NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND

SUPPORTING DOCUMENTATION FOR

*** CYCLOHEXANOL ***

NIOSH/OSHA Draft Technical Standard and Supporting Documentation for CYCLOHEXANOL

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 CYCLOHEXANOL.

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.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for CYCLOHEXANOL

(a) DEFINITIONS

(1) PERMISSIBLE EXPOSURE - "Permissible Exposure" means inhalation of cyclohexanol in concentrations not in excess of 50 parts per million (ppm) (200 milligrams per cubic meter, mg/cu.m.) averaged over an eight hour work shift, as stated in section 1910.93, Table G-1.

(2) ACTION LEVEL - "Action Level" means one half (1/2) of the permissible exposure for cyclohexanol.

(b) EMPLOYEE INFORMATION - Each employer who has a workplace in which cyclohexanol is present shall:

(1) STANDARD AVAILABILITY - Keep a copy of this section with its appendices A, B and C, at the workplace. This material shall be made readily available to affected employees; and

(2) PRESENCE OF CYCLOHEXANOL - Inform affected employees of the quantity, location, and manner of use or storage of cyclohexanol.

(c) EXPOSURE MEASUREMENT

(1) INITIAL DETERMINATION - Each employer who has a place of employment in which cyclohexanol is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of cyclohexanol at or above the action level. The determination shall be made each time there is a change in production, process, or control measures which could result in an increase in airborne concentrations of cyclohexanol. A written determination shall be made and it shall contain at least the following information:

(i) Any information, observations, or calculations which would indicate employee exposure to cyclohexanol;

(ii) Any measurements of airborne concentrations of cyclohexanol taken;

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

(iv) Date of determination, work being performed at the time, location within work site, name, and social security number of each employee considered.

(2) INITIAL EXPOSURE MEASUREMENT - If the employer determines that any employee may be exposed to airborne concentrations of cyclohexanol at or above the action level, the exposure of the employee believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum exposure of the employee.

(3) INDENTIFICATION OF EXPOSED EMPLOYEES - If the exposure measurement taken under paragraph (c)(2) of this section reveals employee exposure to airborne concentrations of cyclohexanol at or above the action level, the employer shall:

(i) Identify all employees who may be exposed at or above the action level; and

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

(4) EXPOSURE ABOVE THE ACTION LEVEL - If an employee exposure measurement reveals that an employee is exposed to airborne concentrations of cyclohexanol at or above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every two months.

(5) EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE - If an employee exposure measurement reveals that an employee is exposed to airborne

concentrations of cyclohexanol above the permissible exposure, the employer shall:

(i) Inform the employee of the exposure as required by paragraph (N)(1) of this section; and

(ii) Measure the exposure of the employee at least monthly; and

(iii) Institute control measures as required by paragraph (E) of this section.

(6) TERMINATION OF EXPOSURE MEASUREMENT - If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to airborne concentrations of cyclohexanol below the action level, the employer may terminate measurement for the employee. For purposes of this subparagraph, use of respirators shall not constitute reduction of employee exposure below the action level.

(d) METHODS OF MEASUREMENT - 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 (Appendix B (iv)). The method of measurement shall have an accuracy, to a confidence level of 95%, of not less than that given in Table 1 below.

Table 1

Concentration	Required Accuracy
Above permissible exposure	Plus or Minus 25%
At or below permissible exposure and above the action level	Plus or Minus 35%
At or below the action level	Plus or Minus 50%

(e) Methods of Compliance

(1) Engineering controls - No employee shall be exposed to cyclohexanol above the permissible limit as defined in paragraph (a)(1) of this section. Engineering and work practice controls shall be used to reduce exposure to cyclohexanol to at or below the permissible exposure.

(i) When mechanical ventilation is used to control exposure, measurements which demonstrate system efficiency (for example: air velocity, static pressure, or air volume) shall be made at least every three months. Measurements of system efficiency shall also be made within five work days of any change in production, process or control which might result in a reduction in control.

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

(iii) Where a fan is located in duct work and where cyclohexanol is present in concentrations greater than 6000 ppm, one fourth of the lower flammable limit, the fan rotating element shall be of non-sparking material or the casing shall consist of, or be lined with, non-sparking material. There shall be sufficient clearance between the fan rotating element and the fan casing so as to prevent contact.

(2) Respirators

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

(a) During the time period necessary to install engineering controls; or
(b) In work situations in which engineering controls are technically not feasible; or
(c) In work situations in which feasible engineering and work practice controls are insufficient to reduce employees exposure to at or below the permissible exposure. Where technically feasible engineering and work practice controls are not sufficient to reduce exposure to at or below permissible exposure, they shall be used to reduce exposure to the lowest level feasible; or
(d) For operations not exceeding 40 hours per year; or
(e) In emergencies.

