

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** YTTRIUM ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for YTTRIUM

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 YTTRIUM.

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 yttrium and compounds (as yttrium) not in excess of 1 milligram 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 yttrium and compounds averaged over an eight-hour work shift.

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

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

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

(ii) Any measurements of yttrium and compounds taken;

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

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

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

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

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

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

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

(6) If an employee exposure measurement reveals that an employee is exposed to yttrium and compounds 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 yttrium and compounds above the permissible exposure. The employee shall also be notified of the results of the exposure measurements and of the corrective action being taken to reduce the exposure to below the permissible exposure.

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to yttrium and compounds

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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.

(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 (Percent of True Value)
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Above permissible exposure	± 25
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At or below permissible exposure and above the action level	± 35
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At or below the action level	± 50
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(d) Compliance. (1) No employee shall be exposed to yttrium and compounds above the permissible exposure as defined in paragraph (a)(1) of this section.

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

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

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

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

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

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

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

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

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

(v) In emergencies.

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

TABLE 2 RESPIRATORY PROTECTION FOR YTTRIUM AND COMPOUNDS (AS YTTRIUM)

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Particulate Concentration	
5 mg/M3 or less	Any dust and mist respirator, except single-use.
10 mg/M3 or less	Any dust and mist respirator, except single-use respirator or quarter-mask.
	Any fume respirator or high efficiency particulate filter respirator.
	Any supplied-air respirator.
	Any self-contained breathing apparatus.
50 mg/M3 or less	A high efficiency particulate filter respirator with a full facepiece.
	Any supplied-air respirator with a full facepiece, helmet or hood.
	Any self-contained breathing apparatus with a full facepiece.
500 mg/M3 or less	A powered air-purifying respirator with a high efficiency particulate filter.
	A Type C supplied-air respirator operated in pressure demand or other positive pressure or continuous-flow mode.
Greater than 500 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.
	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

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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.

(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 yttrium and compounds.

(2) Yttrium nitrate shall be stored so as not to come in contact with combustible materials.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use safety goggles which comply with 1910.133 (a)(2)-(a)(6) where there is any possibility of yttrium nitrate hexahydrate, yttrium chloride, yttrium oxide, or liquids containing these compounds contacting the eyes.

(2) Where there is any possibility that an employee's eyes may be exposed to yttrium nitrate hexahydrate, yttrium chloride, yttrium oxide, or liquids containing these compounds, employers shall provide an eye-wash fountain within the immediate work area for emergency use.

(g) Spills and disposal. In the event that yttrium compounds are spilled the employer shall immediately provide available ventilation and then clean up the spill.

(h) Sanitation. (Reserved).

(i) Training and information. (1) Each employer who has a workplace in which yttrium and compounds are 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 yttrium and compounds above the action level without regard to the use of respirators, or employees who may have any possibility of eye contact with solid yttrium nitrate hexahydrate, yttrium chloride, yttrium oxide or liquids containing these compounds or employees who work where a spill of yttrium and compounds may occur shall annually:

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

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

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

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

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

(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.

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(2) Each employer who has employees exposed to airborne concentrations of yttrium and compounds above the action level, without regard to the use of respirators, or employees who may have any possibility of eye contact with solid yttrium nitrate hexahydrate, yttrium chloride, yttrium oxide or liquids containing these compounds shall obtain information as to whether such employee has a history of any of the following medical conditions:

(i) Chronic lung disease; and

(ii) Skin disease.

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

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

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

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

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

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

(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 examinations of the affected employee.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to yttrium and compounds which are being monitored;

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

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

(E) Name and exposure of the employee monitored.

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

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

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

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

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

(ii) This record shall include:

(A) Date of training;

(B) Name of employee trained;

(C) Content or scope of training provided.

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

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

(ii) This record shall include:

(A) The name of the employee;

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

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(C) Any employee medical complaints relative to exposure to yttrium and compounds;

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

(E) Physician's written opinion; and

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

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

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

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

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

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

(2) When observation of measurement of employee exposure to yttrium and compounds 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 yttrium and compounds that are being performed at the place of exposure; and

(iii) Record the results obtained.

