

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND  
SUPPORTING DOCUMENTATION FOR

\*\*\* QUINONE \*\*\*

NIOSH/OSHA Draft Technical Standard  
and Supporting Documentation for QUINONE

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 QUINONE.

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 quinone not in excess of 0.1 part per million (ppm) (0.4 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 quinone.

(b) Exposure determination and measurement. (1) Each employer who has a place of employment in which quinone is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of quinone 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 quinone.

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

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

(ii) Any measurements of quinone taken;

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

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

(3) If the employer determines that any employee may be exposed to quinone at or above the action level, 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 quinone 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.

(5) If an employee exposure measurement reveals that an employee is exposed to quinone 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.

(6) If an employee exposure measurement reveals that an employee is exposed to quinone above the permissible exposure, the employer 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 quinone above the permissible exposure. The employee shall also be notified of the corrective action being taken to reduce the exposure to at or below the permissible exposure.

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

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

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(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 |
|---------------|-------------------|
|---------------|-------------------|

|                            |            |
|----------------------------|------------|
| 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 quinone above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of quinone 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 technically 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. When mechanical ventilation is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity, static pressure, or air volume, 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 quinone.

(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 technically not feasible; or

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

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

(v) In emergencies.

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(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 QUINONE

| CONDITION                                                                       | PERMISSIBLE RESPIRATORY PROTECTION                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Particulate or Vapor Concentration                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5 ppm (20 mg/M3) or less                                                        | Any supplied-air respirator with a full facepiece, helmet or hood.<br>-----<br>Any self-contained breathing apparatus with a full facepiece.                                                                                                                                                                                                                                                                                     |
| 75 ppm (300 mg/M3) or less                                                      | A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet or hood operated in continuous-flow mode.                                                                                                                                                                                                                                    |
| Greater than 75 ppm (300 mg/M3) or entry and escape from unknown concentrations | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.<br>-----<br>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 and particulates.<br>-----<br>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 quinone.

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

(3) For the purpose of compliance with § 1910.157, quinone 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 quinone shall be Class II, Group G.

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

(6) Quinone 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 impervious clothing, gloves, face shields (eight-inch minimum) and other appropriate protective clothing necessary to prevent skin contact with quinone, where skin contact may occur. Face shields shall comply with § 1910.133(a)(2), (a)(4), (a)(5), and (a)(6).

(2) Employers shall ensure that employees whose clothing has had any possibility of being contaminated with quinone change into uncontaminated clothing before leaving the work premises.

(3) Employers shall ensure that clothing which has had any possibility of being contaminated with quinone is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of quinone from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the quinone, the employer shall inform the person performing the operation of the hazardous properties of quinone.

(4) Where exposure of an employee's body to solid quinone or liquids containing quinone may occur, employers shall provide facilities for quick drenching of the body within the immediate work area for emergency use.

(5) Employers shall ensure that non-impervious clothing which becomes contaminated with quinone be removed immediately and not reworn until the quinone is removed from the clothing.

(6) Employers shall provide and ensure that employees use safety goggles (cup-cover type dust and splash safety goggles) which comply with § 1910.133 (a)(2)-(a)(6) where there is any possibility of quinone or liquids containing quinone contacting the eyes.

(7) Where there is any possibility that an employee's eyes may be exposed to solid quinone or liquids containing quinone, employers shall provide an eye-wash fountain within the immediate work area for emergency use.

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

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

(2) Employers shall ensure that all employees subject to skin contact with quinone wash with soap or mild detergent and water any areas of the body which may have contacted quinone at the end of each work day.

(3) Employers shall ensure that employees do not eat or smoke in areas where quinone is handled, processed or stored.

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

(i) Training and information. (1) Each employer who has a workplace in which quinone 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 quinone above the action level or employees who may have skin or eye contact with quinone, or employees who work where a spill of quinone may occur, shall annually:

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

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

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

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

(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) The employer shall make available to each employee who is to be exposed to quinone or airborne concentrations of quinone at or above the action level a medical examination which shall include the following:

(i) A medical history and physical examination with emphasis on the eyes and skin.

(ii) Eye examination to include visual acuity test and slit lamp inspection of the cornea.