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

(iii) Employers shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.

(iv) Employers shall institute a respiratory protection program in accordance with sections 1910.134(b),(d),(e) and (f).

TABLE 2. RESPIRATORY PROTECTION FOR CYCLOHEXANOL

Condition	
Vapor Concentration	
Equal to or less than 1000 ppm	and organic vapor cartridge(s).
Equal to or less than 2500 ppm	organic vapor canister. Any supplied-air respirator with a full facepiece, helmet or hood. Any self-contained breathing apparatus with a full facepiece.
Equal to or less than 3500 ppm	operated in pressure-demand (positive pressure) mode or with a full facepiece, hood, or helmet operated in continuous flow mode.
Greater than 3500 ppm or	Self-contained breathing apparatus with a full facepiece operated in pressure-demand (positive pressure) mode.

Entry & Escape From Unknown Concentrations	supplied-air respirator with a full facepiece operated mode and an auxiliary self-contained air supply operated in pressure-demand mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand (positive pressure) mode.
Escape	Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.

(f) Fire and Safety

Employers shall familiarize themselves with the information contained in the Substance Technical Guidelines for cyclohexanol which is contained in Appendix B in order to ensure the safe handling and use of cyclohexanol.

(1) Electrical - For the purposes of compliance with section 1910.309, locations classified as hazardous locations due to the presence of cyclohexanol shall be Class I Group D.

(2) Portable fire extinguishers - For the purposes of compliance with section 1910.157, cyclohexanol is classified as a Class B fire hazard.

(3) Powered industrial trucks - For the purposes of compliance with section 1910.178, locations classified as hazardous locations due to the presence of cyclohexanol shall be Class I Group D.

(4) Combustible liquids - For the purposes of compliance with section 1910.106, liquid cyclohexanol is classified as a Class IIIA combustible liquid. Spray finishing operations shall be performed in accordance with sections 1910.107 and 1910.94(c). Dip tank operations shall be performed in accordance with sections 1910.108 and 1910.94(d).

(5) Sources of ignition - Sources of ignition such as smoking or open flames are prohibited where cyclohexanol is handled, used or stored in a manner so as to create a potential fire or explosion hazard.

(6) Storage - Cyclohexanol shall be stored so as not to come in contact with strong oxidizers.

(g) Personal Protective Equipment

(1) Skin Contact

(i) Employers shall provide, and require employees to use, impervious clothing, gloves, face shields (8 inch minimum) and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact to liquid or solid cyclohexanol. Face shields shall comply with section 1910.133(a)(6).

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

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

(2) Eye Contact

(i) Employers shall provide, and require employees to use, splash-proof safety goggles (cup-cover type dust and splash safety goggles), which comply with section 1910.133(a)(6), where eye contact to liquid or solid cyclohexanol may occur.

(h) Spills

(1) Spills of cyclohexanol shall be cleaned up immediately after eliminating potential sources of ignition and utilizing available ventilation.

(i) Sanitation

(1) Employers shall ensure that employees whose skin becomes wet with liquid cyclohexanol promptly wash or shower as necessary to remove any cyclohexanol from the skin.

(2) Employers shall ensure that employees who handle cyclohexanol wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

(j) Training and Information - Each employer who has employees exposed to cyclohexanol in excess of the action level, or employees who may have skin or eye contact with liquid cyclohexanol, or employees who work where accidental release, spill, fire, or explosion of cyclohexanol may occur, shall annually:

(1) Substance Safety Data Sheet - Inform each employee of the information contained in the Substance Safety Data Sheet for cyclohexanol, which is contained in Appendix A; and

(2) Medical -

(I) Advise employees as to the signs and symptoms of exposure to cyclohexanol.

(II) Instruct the employees to advise the employer of the development of signs and symptoms of exposure to cyclohexanol which are listed in Appendix A.

(III) Instruct the employees to inform the employer if they develop any of the medical conditions listed in (k)(2) of this section; and

(3) Procedures -

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

(II) The procedures required by (j)(1), (2), and (3)(I) shall be provided to employees at the expense of the employer during the employee's normal working hours.

(k) Medical Surveillance

(1) The employer shall provide medical procedures as required by paragraph (k). These procedures shall be provided at no cost to the employee.

(2) Preplacement Questionnaire - The employer shall obtain from each employee who will be exposed to liquid cyclohexanol, or airborne concentrations of cyclohexanol at or above the action level, a written statement as to whether such employee has a history of any of the following:

(I) Skin disease
(II) Liver disease
(III) Kidney disease
(IV) Chronic lung disease

(3) Preplacement Medical Examination - The employer shall provide a medical examination for an employee if the employee provides a history of any of the conditions named in paragraph (k)(2).