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

APPENDIX A

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SUBSTANCE SAFETY DATA SHEET
FOR YTTRIUM AND COMPOUNDS (AS YTTRIUM)

- I. SUBSTANCE IDENTIFICATION
- A. Substance: Yttrium and compounds
 - B. Permissible exposure: 1 milligram of yttrium and compounds (as yttrium) per cubic meter of air (mg/M3) averaged over an eight-hour workshift.
 - C. Appearance and odor: a) Yttrium nitrate hexahydrate: Odorless, colorless to pink solid; b) Yttrium chloride: Odorless colorless solid; c) Yttrium oxide: Odorless colorless solid; d) Yttrium metal: Odorless, silvery solid
- II. HEALTH HAZARD DATA
- A. Ways in which the chemical affects your body: Animal experiments suggest that yttrium can affect your body if you inhale it or if it comes in contact with your eyes. These experiments also suggest that it may affect your body if you swallow it.
 - B. Effects of Exposure:
 - 1. Long-term Exposure: Yttrium chloride particles which have become embedded in the eye have caused chemical eye damage in humans. Animal studies have shown that yttrium and compounds have caused irritation of the lungs, lung damage, and liver damage.
 - 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 yttrium and compounds.
- III. EMERGENCY FIRST AID PROCEDURES
- A. Eye Exposure: If yttrium and compounds get into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.
 - B. Skin Exposure: If yttrium and compounds get on your skin wash the contaminated skin using soap or mild detergent and water. If irritation is present after washing get medical attention.
 - C. Breathing: If you or any other person breathes in large amounts of yttrium 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.
 - C. Swallowing: When yttrium and compounds have 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

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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 yttrium and compounds. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required. If you experience difficulty breathing while wearing a respirator, tell your employer.
- B. Protective Clothing: None required.
- C. Eye Protection: You must wear dust-resistant safety goggles where there is any possibility of yttrium nitrate hexahydrate, yttrium chloride, yttrium oxide contacting your eyes. You must wear splash-proof safety goggles where there is any possibility of liquids containing yttrium and compounds contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING, AND STORAGE

- A. Yttrium nitrate must be stored so as not to come in contact with combustible materials.
- B. Yttrium and compounds must be stored in tightly closed containers in a well ventilated area.
- C. Eye flushing facilities, where provided, must be readily available and you should know where they are and how to operate them.
- D. Ask your supervisor where yttrium and compounds are used in your work area and for any additional safety and health rules.

VI. ACCESS TO INFORMATION

- A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for yttrium and compounds. In addition, your employer must instruct you in the safe use of yttrium and compounds, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to yttrium and compounds. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and the actions which are being taken to reduce your exposure.

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- C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure data for at least one year and to keep medical data during your employment, and for a period of one year following your termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.
- D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

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

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR YTTRIUM AND COMPOUNDS (AS YTTRIUM)

(This standard for yttrium and compounds should not be interpreted to apply only listed below for which substance specific information has been provided)

- a. Yttrium metal
 - I. PHYSICAL AND CHEMICAL DATA
 - A. Substance Identification
 - 1. Synonyms: None
 - 2. Formula: Y
 - 3. Molecular weight: 88.9
 - B. Physical Data
 - 1. Boiling point (760 mm Hg): 2927 C (5300 F)
 - 2. Specific gravity (water = 1): 4.47
 - 3. Vapor density (air = 1 at boiling point of Yttrium metal): Not applicable
 - 4. Melting point: 1509 C (2748 F)
 - 5. Vapor pressure at 20 C (68 F): Essentially zero
 - 6. Solubility in water, grams of yttrium metal per 100 grams of water at 20 C (68 F): Insoluble
 - 7. Evaporation rate (butyl acetate = 1): Not applicable
 - 8. Appearance and odor: Odorless, silvery solid
- b. Yttrium nitrate hexahydrate
 - I. PHYSICAL AND CHEMICAL DATA
 - A. Substance Identification

