditions, he must refer such employee for further medical examination.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Isophorone," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 327.
2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1763-1765.
3. Silverman, L., et al: "Further Studies on Sensory Response to Certain Industrial Solvent Vapors," Journal of Industrial Hygiene and Toxicology, 28:262-266, 1946.

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REFERENCES AND SOURCES  
ISOPHORONE

1910.1000

- (d) Compliance - Open surface tank classification based on relative evaporation rate of 275 hours (from Doolittle)
- (e) Fire and Safety
- (1) Electrical - Classification based on "Fire Hazard Classification of Chemical Vapors Relative to Explosion-proof Electrical Equipment," H. Carhart et al., National Academy of Science, 1973, report to U.S. Coast Guard, report no. CG-D-92-74, p. 16.
- (f) Personal Protective Equipment, and, (h) Sanitation
- Eye: Sax, "Dangerous Properties of Industrial Materials;" Union Carbide Corp., "Toxicology Studies;" Grant, "Toxicology of the Eye;" Exxon Chemical Co., Technical Information
- Skin: Sax, "Dangerous Properties of Industrial Materials;" Union Carbide Corp., "Toxicology Studies;" Exxon Chemical Co., Technical Information
- Ingestion: Union Carbide Corp., "Toxicology Studies;" Christensen, "NIOSH Toxic Substances List;" Exxon Chemical Co., Technical Information; Gleason, "Clinical Toxicology of Commercial Products"

COMMENTS

Eye - Classification: 1

Output statement numbers: 9, 13

Exceptions: None

Sax reports, without qualification, that "it can cause irritation, lachrymation, possible opacity of the cornea and necrosis of the cornea (experimental)."

According to Union Carbide, "one large drop produced severe surface burns in the rabbit eye. A small drop, as might occur in a fine spray, caused minor injury. Eye protection should be worn when handling this chemical."

Grant states that "the liquid tested by application of a drop to rabbit corneas causes mild transient injury, graded 4 on a scale of 1 to 10 after 24 hours. One instance of corneal burn in a human being recovered rapidly." Writing of vapor exposures, he adds "exposure to 840 ppm for four hours reduced corneal transparency or rendered the cornea stainable with fluorescein in guinea pigs but not rats."

According to Exxon, "the liquid is a severe eye irritant and may damage eye tissues if not promptly removed."

It is difficult to determine from the above data whether or not isophorone causes permanent eye damage. Grant's statement that any injury is transient is most likely to be a personal opinion based on the fact that isophorone is a ketone. The source of the data he refers to, Smyth and Carpenter's original range-finding data, makes no claim that reversibility of the injury was addressed. However, it is concluded to be advisable to assign it a classification of 1.

Skin - Classification: 2

Output statement numbers: 2, 7b, 16g, 16i

Exceptions: None

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Sax reports that this compound is an acute local irritant of high toxic hazard.

Union Carbide gives a rabbit skin penetration LD50 of 1.5 ml/kg. It also notes that "no skin sensitization was produced in ten human volunteers."

Exxon reports that isophorone has a rabbit dermal LD50 in excess of 3 g/kg, and hence, "has a low order of acute toxicity by . . . skin absorption." It adds that "isophorone is slightly-to-moderately irritating to the skin on prolonged, excessive contact. Repeated contact with the liquid may dry and crack the skin. If neglected, this could result in dermatitis."

Isophorone has a melting point of 17 degrees F. At 20 degrees C, it has a vapor pressure of 0.2 mm Hg and a solubility in water of 1.2%. The flash point of the substance is 184 degrees F.

Since skin absorption has not been positively shown to be excessively hazardous from brief exposures, it is concluded that a classification of 2 is sufficient. Statement 20a is not used because it is felt that the small quantities involved would have innocuous effects.

Ingestion - Classification: 2

Output statement number: 20b

Exceptions: None

Union Carbide lists an oral LD50 to rats of 1.87 gram/kg. Christensen gives one of 2330 mg/kg, also for rats. Exxon states that the oral LD50 to rats exceeds 3g/kg, and that "Isophorone has a low order of acute toxicity by ingestion.."