(4) Results of Preplacement Examination - The employer shall obtain a physician's written opinion based on the medical examination pursuant to paragraph (k)(3).

(5) Periodic Medical Examinations - The employer shall provide a medical examination for an employee if the employee advises the employer of the development of:

(I) Any of the medical conditions listed in (k)(2)
(II) Signs and symptoms listed in Appendix A which the employee suspects may be caused by exposure to cyclohexanol.

(6) Results of Periodic Examinations - The employer shall obtain a physician's written opinion based on the medical examination pursuant to paragraph (k)(5).

(7) Exclusion or Removal from Exposure - No employee shall continue to be exposed to cyclohexanol if such exposure could place the employee at increased risk of material impairment of his health.

(8) Emergency Procedures - The employer shall provide emergency and follow-up medical examinations and treatment for any employee injured through exposure to cyclohexanol.

(9) Informing the Physician - The employer shall provide to the examining physician the following information:

(I) A copy of this section with its Appendices A, B and C for cyclohexanol;
(II) A description of the employee's duties as they relate to his exposure to cyclohexanol;
(III) A description of any personal protective equipment, including respirators, required to be used;
(IV) The results of any employee's exposure measurement, if available;
(V) The employee's anticipated exposure level; and

(VI) Upon request of the physician, information from previous medical examination of the employee.

(10) Physician's Written Opinion

(I) The physician's written opinion shall be a signed statement by the examining physician specifically stating:

(A) Whether the employee has any detected medical conditions which could be directly or indirectly aggravated by exposure to cyclohexanol or which could significantly interfere with the ability of the employee to follow recommended or required procedures for protecting himself from unusual or emergency exposure.

(B) Any recommended limitations upon the employee's exposure to cyclohexanol.

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

(II) The written opinion shall not reveal medical information unrelated to exposure to cyclohexanol.

(11) Refusal to be Medically Examined - 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 risks involved by refusing to be examined.

(12) 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.

(l) RecordKeeping.

(1) Initial determination.

(i) The employer shall keep an accurate record of all initial determinations required to be made pursuant to paragraph (c)(1) of this section.

(ii) The record shall include the written determination and any supporting documentation as required in paragraph (c)(1) 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 cyclohexanol.

(ii) This record shall include:

(a) The date of measurement;

(b) A reference to the subparagraph of this regulation which required the measurement, if any;

(c) Operations involving exposure to cyclohexanol which are being monitored;
(d) Sampling and analytical methods used and evidence of their accuracy;
(e) Number, duration, and results of samples taken;
(f) Name, Social Security number, 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.

(3) Mechanical ventilation.

(i) When mechanical ventilation is used as an engineering control, the employer shall maintain a record of measurements demonstrating the effectiveness of such ventilation as required by paragraph (e)(1)(i) of this section.

(ii) This record shall include:
(a) Date of measurement;
(b) Type of measurement taken;
(c) Result of measurement.

(iii) This record shall be maintained for at least one year.

(4) Training and information.

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

(ii) The record shall include:
(a) Date of training;
(b) Name and Social Security number of employees trained;
(c) Substance of training provided.

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

(5) Medical records.

(i) The employer shall keep an accurate medical record for each employee.

(ii) The record shall include:
(a) Physician's written opinion;
(b) Preplacement questionnaire;
(c) Any employee medical complaints relative to exposure to cyclohexa
(d) A signed statement of any refusal to be examined;
(e) A copy of information provided to the physician pursuant to paragraph (k)(9)(ii) through (vi) of this section.

(iii) This record shall be maintained for the duration 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 and the Director.

(ii) Employee exposure measurement records required to be maintained by this section shall be made available to employees and former employees and their designated representatives.

(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.

(m) Observation of monitoring.

(1) Duty.

The employer shall give affected employees or their representatives an opportunity to observe any monitoring of employee exposure to cyclohexanol which is conducted pursuant to this section.

(2) Exercise of opportunity to observe monitoring.

(i) When observation of the monitoring of employee exposure to cyclohexanol requires entry into an area where the use of personal protective devices is required, the observer shall use such equipment and comply with all other applicable safety procedures.

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

(a) Receive an explanation of the measurement procedures;

(b) Visually observe all steps related to the measurement of exposure to cyclohexanol that are being performed at the place of exposure.

(c) Record the results obtained.

(n) Employee notification.

(1) The employer shall notify in writing, within five work days, every employee who is found to be exposed to cyclohexanol above the permissible exposure. The employee shall also be notified of the level of his exposure and the corrective action being taken to reduce the exposure to at or below the permissible exposure.