(3) The employer shall obtain from the physician, as a record of the examination, the following information:

(i) A written opinion which conforms with paragraph (j)(7) of this section.

(ii) Record of the results of the eye examination.

(4) The employer shall make available to each employee, exposed to quinone in excess of the action level at 12 months from the date of the employee's first exposure, and at every 12 months of exposure in excess of the action level thereafter, a medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the eyes and skin.

(ii) Eye examination to include visual acuity test and slit lamp inspection of the cornea.

(5) The employer shall obtain from the physician, as a record of the periodic examination, the following information:

(i) A written opinion which conforms with paragraph (j)(7) of this section.

(ii) Record of the results of the eye examination.

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

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

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

(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;

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

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

(7)(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 condition which would place the employee at increased risk of material impairment of the employee's health from exposure to quinone or would directly or indirectly aggravate any detected medical condition;

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

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

(8) No employee shall be exposed to quinone or airborne concentrations of quinone in such a way as would put the employee at increased risk of material impairment of his health from such exposure. This determination may be based on the physician's written opinion.

(9) The employer shall provide emergency and follow-up medical examinations and treatment for any employee injured through exposure to quinone.

(10) If the examining physician chooses to use alternative medical examinations to those specified in paragraphs (j)(2) and (4) of this section, the employer may accept such alternative medical surveillance examinations as meeting the requirements of this part provided that the employer:

(i) Obtains a statement from the examining physician setting forth the alternative medical examinations and the rationale for substitution and evidence that they will be equally effective.

(ii) Informs each exposed employee of the fact that alternative medical examinations to those required in paragraphs (j)(2) or (4) of this section are to be made available.

(11) 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.

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(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.

(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 quinone.

(ii) This record shall include:

(A) The date of measurement;

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

(C) Sampling and analytical methods used and evidence of their accuracy, including the method, results and date of calibration of sampling equipment;

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

(E) 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 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 and social security number 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) Results of tests required by paragraph (j)(2) and (j)(4) of this section:

(B) Any employee medical complaints relative to exposure to quinone;

(C) A copy of information provided to the physician pursuant to paragraph (j)(6)(ii), (iii), (iv), (v), and (vi) of this section.

(D) Physician's written opinion; and

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

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(iii) This record shall be maintained for the duration of and for a period of thirty years 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) Employee exposure determination and 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.

(1) Employee observation of measurement. (1) The employer shall give affected employees or their representatives an opportunity to observe any measurement of employee exposure to quinone which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to quinone 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.

(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 quinone that are being performed at the place of exposure; and

(iii) Record the results obtained.

NOTE: The information contained in the following appendixes is advisory in nature and is not intended, by itself, to create any additional obligations not otherwise imposed or detract from any existing obligation.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET  
FOR QUINONE

I. SUBSTANCE IDENTIFICATION

A. Substance: Quinone

B. Permissible Exposure: 0.1 parts of quinone per million parts of air (ppm) (0.4 milligrams of quinone per cubic meter of air (mg/M3)) averaged over an eight-hour work shift.

C. Appearance and Odor: Pale yellow solid with an acrid odor

II. HEALTH HAZARD DATA

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- A. Comments: Quinone is particularly hazardous to the eyes.
- B. Ways in which the chemical affects your body: Quinone 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.
- C. Effects of Overexposure:
  - 1. If quinone comes in contact with the skin or the lining of the nose and throat, it may cause irritation, discoloration, redness, swelling and blistering. Prolonged contact with the skin may cause ulceration. Contact with the eyes may cause irritation, discoloration and damage which may produce vision difficulties and may be permanent.
  - 2. 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 quinone.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If solid quinone or liquids containing quinone get into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.
- B. Skin Exposure: If quinone gets on your skin, immediately wash the contaminated skin using soap or mild detergent and water. If quinone penetrates through your clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.
- C. Breathing: If you or any other person breathes in large amounts of quinone 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 quinone has been swallowed, 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 equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators: Respirators are not the best way to control exposure to quinone. 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