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1. Synonyms: None
2. Formula: $Y(NO_3)_3 \cdot 6H_2O$
3. Molecular weight: 383

B. Physical Data

1. Boiling point (760 mm Hg): Decomposes
2. Specific gravity (water = 1): 2.68
3. Vapor density (air = 1 at boiling point of Yttrium nitrate hexahydrate): Not applicable
4. Melting point: 100 C (212 F) loses water
5. Vapor pressure at 20 C (68 F): Essentially zero
6. Solubility in water, grams of yttrium nitrate hexahydrate per 100 grams of water at 20C (68 F): 142
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless to pink, odorless solid

c. Yttrium chloride

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: None
2. Formula: YCl_3
3. Molecular weight: 195.3

B. Physical Data

1. Boiling point (760 mm Hg): 1510 C (2750 F)
2. Specific gravity (water = 1): 2.67
3. Vapor density (air = 1 at boiling point of Yttrium chloride): Not applicable
4. Melting point: 720 C (1328 F)
5. Vapor pressure at 20 C (68 F): Essentially zero
6. Solubility in water, grams of yttrium chloride per 100 grams of water at 20 C (68 F): 79
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless, odorless solid

d. Yttrium oxide

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: None
2. Formula: Y_2O_3
3. Molecular weight: 225.8

B. Physical Data

1. Boiling point (760 mm Hg): 4300 C (7772 F)
2. Specific gravity (water = 1): 4.84
3. Vapor density (air = 1 at boiling point of Yttrium oxide): Not applicable
4. Melting point: 2417 C (4380 F)
5. Vapor pressure at 20 C (68 F): Essentially zero
6. Solubility in water, grams of yttrium oxide per 100 grams of water at 20 C (68 F): Insoluble
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless, odorless solid

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: Not applicable
2. Autoignition temperature: Not applicable

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3. Flammable limits in air, % by volume: Not applicable
 4. Extinguishing media: Not applicable
- B. Reactivity
1. Conditions contributing to instability: Heat.
 2. Incompatibilities: Contact of yttrium nitrate with combustible materials may cause fires and explosions.
 3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released when yttrium nitrate decomposes.
 4. Special precautions: None.

III. SPILL AND DISPOSAL PROCEDURES

- A. If yttrium and compounds are spilled, the following steps should be taken:
1. Ventilate area of spill.
 2. Collect spilled material in the most convenient and safe manner for reclamation, or for disposal in a secured sanitary landfill. Liquid containing yttrium and compounds should be absorbed in vermiculite, dry sand, earth or a similar material.
- B. Persons not wearing protective equipment should be restricted from areas of spills until cleanup has been completed.
- C. Waste disposal methods: Yttrium and compounds may be disposed of in sealed containers in a secured sanitary landfill.

IV. MONITORING AND MEASUREMENT PROCEDURES

- A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the eight-hour exposure may be determined from a single eight-hour sample or two four-hour samples. Several short-time interval samples (up to 30-minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by collection of the particulates using a high efficiency membrane filter with subsequent chemical analysis of the sample. Detector tubes certified by NIOSH under 42 CFR part 84 or other direct-reading devices calibrated to measure yttrium and compounds may be used. The method of measurement must determine the concentration of yttrium and compounds to plus or minus 35% of the true value.
- B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described above. 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 yttrium and compounds to plus or minus 25% of the true value.
- C. METHODS: Methods meeting these accuracy requirements are available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161 under

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the title "NIOSH Analytical Methods for Set N" (Order number XXXXXXXXXXXX).

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

V. MISCELLANEOUS PRECAUTIONS

- A. Store yttrium and compounds in tightly closed containers in a well ventilated area.
- B. Employers should advise employees of all areas and operations where their exposure to yttrium and compounds could occur.