(2) Pursuant to paragraph (k) of this Section, when an employee is medically examined the employer shall provide the employee with a copy of the physician's written opinion.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET

I. SUBSTANCE IDENTIFICATION

SUBSTANCE: Cyclohexanol

PERMISSIBLE EXPOSURE: 50 parts of cyclohexanol vapor per million parts of air (ppm) or 200 milligrams of cyclohexanol vapor per cubic meter of air (mg/cu m)

APPEARANCE AND ODOR: Thick colorless liquid or sticky solid with a faint camphor-like odor.

II. HEALTH HAZARD DATA

A. Ways in Which the Chemical Affects Your Body: Cyclohexanol can affect your body if it is swallowed, inhaled, or if it comes in contact with your skin or eyes.

B. Effects of Overexposure:

1. Short-Term Overexposure: Overexposure to cyclohexanol may cause headache and irritation of the eyes, nose and throat.
2. Long-Term Overexposure: Repeated exposure to cyclohexanol may cause irritation of the skin.
3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms associated with cyclohexanol exposure.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If cyclohexanol gets into your eyes, wash the eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

B. Skin Exposure: If cyclohexanol gets on your skin, wash the contaminated skin with water promptly. If cyclohexanol soaks through your clothing, remove the clothing promptly and flush the skin with water. CDo not rewear the clothing until the cyclohexanol has been removed. Replace or repair impervious clothing that has developed leaks. If there is skin irritation, get medical attention.

C. Breathing: If you or any other person breathes in large amounts of cyclohexanol remove 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 cyclohexanol has been swallowed get medical attention immediately. If medical attention is not immediately available get the affected person to vomit by having him touch the back of the throat with his finger or by giving him large amounts (one pint or more) of warm salt water (two tablespoons of salt per pint of water). Do not make an unconscious person vomit.

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 equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

A. RESPIRATORS: Respirators are not the best way to control exposure to cyclohexanol. You can only be required to wear them for routine use if your employer is in the process of installing controls or other 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)/National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) If you can smell cyclohexanol 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 impervious clothing, gloves, face shields, and other appropriate protective clothing to prevent repeated or prolonged skin contact with liquid or solid cyclohexanol.

C. EYE PROTECTION: You must wear splash-proof safety goggles (cup-cover type dust and splash safety goggles) where eye contact to liquid or solid cyclohexanol may occur.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

Cyclohexanol is a combustible liquid and its vapors can form explosive mixtures with air at elevated temperatures. It must be stored in tightly closed containers in a cool well-ventilated area away from heat and strong oxidizers. Sources of ignition such as smoking and open flames are prohibited wherever cyclohexanol is handled, used or stored in a manner that could create a potential fire or explosion hazard. You must use non-sparking tools when opening or closing metal containers of cyclohexanol, and containers must be bonded and grounded when pouring or transferring liquid cyclohexanol. If your skin becomes contaminated with liquid cyclohexanol, you must promptly wash or shower as necessary to remove the cyclohexanol from your skin. You must promptly remove any non-impervious clothing that becomes wet with liquid cyclohexanol and this clothing must not be reworn until the cyclohexanol is removed from the clothing. If you handle liquid or solid cyclohexanol, you must wash

your hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them. Ask your supervisor where cyclohexanol is used in your work area and for any additional plant safety and health rules.

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APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
CYCLOHEXANOL

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Hexalin; hydroxycyclohexane; hydralin; anol; hexahydrophenol; cyclohexyl alcohol
2. Formula: $C_6H_{11}OH$
3. Molecular weight: 100

B. Physical Data

1. Boiling point (760 mm Hg): 161 C (322 F)
2. Specific gravity (H_2O=1): 0.96
3. Vapor density (air=1 at boiling point of cyclohexanol): 3.5
4. Melting point: 23.6 C (75 F)
5. Vapor pressure at 20 C (68 F): 1 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 3.6
7. Evaporation rate (butyl acetate=1): 0.08
8. Appearance and odor: Colorless viscous liquid or sticky solid with a faint camphor odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: 67.8 C (154 F) (closed cup)
2. Autoignition temperature: 300 C (572 F)
3. Flammable limits in air, % by volume: lower: 2.4 (calculated at flas
4. Extinguishing media: Alcohol foam, dry chemical, carbon dioxide
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: Cyclohexanol is a combustible liquid. At elevated temperatures its vapors can form explosive mixtures with air. All ignition sources must be controlled where cyclohexanol is used, handled or stored. Cyclohexanol vapors are heavier than air and may travel along the ground and be ignitied by sparks or open flames at locations remote from the site at which cyclohexanol is handled.
7. For purposes of complying with the requirements of 29 CFR 1910.106, cyclohexanol is classified as a Class IIIA combustible liquid. At 6000 ppm, one-fourth of the lower flammable limit, cyclohexanol 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 Article 500 of the National Electrical Code for cyclohexanol shall be Class I Group D.