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(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 their use is required. If you can smell quinone 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 shield or other appropriate protective clothing to prevent skin contact with quinone where skin contact may occur. Replace or repair impervious clothing that has developed leaks.
- C. Eye Protection: You must wear dust-resistant safety goggles where there is any possibility of solid quinone contacting your eyes. You must wear splash-proof safety goggles where there is any possibility of liquids containing quinone contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Quinone is a combustible solid and its dust can form explosive mixtures with air.
- B. Quinone must be stored in tightly closed containers in a cool, well-ventilated area away from heat and strong oxidizers.
- C. Sources of ignition such as smoking and open flames are prohibited wherever quinone is handled, used or stored in a manner that could create a potential fire or explosion hazard.
- D. If your work clothing has had any possibility of being contaminated with quinone, you must change into uncontaminated clothing before leaving the work premises.
- E. You must immediately remove any non-impervious clothing that becomes contaminated with quinone and this clothing must not be reworn until the quinone is removed from the clothing.
- F. If your skin becomes contaminated with quinone, you must immediately wash or shower with soap or mild detergent and water to remove the quinone from your skin.
- G. If you are subject to skin contact with quinone, at the end of each work day you must wash with soap or mild detergent and water any areas of your body that may have contacted quinone.
- H. You must not eat or smoke in areas where quinone is handled, processed or stored.
- I. If you handle quinone, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.
- J. Fire extinguishers, eye flushing facilities and quick drenching facilities, where provided, must be readily available and you should know where they are and how to operate them.

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- K. Ask your supervisor where quinone is used in your work area and for any additional plant 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 quinone. In addition, your employer must instruct you in the safe use of quinone, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to quinone. 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 of the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of exposure determinations, exposure measurements, and medical surveillance. Your employer is required to make records of exposure determinations and your exposure measurements available to you or your representative upon your request. Your employer is required to release your medical records to your physician upon your written request.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES  
FOR QUINONE

- I. PHYSICAL AND CHEMICAL DATA
- A. Substance Identification
1. Synonyms: p-Benzoquinone
  2. Formula: OC6H4O
  3. Molecular weight: 108.1
- B. Physical Data
1. Boiling point (760 mm Hg): Sublimes
  2. Specific gravity (water = 1): 1.32
  3. Vapor density (air = 1 at boiling point of quinone): 3.7
  4. Melting point: 113 C (235 F)
  5. Vapor pressure at 20 C (68 F): 0.1 mm Hg
  6. Solubility in water, % by weight at 20 C (68 F): 1.5
  7. Evaporation rate (butyl acetate = 1): Data not available
  8. Appearance and odor: Pale yellow solid with an acrid odor
- II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA
- A. Fire
1. Flash point: Data not available
  2. Autoignition temperature: Data not available
  3. Flammable limits in air, % by volume: Data not available
  4. Extinguishing media: Water spray, dry chemical, carbon

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- 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: Quinone is a combustible solid. Its dust can form explosive mixtures with air. All ignition sources must be controlled where quinone is used, handled or stored in a manner that could create a potential fire or 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 quinone shall be Class II, Group G.

B. Reactivity

1. Conditions contributing to instability: Heat.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as quinone fumes and carbon monoxide) may be released in a fire involving quinone.
4. Special precautions: Quinone will attack some forms of plastics, rubber and coatings.

III. SPILL AND DISPOSAL PROCEDURES

- A. If quinone is spilled, the following steps should be taken:
  1. Ventilate area of spill.
  2. For small quantities, sweep onto paper or other suitable material, place in an appropriate container and burn in a safe place (such as a fume hood). Large quantities may be reclaimed; however, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.
- B. Persons not wearing protective equipment should be restricted from areas of spills until cleanup has been completed.
- C. Waste disposal methods: Quinone may be disposed of:
  1. By making packages of quinone in paper or other flammable material and burning in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.
  2. By dissolving quinone in a flammable solvent (such as alcohol) and atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

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 eight-hour sample or two (2) 4-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

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breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analysis may be performed by collection of the particulates and vapors using a high efficiency membrane filter followed by an adsorption tube with subsequent chemical analysis of both the filter and adsorption tube. Detector tubes certified by NIOSH under 42 CFR part 84 or other direct-reading devices calibrated to measure quinone may be used. The method of measurement must determine the concentration of quinone 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 quinone to plus or minus 25%.

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 M" (Order number XXXXXXXXXX).

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 quinone in tightly closed containers in a cool, well ventilated area.