No data could be found regarding the chronic effects of ingestion of this compound. Since Gleason and others note that it is reputed to produce kidney damage by inhalation, it is concluded that a classification of 2 is appropriate.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th edition, 1975 (NFPA)

Exxon Chemical Co., "Isophorone" and Material Safety Data Sheet (Exxon)

Sources of data items used:

- I. A. 1. Synonyms: Exxon
- 2. Formula: NFPA-325M, Exxon
- 3. Molecular weight: Exxon
- B. 1. Boiling point: NFPA-325M, Exxon
- 2. Specific gravity: Exxon
- 3. Vapor density: Exxon
- 4. Melting point: Exxon
- 5. Vapor pressure: Exxon
- 6. Solubility in water: Exxon
- 7. Evaporation rate: Exxon
- 8. Appearance and odor: NFPA-49, Exxon
- II. A. 1. Flash point: NFPA-325M, Exxon
- 2. Autoignition temperature: NFPA-325M, Exxon
- 3. Flammable limits: NFPA-325M, Exxon
- 4. Extinguishing media: NFPA-49

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- 5. Special fire fighting procedures: NFPA-49, Exxon
- 6. Unusual fire and explosion hazards: Exxon
- B. 1. Conditions contributing to instability: ADL
- 2. Incompatibilities: NFPA-49
- 3. Hazardous decomposition products: None
- 4. Special precautions: Exxon
- III. A. Steps if released or spilled: NFPA-49, Exxon
- C. Waste disposal method: Exxon
- V. Miscellaneous precautions: NFPA-49, Exxon

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

- Browning, E., "Toxicity and Metabolism of Industrial Solvents," Elsevier, 1965 (Browning)
- "Chemical Abstracts," 66 -75, 1967 - 71 (CA)
- Doolittle, A. K., "The Technology of Solvents and Plasticizers," Wiley, 1954 (Doolittle)
- Fairhall, L. T., "Industrial Toxicology," 2nd edition, Williams and Wilkins, 1957 (Fairhall)
- International Labour Office, "Encyclopedia of Occupational Health and Safety," Geneva, 1972 (ILO)
- "Isophorone," Exxon Chem. Co., Material Safety Data Sheet, October 1971 (Exxon MSDS)
- "Isophorone," Exxon Chem. Co., Technical Information (Exxon TI)
- Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 2nd edition, vol. I, 1964 (K-O)
- Mosher, R. H. and Davis, D. S., "Industrial and Specialty Papers," vol. I, Chem. Pub. Co., 1968 (Mosher)
- "National Fire Codes," vol. 3, National Fire Protection Assoc., Boston, 1973 (NFPA-49)
- "Paint Technology Manuals - Part One," Oil and Color Chemists' Assoc., Chapman and Hall, 1961 (Paint Manual)
- Patty, F. A., "Industrial Hygiene and Toxicology," vol. II, Interscience, 1962 (Patty)

References for Specific Use/Exposure

- 1. Browning, CA, Exxon TI, Fairhall
- 2. Exxon TI, Doolittle, Browning, CA, Paint Manual, Mosher
- 3. Exxon TI, Mosher
- 4. Exxon TI, CA
- 5. Exxon TI, K-O, Browning, CA, Fairhall
- 6. ILO, Exxon TI, K-O, NFPA-49, Browning

References for Specific Control Methods

Exxon MSDS, ILO, NFPA-49, Browning, and Patty were the references used in all the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Isophorone

D. O. L. STANDARD: 25 ppm

WARNING PROPERTIES:

Odor Threshold: Patty points out that the vapors of isophorone "have an unpleasant odor to unacclimated humans, (but that) humans may lose their ability to detect the presence of isophorone if vapor exposures are prolonged." The Handbook of Organic Industrial Solvents states that the odor is objectionable "at approximately 10 ppm."

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**Irritation Levels:** Patty states that "Silverman, Schulte, and First, using unconditioned human volunteers distracted with movies, found that a short exposure to the vapors of isophorone was definitely irritating to the eyes, nose, and throat at a level of 25 ppm."

Grant points out that "human beings can detect eye irritation at a concentration as low as 25 ppm but have no persistent discomfort at 40 to 80 ppm. Objectionable irritation of the eyes and nose is experienced at 200 to 400 ppm, and the conjunctiva appears irritated." Half-facepiece respirators are allowed up to a concentration of 200 ppm unless eye irritation occurs. If eye irritation occurs, a full facepiece respirator must be worn.

**Evaluation of Warning Properties:** Although isophorone has an objectionable odor, odor is not considered an adequate warning property since olfactory fatigue occurs on continued exposure. Irritation is not considered an adequate warning property either, since humans have no persistent discomfort at concentrations as low as 40 to 80 ppm.

For the purposes of this standard, therefore, gas sorbent respiratory equipment is not permitted.

**IDLH:** 800 ppm

**Basis for IDLH Value:** The chosen IDLH is based upon the report by Union Carbide Corporation that exposure of animals for one hour to 880 ppm caused serious organ damage. Only one out of 6 animals died from and 8-hour exposure to air saturated with isophorone.