B. Reactivity

1. Conditions contributing to instability: heat
2. Incompatibilities: Contact with strong oxidizers may cause fire and explosion
3. Hazardous decomposition products: toxic gases and vapors (such as carbon monoxide) may be released in a fire involving cyclohexanol.
4. Special precautions: Cyclohexanol will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

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

1. Remove all ignition sources
2. Ventilate area of spill or leak
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood) and burn the paper. Large quantities can be collected, mixed with ethyl alcohol 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:
Cyclohexanol may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a sanitary landfill.
2. By mixing with ethyl alcohol and 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 average 8-hour exposure may be determined from a single sample or two (2) 4-hour samples. Short term interval samples (up to 30 minutes) may also be used to determine average exposure level if a minimum of five (5) measurements are taken in a random manner over the 8-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random equal duration samples taken on one (1) work shift is an estimate of an employee's average level of exposure for that work shift. 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, gas and vapor adsorption tubes with subsequent chemical analyses or dosimeters. The method of measurement must determine the concentration of cyclohexanol to plus or minus 35%.

b. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring 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 (AIHA). The method of measurement must determine the concentration of cyclohexanol to plus or minus 25%. Methods meeting these accuracy requirements are available in the "NIOSH Monitoring Methods Manual".

V. MISCELLANEOUS PRECAUTIONS

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

B. High exposures to cyclohexanol can occur when transferring the liquid from one container to another.

C. Non-sparking tools must be used to open and close metal cyclohexanol containers. These containers must be effectively grounded and bonded prior to pouring.

D. Employers must advise employees of all plant areas and operations where exposure to cyclohexanol could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to cyclohexanol is likely to occur are: its use as a solvent for some oils, lacquers, and other surface coatings; in the compounding of certain textile soaps and drycleaning fluids, and as an intermediate in the production of nylon , caprolactum, and plasticizers; its use in cleaning and degreasing; and in its manufacture and subsequent repackaging.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; minor skin absorption.

II. TOXICOLOGY

Cyclohexanol vapor has a narcotic effect at high concentrations, and causes irritation of the eyes, nose and throat. Prolonged exposure at 145 ppm resulted in minimal changes in the liver and kidneys of rabbits. Lethargy occurs in the monkey at 700 ppm, and narcosis in rabbits at 1000 ppm. The liquid defats the skin and may produce dermatitis upon prolonged or frequently occuring contacts. No chronic systemic effects have been reported in humans.

III. SIGNS AND SYMPTOMS

Irritation of the eyes, nose and throat. Narcosis may occur at sustained high levels.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Give artificial resuscitation if indicated. Wash eyes and contaminated skin with water. If swallowed and the person is conscious, induce vomiting. Recovery is usually complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Most reported effects of cyclohexanol are caused by its irritant properties. It is important that the physician becomes familiar with plant operating conditions in which exposure to cyclohexanol 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 examination 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 exposure. Only those giving a positive history of these conditions must be referred for further medical examinations.

1. Skin disease -- Cyclohexanol 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.

2. Liver disease -- Although cyclohexanol 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 cyclohexanol 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. Chronic lung disease -- In persons with impaired pulmonary function, especially those with obstructive airway disease, the breathing of cyclohexanol might cause exacerbations of symptoms due to its irritant properties.

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.

References

1. Browning, Ethel: Toxicity and Metabolism of Industrial Solvents, Elsevier Publishing Company, Amsterdam, 1965, pp. 385-388.

2. American Conference of Governmental Industrial Hygienists: "Cyclohexanol," (3d ed., 2d printing), Documentation of the Threshold Limit Values for Substances in Workroom Air, Cincinnati, 1974, p. 65.

3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1477-1480.

REFERENCES AND SOURCES
CYCLOHEXANOL
1910.93

(f) Personal Protective Equipment, and, (h) Sanitation

Eye: Grant, "Toxicology of the Eye"

Skin: Browning, "Toxicity and Metabolism of Industrial Solvents;" Patty, "Industrial Hygiene and Toxicology;" "Encyclopedia of Occupational Safety and Health," International Labour Office

Ingestion: Browning, "Toxicity and Metabolism of Industrial Solvents;" Patty, "Industrial Hygiene and Toxicology"

COMMENTS

Eye - Classification: 2 and 6
Output statement numbers: 10 and 12 combined
Exceptions: None

Grant reports that "testing by application of a drop to rabbits' eyes causes moderate injury, graded 7 on a scale of 1 to 10 after 24 hours."

In the absence of any indication in the literature that the injury caused is irreversible, it must be concluded that classifications of 2 and 6 are appropriate.