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

VI. COMMON OPERATIONS

Common operations in which exposure to quinone is likely to occur are: during its production and its use as an intermediate for making hydroquinone, bactericides, fungicides, insecticides and pharmaceuticals; as a tanning agent for specialty leathers; as an oxidizing agent in organic synthesis; during its use in the polymer resin and photographic industry; and in making quinhydrone electrodes.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Quinone is a solid with appreciable vapor pressure and the vapor or dust is very hazardous to the eyes. Acute exposure causes conjunctival irritation and in some cases corneal edema, ulceration and scarring;

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transient eye irritation may be noted above 0.1 ppm and becomes marked at 1-2 ppm. Chronic exposure causes the gradual development of changes characterized as: (1) brownish discoloration of the conjunctiva and cornea confined to the intrapalpebral fissure, (2) small opacities of the cornea, and (3) structural corneal changes which result in loss of visual acuity. The pigmentary changes are reversible, but the more slowly developing structural changes in the cornea may progress. Although pigmentation may occur with less than 5 years of exposure, this is uncommon and usually is not associated with serious injury. Skin contact may cause irritation and staining. Systemic effects from industrial exposure have not been reported. Skin cancer has been reported in mice painted with a quinone solution. A 0.1 or 0.25 percent solution of quinone in benzene was applied to the skin of mice daily or every other day; of 87 mice surviving for 200 days, 9 had papillomas of the skin, 3 had cancer of the skin, and 8 had lung cancer.

### III. SIGNS AND SYMPTOMS

Eye irritation, including conjunctivitis and keratitis; skin irritation.

### IV. SPECIAL TESTS

Preplacement and periodic ophthalmic examinations, including visual acuity and inspection of the cornea by slit lamp illumination.

### V. TREATMENT

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

### VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

#### A. GENERAL

Most reported effects of quinone are caused by its ability to produce eye irritation, pigmentation, and structural corneal changes. It is important that the physician become familiar with plant operating conditions in which exposure to quinone 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

The following medical procedures must be made available to each employee who is exposed to quinone:

1. A complete history and physical examination -- The purpose is to detect preexisting conditions that might place the exposed

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employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of congenital or acquired eye defects would be expected to be at increased risk from exposure. Persons with poor visual acuity from high degrees of astigmatism, keratoconus, or preexisting corneal injury should be excluded from repeated uncontrolled exposure to quinone vapor. Examination of the eyes and skin should be stressed.

2. Ophthalmic examination -- Quinone causes eye damage in humans. An ophthalmic examination must be performed including visual acuity and slit lamp inspection of the cornea.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Quinone," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 221.
2. Hygienic Guide Series: "Quinone," American Industrial Hygiene Association Journal, 24:194-195, 1963.
3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1383-1385.
4. Grant, W. Morton: Toxicology of the Eye (2d ed.), Charles C. Thomas, Illinois, 1974, pp. 878-879.
5. Anderson, B. and F. Oglesby: "Corneal Changes from Quinone-Hydroquinone Exposure," A.M.A. Archives of Ophthalmology, 59:495-501, 1958.
6. Anderson, B.: "Corneal and Conjunctival Pigmentation Among Workers Engaged in Manufacture of Hydroquinone," Archives of Ophthalmology, 38:812-826, 1947.
7. Takizawa, N.: "On the Carcinogenic Action of Certain Quinones," Proceedings of the Imperial Academy, 16:309-312, 1940.

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REFERENCES AND SOURCES

QUINONE

1910.93

- (f) Personal Protective Equipment, and, (h) Sanitation
- Eye: "Documentation of Threshold Limit Values;" "Encyclopedia of Occupational Safety and Health," International Labour Office; Sax, "Dangerous Properties of Industrial Materials;" Anderson and Oglesby, "Corneal Changes from Quinone and Hydroquinone Exposure," AMA Arch Ophth 59, p. 445 - 50
- Skin: Sax, "Dangerous Properties of Industrial Materials;" Hunter, "The Diseases of Occupation;" "Encyclopedia of Occupational Safety and Health," International Labour Office; Takizawa, Imperial Academy Proceedings, 16(7), p. 389 - 412, "Quinone," AIHA Hygienic Guide Series
- Ingestion: Sax, "Dangerous Properties of Industrial Materials;" Spector, "Handbook of Toxicology"