**Other Toxicological Information:** The Documentation of TLV's states that "Smyth and associates concluded from their work on experimental animal exposure that no effect whatever resulted from exposure at 25 ppm of isophorone vapor. Animals, 10 rats and 10 guinea pigs, were exposed for 30 eight-hour days to concentrations ranging from 25 to 500 ppm. Isophorone, in higher concentrations, injured primarily as a kidney poison.

"Smyth and Seaton reported that men exposed at 40, 85, 200 and 400 ppm isophorone experienced eye, nose and throat irritation. A few complaints of nausea, headache, dizziness, faintness, inebriation and a feeling of suffocation resulted from 200 and 400 ppm. Symptoms of irritation and narcotic action decreased at concentrations of 40 and 85 ppm. Useful warning properties existed only at 200 and 400 ppm.

"On the basis of the above material, a TLV of 25 ppm was proposed to prevent irritative and narcotic effects. Silverman et al., however, reported isophorone vapor was irritating to unconditioned volunteers at 25 ppm. According to Patty, moreover, the experiments of Smyth et al. were made with impure material. In his opinion the concentrations given in some cases exceeded possible levels, others were higher than actually present, and the results were not valid. He recommended a TLV of 10 ppm."

Union Carbide Corporation's Chemical Company Guide for isophorone states that "breathing vapors in a state approaching saturation in air killed one of six animals (rats) in eight hours of exposure.

"Breathing a concentration of 880 parts per million for one hour caused serious organ damage."

Union Carbide gives a single skin penetration, rabbit

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LD50 of 1.50 milliliters per kilogram of body weight.

LFL: 8000 ppm

VAPOR PRESSURE AT 20 C: 0.2 mm Hg

SATURATED CONCENTRATION AT 20 C: Approximately 265 ppm

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USE/EXPOSURE AND CONTROL DOCUMENTS  
ISOPHORONE

|    | Use/Exposure                                                                                                                                                                                                                                                                                                                                                                                                                   | Principal Route<br>of Entry | Currently Used<br>Control Methods                                                                                                                     |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Inhalation of vapor and skin contact with liquid during use as solvent for vinyl resins, nitrocellulose, (rocket propellants) natural resins, waxes, oils, fats, chlorinated rubber, herbicides                                                                                                                                                                                                                                | A,B                         | Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices, gloves, goggles, face shield) |
| 2. | Inhalation of vapor and skin contact with liquid during use as solvent for coatings; roll-coating finishes (coated aluminum coil - used for building and construction, residential siding, mobile homes, awnings, aircraft, automobile, appliance, containers, furniture, instruments, boat building, and paper industries); vinyl coatings; acrylic coatings, electronically sprayed cellulosic resin coatings; paint solvent | A,B                         | Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices, gloves, goggles, face shield) |
| 3. | Inhalation of vapor and skin contact with liquid during use as solvent in formulation of adhesives (bonding of polystyrene or polyvinyl chloride)                                                                                                                                                                                                                                                                              | A,B                         | Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices, gloves, goggles, face shield) |
| 4. | Inhalation of vapor and skin contact with liquid during use as solvent in manufacture of inks - high quality vinyl silk-screen inks and ink pastes (good solvency and slow evaporation rate improve flow characteristics)                                                                                                                                                                                                      | A,B                         | Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices, gloves, goggles, face shield) |
| 5. | Inhalation of vapor and skin contact with liquid during use for organic                                                                                                                                                                                                                                                                                                                                                        | A,B                         | Local exhaust ventilation; general dilution ventilation; personal protective equip-                                                                   |

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synthesis: manufacture  
of lubricating oil additives,  
fungicides, tetramethyl-  
guanidine; solvent in  
manufacture of acrylic acid  
and polyimides

ment (respiratory protec-  
tive devices, gloves,  
goggles, face shield)

- |    |                                                                                                                                                         |     |                                                                                                                                                                          |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6. | Inhalation of vapor and<br>skin contact with liquid<br>during manufacture,<br>distribution, and main-<br>tenance of equipment and<br>storage containers | A,B | Local exhaust ventilation;<br>general dilution ventilation;<br>personal protective equip-<br>ment (respiratory protec-<br>tive devices, gloves,<br>goggles, face shield) |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

- A -- Inhalation
- B -- Skin and eye contact resulting  
in localized irritation
- C -- Ingestion
- D -- Skin contact resulting in  
absorption and subsequent  
systemic poisoning