VI. COMMON OPERATIONS

Common operations in which high exposure to yttrium and compounds may occur are: a) During the use of the metal as an alloy with iron; in the manufacture and use of the alloy "mischmetal" for lighter flints; and b) During the use of yttrium metal, yttrium nitrate hexahydrate, yttrium chloride, or yttrium oxide in the manufacture of fast glass polishes, luminescent tube materials for TV, and high temperature glasses.

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

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Yttrium and compounds have caused pulmonary irritation in animals. Systemic absorption by animals of the citrate complex of yttrium resulted in dyspnea and pulmonary edema; yttrium chloride produced liver edema, portal congestion, pleural effusion, and pulmonary hyperemia. Intraperitoneal injection of yttrium chloride in animals caused peritonitis with serous or hemorrhagic ascites. Intratracheal injection of 50 mg of yttrium oxide in rats produced diffuse sclerosis of the lungs. Application of a 0.1 M solution of yttrium chloride to the eyes of rabbits caused no injury; similar exposure of eyes from which the corneal epithelium had been removed resulted in immediate slight haziness of the cornea which subsequently became opaque and vascularized.

III. SIGNS AND SYMPTOMS

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By analogy to effects caused in animals, pulmonary irritation may occur. Particles embedded in cornea may cause severe eye damage.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Flush eyes with water. If swallowed and the person is conscious, administer large quantities of water orally and induce vomiting. Give artificial resuscitation if indicated.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Yttrium compounds in animals at high doses have caused pulmonary irritation. It is important that the physician become familiar with plant operating conditions in which exposure to yttrium occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. PREPLACEMENT

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

1. Chronic respiratory disease -- In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of yttrium might cause exacerbation of symptoms due to its irritant properties.
2. Eye disease -- Yttrium may cause severe eye damage. Those with pre-existing eye problems may be at increased risk from exposure.

C. PERIODIC EXAMINATIONS

Routine periodic examinations are not required. However, if the employer becomes aware of an employee with the above listed

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conditions, he must refer such employee for further medical examination.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Yttrium as Y," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 283.

2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1058-1067.

3. Grant, W. Morton: Toxicology of the Eye (2d ed.), Charles C. Thomas, Springfield, Illinois, 1974, p. 1091.

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REFERENCES AND SOURCES

YTTRIUM COMPOUNDS

1910.1000

- (f) Personal Protective Equipment, and, (h) Sanitation
Eye: Grant, "Toxicology of the Eye;" Patty, "Industrial Hygiene and Toxicology"
Skin: Patty, "Industrial Hygiene and Toxicology;" "Encyclopedia of Occupational Safety and Health," International Labour Office
Ingestion: Patty, "Industrial Hygiene and Toxicology;" ACGIH, "Documentation of Support of Threshold Limit Values for Substances in Workroom Air"

COMMENTS

Eye - Classification: 1 and 5
Output statement numbers: 9 and 11 combined, 13
Exceptions: None

For yttrium chloride, Grant reports "I have found that appli of 0.1 M solution (pH 5.4) for ten minutes on the intact eye caus injury, but similar exposure of eyes from which the corneal epith had been removed to facilitate penetration of the yttrium chlorid resulted in immediate slight haziness of the cornea, with subsequ increasing opacity in the next several days. Finally the corneas became completely opaque and vascularized. Exposure to 0.01 M so after removal of the epithelium resulted in slight to mild perman opacification."

Patty, citing work done at Oak Ridge, reports that yttrium " applied to the rabbits' cornea denuded of epithelium, resulted in permanent opacification. The intact epithelium, however, provide complete barrier and protection for the cornea against these subs Under industrial conditions in which fragments might penetrate th corneal epithelium severe damage could result if immediate remova of the lanthanons were not done."

It is evident that yttrium and its compounds have the potent for causing permanent corneal opacification when contacted in the industrial environment. Classifications of 1 and 5 are, therefor concluded to be warranted for the three compounds of concern to t standard.