COMMENTS

Eye - Classification: 1 and 5

Output statement numbers: 9, 11, 13

Exceptions: 9 and 11 combined

The Documentation of Threshold Limit Values reports that "the vapor of quinone condensing on the eyes produces serious disturbances in vision . . . causing discoloration, severe irritation, erythema, swelling and the formation of papules and vesicles." It adds that prolonged exposure will result in necrosis. Hunter states that quinone can cause "dystrophy of the cornea, including ulceration of the corneal surface." The ILO notes, "it was reported that the injury (from condensed vapors) usually extends through the entire layer of the conjunctivus and is characterized by a deposit of pigment . . . (and) the staining, varying from diffuse brown to globules of brown-black is located primarily in the zones extending from the canthi medially to the edges of the cornea." They add, "all layers of the cornea are involved in the injury, with a resultant discoloration that may be white and opaque or brownish-green and translucent . . . (and) alteration of the cornea can occur after the pigment has disappeared." According to Sax, contact with quinone can cause moderate lachrymation, photophobia and a burning sensation. He notes that in a few cases there has been an appreciable loss of vision. The abstract of Anderson and Oglesby's work also notes that the curvature of the cornea can be profoundly altered by exposure to quinone and these changes become apparent long after exposure when the more obvious staining and pigmentation have disappeared. It adds that this leads to a flattening of the cornea or a double angulation which has some characteristics of keratoconus. It is reported that these changes have resulted in the development of high degrees of astigmatism.

ILO also notes that "ulceration of the cornea has resulted from one brief exposure to a high concentration of the vapor of quinone." Though none of the sources describe the effects

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of eye contact with the solid or liquids containing it, it can be concluded that the localized high concentration presented by such contact can have serious effects. The substance is, therefore, assigned classifications of 1 and 5. Due to the vapor pressure of quinone and the reported (see discussion under skin) problems associated with condensation of quinone vapors on the skin and mucous membranes, statements 9 and 11 are intended, where appropriate, to also require protection against quinone vapors. Statement 13, however, is intended to apply specifically for "solid quinone or liquids containing quinone."

Skin - Classification: 1 and 5

Output statement numbers: 2, 5a, 6, 8b, 14g, 14i, 15, 20a

Exceptions: See below

Sax notes that quinone is an acute local irritant of severe effect and a chronic local irritant of moderate effect. Hunter found that quinone can cause localized new growth of the skin, other papillomatous or keratotic and squamous-celled carcinoma of the skin. According to the ILO, "in man, severe local damage to the skin and mucous membranes may follow contact with the crystalline material, solutions of quinone or vapors condensing upon the exposed parts of the skin." The abstract of Takizawa's work notes that in 15 - 20% of mice painted every other day with a quinone solution, papillomas were produced and in a certain proportion of these cases the papillomas progressed into epitheliomas; the compound is, therefore, considered carcinogenic. The report also states quinone was thought to produce lung cancer of the adenocarcinoma type.

Quinone sublimes, has a melting point of 235.4 degrees F, a vapor pressure of 0.1 mm Hg at 20 degrees C, and a solubility in water of 1.5%

The effects of repeated or prolonged contact with the substance can obviously be severe. The effects of a single brief exposure are, however, unclear. Since the Hygienic Guide recommends that contaminated skin should be immediately washed, the substance is assigned classifications of 1 and 5 but statement 2 is used to prevent contact where it may occur instead of statement 1, and statement 8b is used instead of 8a. Since an important route of exposure is from the condensation of quinone vapors on the skin, various statements are simply applied for "quinone" and not any particular form or state of the substance. Statement 8b, however, is intended to apply specifically for "solid quinone or liquids containing quinone."

Ingestion - Classification: 1 and 5

Output statement numbers: 19, 20a

Exceptions: None

According to Sax, quinone is an acute local, acute systemic and chronic systemic ingesta of severe hazard. Spector lists an oral rat LD50 of 130 mg/kg. The ILO reports, "large doses of quinone absorbed from the gastroenteric tract of animals induce local changes, crying, clonic convulsion, respiratory difficulties, a drop in blood pressure and death

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by paralysis of the medullary centres." They add that "asphyxia appears to play a major role in causing death because of pulmonary damage resulting from the excretion of quinone into the aveoli and because of certain not-to-well-defined effects of quinone upon haemoglobin." They also found the urine of severely poisoned animals contained protein, blood, casts and "free" and "conjugated" hydroquinone.