Skin - Classifications: 2 and 6
Output statement numbers: 2, 7b, 17g, 17i, 20a
Exceptions: None

Skin penetration lethal doses, for rabbits, of 12.7 to 22.7 g/Kg are reported in Browning and Patty. Browning notes "by skin application, there was a fall in temperature, jerking and twitching of the limbs and chest muscles and narcosis. Application of soaps containing up to 15% of cyclohexanol caused only slight local effects, but the higher concentrations caused some lacrimation which, it was presumed, was the result of absorption from the skin, since there was practically no vaporisation (sic) . . . from the skin." She, therefore, adds "in large doses it is readily absorbed through the skin."

Patty notes that "application of 10 ml of cyclohexanol upon the intact skin of a rabbit for 1 hour on each of 10 successive days induced narcosis, tremors, athetoid movements, and hypothermia, together with necrosis, exodative ulceration, and thickening of the skin in the area of contact." A number of animals subjected to these applications were fatally poisoned. ILO states that "prolonged contact with the skin results in irritation, and the liquid is slowly absorbed through the skin."

Cyclohexanol has a melting point of 75 degrees F and a vapor pressure of 1 mm Hg at 20 degrees C. It is 3.6% soluble in water and has a flash point of 154 degrees F.

Below, it is recorded that the effects of excessive skin absorption are similar to those of oral administration and include "toxic degenerative lesions and vascular damage." Though the acute skin penetration lethal doses given indicate that the rate of absorption is low, the various information indicates that effects may be significant from even small amounts penetrating the skin. Classifications of 2 and 6 are concluded to be appropriate to prevent the cited effects if statements

17g and 17i are used instead of 16g and 16i, especially since the vapor pressure of the substance is low.

Ingestion - Classifications: 2 and 6
Output statement numbers: 20a
Exceptions: See below

Browning reports "animal experiments have led to the conclusion that there is no appreciably prolonged retention in the organism . . . By oral administration, Treon et al. observed diarrhoea, ataxia, lethargy, narcosis, collapse, loss of reflexes and death, but no convulsions. Animals which survived recovered from the narcosis in 5.5 to 16 hours." Patty states "the oral administrations of lethal doses of cyclohexanol (2.6 g or more/kg of body weight) to rabbits caused severe vascular damage and extreme toxic effects with massive coagulation necrosis of myocardium, lung, liver, kidney, and brain. Animals that survived somewhat smaller doses developed toxic degenerative lesions and vascular damage of much lesser degree. The changes observed following the cutaneous application . . . were very similar, in general . . ."

Use of statement 20a alone is considered adequate.

SUBSTANCE TECHNICAL GUIDELINES
CYCLOHEXANOL

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Hexalin; hydroxycyclohexane; hydralin; anol; hexahydrophenol; cyclohexyl alcohol
2. Formula: $C_6H_{11}OH$
3. Molecular weight: 100

B. Physical Data

1. Boiling point (760 mm Hg): 161 C (322 F)
2. Specific gravity (water=1): 0.96
3. Vapor density (air=1 at boiling point of cyclohexanol): 3.5
4. Melting point: 23.6 C (75 F)
5. Vapor pressure at 20 C (68 F): 1 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 3.6
7. Evaporation rate (butyl acetate=1): 0.08
8. Appearance and odor: Colorless viscous liquid or sticky solid with a faint camphor odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: 67.8 C (154 F) (closed cup)
2. Autoignition temperature: 300 C (572 F)
3. Flammable limits in air, % by volume: lower: 2.4 (calculated at flas
4. Extinguishing media: Alcohol foam, dry chemical, carbon dioxide
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: Cyclohexanol is a combustible liquid. At elevated temperatures its vapors can form explosive mixtures with air. All ignition sources must be controlled where cyclohexanol is used, handled or stored

in a manner that could create a potential fire or explosion hazard. Cyclohexanol vapors are heavier than air and may travel along the ground and be ignited by sparks or open flames at locations remote from the site at which cyclohexanol is handled.

7. For purposes of complying with the requirements of 29 CFR 1910.106, cyclohexanol is classified as a Class IIIA combustible liquid. For example, 6000 ppm, approximately one-fourth of the lower flammable limit, is one situation in which cyclohexanol 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 Article 500 of the National Electrical Code for cyclohexanol shall be Class I Group D.

B. Reactivity

1. Conditions contributing to instability: Heat.

2. Incompatibilities: Contact with strong oxidizers may cause fire and explosion

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving cyclohexanol.

4. Special precautions: Cyclohexanol will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

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

1. Remove all ignition sources.

2. Ventilate area of spill or leak.

3. 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 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: Cyclohexanol 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 average 8-hour exposure may be determined from a single sample or two (2) 4-hour samples. Short term interval samples (up to 30 minutes) may also be used to determine average exposure level if a minimum of five (5) measurements are taken in a random manner over the 8-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random equal duration samples taken on one (1) work shift is an estimate of an employee's average level of exposure for that work shift. 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, gas and vapor adsorption tubes with subsequent chemical analyses or dosimeters. The method of measurement must determine the concentration of cyclohexanol to plus or minus 35%.

b. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring 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 (AIHA). The method of measurement must determine the concentration of cyclohexanol to plus or minus 25%. Methods meeting these accuracy requirements are available in the "NIOSH Monitoring Methods Manual".