The substance is concluded to present sufficient hazard to warrant classifications of 1 and 5.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

Eastman Kodak Co., Material Safety Data Sheet (East)

Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd edition, Vol. 16, p. 907 (K-O)

"Beilstein's Handbuch der Organischen Chemie," Vol. 7, p. 609 and supplements (Beil)

"Lange's Handbook of Chemistry," 11th edition (Lange)

Sources of data items used:

- I. A. 1. Synonyms: East  
2. Formula: East  
3. Molecular weight: Lange
- B. 1. Boiling point: East  
2. Specific gravity: Lange  
3. Vapor density: ADL  
4. Melting point: Lange  
5. Vapor pressure: East  
6. Solubility in water: Beil  
7. Evaporation rate: Not available  
8. Appearance and odor: East
- II. A. 1. Flash point: Not applicable  
2. Autoignition temperature: Data not available  
3. Flammable limits: Data not available  
4. Extinguishing media: East  
5. Special fire fighting procedures: ADL  
6. Unusual fire and explosion hazards: East; Beil
- B. 1. Conditions contributing to instability: ADL  
2. Incompatibilities: ADL  
3. Hazardous decomposition products: ADL  
4. Special precautions: ADL
- III. A. Steps if released or spilled: East; ADL  
C. Waste disposal method: East
- V. Miscellaneous precautions: ADL

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References used in the preparation of this document include:

"Chemical Abstracts," American Chemical Society, Volumes 66 - 75, 1967 - 1971 (CA)

-International Labour Office, "Encyclopedia of Occupational Health and Safety," 1972 (ILO)

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 1st edition, 1954 (Chem Tech); 2nd edition, 1972 (K-O)

Mark, H. F., Gaylord, N. G. and Bikales, E. M., "Encyclopedia of Polymer Science and Technology," Interscience Publishers, 1964 (Poly Sci)

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Plunkett, E. R., "Handbook of Industrial Toxicology," Chemical Publishing Co., Inc., 1966 (Plunkett)  
"Quinone," Hygienic Guide Series, American Industrial Hygiene Association, March - April 1963 (Hygienic Guide)

References for Specific Use/Exposure

1. Chem Tech, ILO, K-0
2. CA, Chem Tech, K-0, Poly Sci
3. Chem Tech
4. ILO, K-0
5. ILO
6. K-0
7. ADL estimate

References for Specific Control Methods

Hygienic Guide and Plunkett were the references used in all the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Quinone

D. O. L. STANDARD: 0.1 ppm or 0.4 mg/M3

WARNING PROPERTIES:

Odor Threshold: According to the AIHA Hygienic Guides, the "odor of quinone is not readily apparent at 0.1 ppm." Grant, however, reports that the "vapors are perceptible by smell to human beings at about 0.1 ppm in air." According to the Hygienic Guides, olfactory fatigue occurs upon exposure to quinone.

Eye Irritation Level: The Hygienic Guides note that "transient eye irritation may be noted above 0.1 ppm and becomes marked at 1 - 2 ppm." Grant states that "at 0.5 ppm the vapors are irritating to the eyes and at 3.0 ppm they are very irritating."

Evaluation of Warning Properties: The Hygienic Guides state that "exposure evaluation by odor and irritant effects is not adequate to assure safety because: 1) the odor of quinone is not readily apparent at 0.1 ppm, 2) olfactory fatigue occurs, and 3) repeated exposure to levels causing sensory irritation may cause chronic eye injury." For these reasons, quinone is treated as a material with poor warning properties. The concentration of quinone in saturated air at 20 C could result in a significant exposure relative to the permissible exposure. Gas sorbent respiratory equipment is not permitted.

IDLH: 75 ppm (300 mg/M3)

Basis for IDLH Value: This IDLH is based upon the mouse LCLO of 320 mg/M3 quinone which is given in the NIOSH Toxic Substances List. There is no other acute inhalation toxicity information available upon which to base the IDLH for quinone.

Other Toxicological Information: According to the AIHA Hygienic Guides, the severity of health hazards from acute and chronic exposures to quinone is high.

The Hygienic Guides state that "quinone vapor causes eye irritation. Single or repeated exposures to markedly irritating concentrations may cause corneal edema, ulceration, and scarring. The typical eye effects which develop gradually from chronic exposure are 1) brownish discoloration of conjunctiva and cornea confined to the intrapalpebral fissure, 2) small opacities of the cornea, and 3) structural changes in the cornea which result in loss of visual

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acuity. The pigmentary changes are reversible, but the more slowly developing structural changes in the cornea may progress. Although pigmentation may appear with less than five years of exposure, this is uncommon and usually is not associated with serious injury.

"There has been no evidence of systemic injury associated with exposure sufficient to cause these local eye injuries. Skin contact may cause irritation and staining."

The Documentation of TLV's discusses only the effects on the eye of quinone vapor and dust. According to the Documentation, "no systemic effects arise at a level of 0.1 ppm quinone vapor, while eye lesions are uncommon and mild when they do occur."

Gleason and Spector both note that no systemic poisonings have been reported for quinone, and Patty states that "cases of oral poisoning have not been reported."

The ILO states that "large doses of quinone which have been absorbed from the subcutaneous tissues, or from the gastroenteric tract of animals, induce local changes, crying, clonic convulsions, respiratory difficulties, drop in blood pressure and death by paralysis of the medullary centres. Asphyxia appears to play a major role in causing death because of pulmonary damage resulting from excretion of quinone into the alveoli and because of certain not - too-well defined effects of quinone upon haemoglobin."

The NIOSH Toxic Substances List gives a mouse LCL0 of 320 mg/M3 quinone, and references a Russian journal (Promyshlennaya Toksikologia Klinika, Prof. Zabolevanii, Khim. Etiol. Sb). The LCL0 is "the lowest concentration of a substance, other than an LC50, in air which has been reported to have caused death in man or to have caused death in animals when they have been exposed for 24 hours or less, death in animals."

LFL: Data not available

VAPOR PRESSURE AT 20 C: 0.1 mm Hg

SATURATED CONCENTRATION AT 20 C: 132 ppm (582 mg/M3)

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|    | Use/Exposure                                                                                                                                                                                                                                                                                                 | Principal Route<br>of Entry | Currently Used<br>Control Methods                                                                                           |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 1. | Inhalation of vapor and skin contact with crystals during use in the synthesis of organic chemicals and intermediates (strong oxidizing agent): photography - developer hydroquinone; agriculture - bactericides, fungicides, insecticides; pharmaceuticals - cortisone, addition compounds with barbituates | A,B                         | Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves) |
| 2. | Inhalation of vapor and skin contact with crystals during use in the polymer and resins industry (polymerization inhibitor and retarder - antioxidant, curing agent, copolymer, catalyst systems)                                                                                                            | A,B                         | Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves) |
| 3. | Inhalation of vapor and skin contact with crystals during use in the photographic industry (reaction with silver gives a reduction in contrast, quinone solutions containing bromide may be used for intensification of negatives and for toning of positives)                                               | A,B                         | Local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves)                    |
| 4. | Inhalation of vapor and skin contact with liquid during use in the leather industry as a tanning agent (for hides)                                                                                                                                                                                           | A,B                         | Local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves)                    |
| 5. | Inhalation of vapor and skin contact with crystals during the manufacture and processing of quinone (oxidation of aniline)                                                                                                                                                                                   | A,B,                        | Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles) |

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with sodium dichromate  
in the presence of sul-  
furic acid)

- |    |                                                                                                                                                                                                                                                                   |     |                                                                                                                                                               |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6. | Inhalation of vapor and skin contact with crystals or solution during manufacture and use of quinhydrone electrodes (inert metal electrode - platinum or gold - in contact with a saturated solution of 1:1 quinone and hydroquinone) - used for pH determination | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves)                                                      |
| 7. | Inhalation of vapor and skin contact with crystals during cleaning and maintenance of storage vessels and during clean up of accidental spills                                                                                                                    | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves, protective clothing, respiratory protective devices) |

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