V. MISCELLANEOUS PRECAUTIONS

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

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

VI. COMMON OPERATIONS

Common operations in which exposure to cyclohexanol is likely to occur are: its use as a solvent for some oils, lacquers, and other surface coatings; in the compounding of certain textile soaps and drycleaning fluids, and as an intermediate in the production of nylon, caprolactum, and plasticizers; its use in cleaning and degreasing; and in its manufacture and subsequent repackaging.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Cyclohexanol

D. O. L. STANDARD: 50 ppm

WARNING PROPERTIES:

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

Irritation Levels: The Documentation of TLV's states that "Nelson and his associates found 100 parts of cyclohexanol to be objectionable to the ten persons subjected to this concentration in a study of sensory response to a number of solvent vapors. In this study the individuals classified the effect of the vapor on the eyes, nose and throat after three to five minutes' exposure as objectionable. The limit of 50 ppm was chosen to reduce objectionable irritation."

Evaluation of Warning Properties: Since cyclohexanol is known to produce eye, nose and throat irritation at a concentration only 2 times the permissible exposure limit, cyclohexanol is treated as a substance with good warning properties. Gas sorbent respiratory equipment is permitted.

IDLH: 3500 ppm

Basis for IDLH Value: There are no acute inhalation toxicity data available upon which to base an IDLH concentration for cyclohexanol. The chosen IDLH (3500 ppm), therefore, has been estimated from the rabbit oral LD50 from data (2.2 - 2.6 g/kg) given in Browning. The chosen IDLH is probably conservative, since the lower end of the range of the LD50 values (2.2 g/kg) has been used to estimate the IDLH.

Other Toxicological Information: The following excerpt has been taken from

Patty:

"Pohl was unable to observe any effects when a dog was exposed to air saturated with cyclohexanol for 10 minutes/day on 7 successive days. However, exposure of animals to sufficiently high concentrations

PHYSIOLOGICAL RESPONSE OF ANIMALS SUBJECTED TO VAPORS OF CYCLOHEXANOL

Number of animals exposed	CONCENTRATION mg/liter	ppm	Duration of exposure hr(a)	Percentage mortality	Signs of intoxication
4 rabbits	4.93	1229	150	50	Narcosis, lethargy, incoordination, conjunctival congestion and irritation, and salivation
4 rabbits	4.00	997	330	50	Narcosis, lethargy, conjunctival congestion and irritation, lacrimation, salivation, few convulsive movements
1 monkey	2.78	693	300	0	Lethargy, conjunctival irritation
4 rabbits	1.09	272	300	0	Slight conjunctival irritation
4 rabbits	0.58	145	300	0	None

(a) 6 hrs/day, 5 days/week

of cyclohexanol in air for 6 hours/day, 5 days/week induces an intoxication characterized by conjunctival congestion and irritation, lacrimation, salivation, lethargy, incoordination, narcosis, and mild convulsions. Under suitable conditions this intoxication may terminate in death . . ."

Toxic degenerative changes were found in the brain, heart, liver and kidneys of rabbits exposed repeatedly to concentrations of cyclohexanol in air ranging from 997 to 1229 ppm (4.00 to 4.93 mg/liter). Similar but less severe changes were seen in the myocardium, liver and kidneys of rabbits exposed to vapors of this compound at the concentration of 145 ppm (0.58 mg/liter) suffered little or no injury, slight degenerative changes being barely demonstrable in the liver and kidney.

Browning reports similar information. In addition, Browning gives an oral LD50 for rabbits of 2.2 - 2.6 g/Kg.

LFL: 24,000 ppm
VAPOR PRESSURE AT 20 C: 1 mm Hg
SATURATED CONCENTRATION AT 20 C: Approximately 1315 ppm

USE/EXPOSURE AND CONTROL DOCUMENT
CYCLOHEXANOL

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of vapor and skin contact with liquid during synthesis of adipic acid (primarily nylon 66 production)	A,B	General dilution ventilation; personal protective equipment (goggles, face shield, gloves, aprons)
2.	Inhalation of vapor during synthesis of caprolactum	A	General dilution ventilation
3.	Inhalation of vapor and skin contact with liquid during application of surface coatings including natural and synthetic textile dyes, cotton mercerizers, and paints, varnishes, lacquers and shellacs	A,B	General dilution ventilation; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, coveralls)
4.	Inhalation of vapor and skin contact with liquid during cleaning and degreasing operations	A,B	Local exhaust ventilation; personal protective equipment (gloves, aprons)
5.	Inhalation of vapor and skin contact with liquid during subdivision and packaging of cyclohexanol	A,B	Local exhaust ventilation; personal protective equipment (gloves, aprons)
6.	Inhalation of vapor and skin contact with liquid during production of dicyclohexyl phthalate, other cyclohexyl ester, soaps, synthetic detergents and rubber cement	A,B	Local exhaust ventilation

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

------ JES2 JOB STATISTICS ------

1,262 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

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*** JES2 NJE *A*     FWMMITS  OSH     JOB  902     END     PRINTER8   MITS-PERIF-0205     12.53.39 PM 30
*** JES2 NJE *A*     FWMMITS  OSH     JOB  902     END     PRINTER8   MITS-PERIF-0205     12.53.39 PM 30
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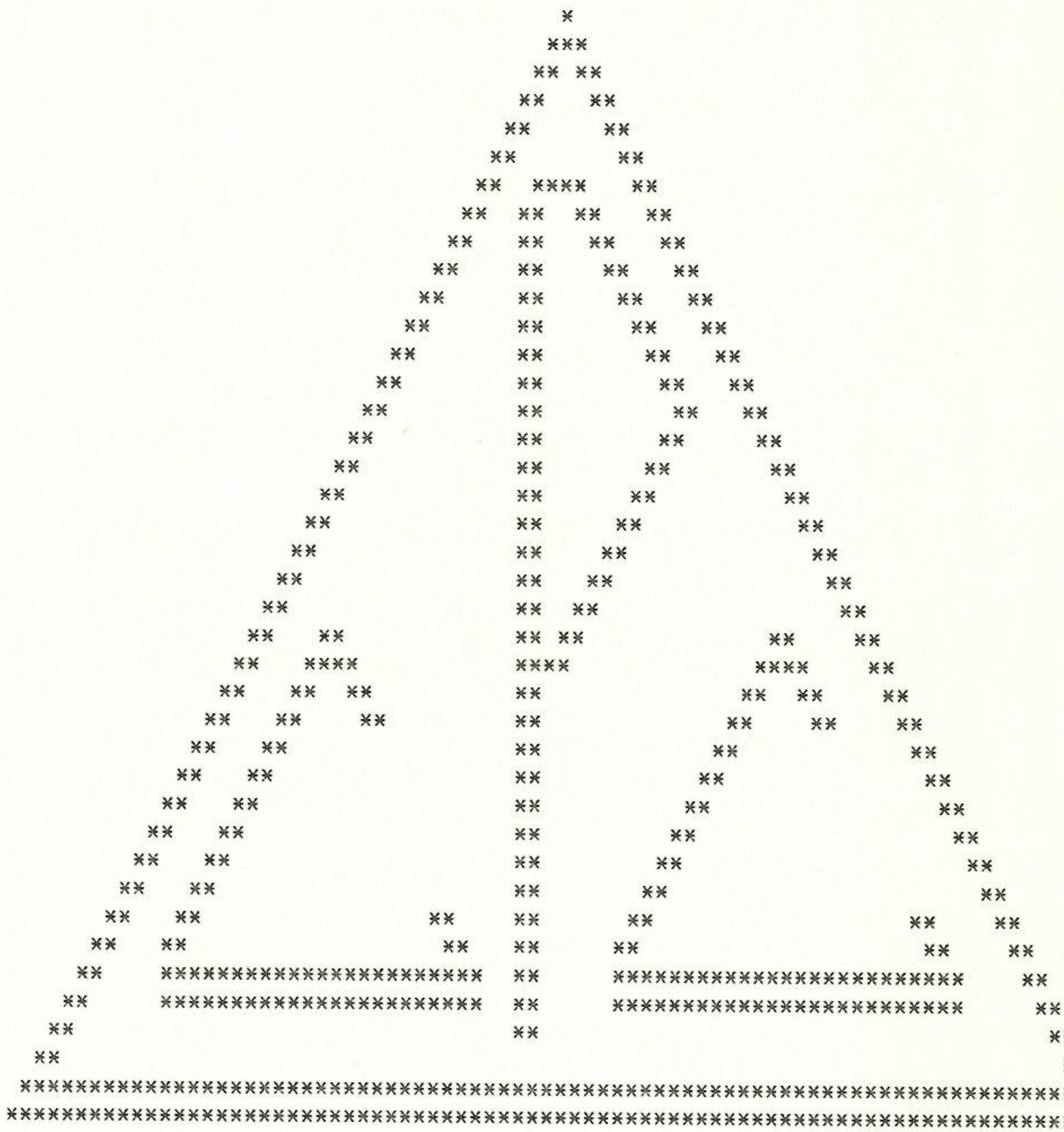

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