Skin - Classification: 0
Output statement numbers: None
Exceptions: None

A search of the literature failed to reveal any specific information pertaining to the effects of external skin contact wi yttrium nitrate hexahydrate, yttrium chloride or yttrium oxide. ILO simply states that "good personal hygiene is important and pe protective clothing should be worn." Patty notes that open wound slowly in the presence of yttrium.

Yttrium nitrate hexahydrate, a solid, decomposes at 212 degr and is 142% soluble in water. Yttrium chloride melts at 1328 deg and is 79% soluble in water. Yttrium oxide is insoluble in water and melts at 4380 degrees F.

The lack of any comments in the literature indicating that n skin contact is hazardous leads to the conclusion that a classifi of zero is appropriate.

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Ingestion - Classification: 0

Output statement numbers: None

Exceptions: None

Patty states "on available evidence, which is incomplete, the acute toxicity of the lanthanons, including Y (yttrium), is low to high, parenterally." Generally, he reports "the acute toxic response is similar for all lanthanons provided the nonmetallic moiety is the same. Marked differences in the acute response occur, however, between the citrate complex and the chlorides The former is characterized by dyspnea and pulmonary edema; the latter, by liver edema and pulmonary congestion, pleural effusion, and pulmonary hyperemia." Patty also notes that only one chronic study has been conducted in which yttrium trichloride was given by intraperitoneal injections to rats. He reports that "the fact that the rats tolerated without systemic toxic effects a dose of 60 mg/kg would indicate a low order of chronic toxicity (for this substance) at least every 2 days for 5 months."

The ACGIH notes that "yttrium nitrate, chloride, and oxide have intraperitoneal LD50's for rats of 350, 450 and 500 mg/kg body weight respectively, indicating a relatively low order of toxicity by this route."

The data are obviously very incomplete in relation to ingestion. Since Patty reports the compounds to be of low oral toxicity, however, they are assigned a classification of zero.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd ed., Vol. 17, p. 143 (K-O)

Lange's Handbook of Chemistry, 11th ed. (Lange)

Sources of data items used:

- I. A.1. Synonyms: None
- 2. Formula: Lange, K-O
- 3. Molecular weight: Lange
- B.1. Boiling point: Lange, K-O
- 2. Specific gravity: Lange, K-O
- 3. Vapor density: Not applicable
- 4. Melting point: Lange
- 5. Vapor pressure: ADL
- 6. Solubility in water: Lange
- 7. Evaporation rate: Not applicable
- 8. Appearance and odor: Lange
- II. A.1. Flash point: Not combustible
- 2. Autoignition temperature: None
- 3. Flammable limits: None
- 4. Extinguishing media: None
- 5. Special fire fighting procedures: None
- 6. Unusual fire and explosion hazard: None
- B.1. Conditions contributing to instability: ADL
- 2. Incompatibilities: ADL
- 3. Hazardous decomposition products: ADL
- 4. Special precautions: None
- III. A. Steps if released or spilled: ADL
- B. Waste disposal method: ADL

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V. Miscellaneous precautions: ADL

VI. Common operations: K-O

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

Considine, D.M., "Chemical and Process Technology Encyclopedia," McGraw - Hill, 1974 (Considine)

International Labour Organization, "Encyclopedia of Occupational Health and Safety," Geneva, 1972 (ILO)

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 2nd edition, 1972 (K-O)

Spedding, F. H. and Daane, A. H. - editors, "The Rare Earth," Wiley, 1961 (Spedding)

U. S. Department of Interior, Bu Mines Bulletin 650, "Mineral Facts and Problems," 1970 (Bu Mines)

References for Specific Use/Exposure

1. Bu Mines, Considine, Spedding
2. Bu Mines, Spedding, K-O, Considine
3. K-O, Bu Mines, Considine
4. Bu Mines, Spedding, Considine
5. Bu Mines
6. Bu Mines, Spedding, Considine
7. Bu Mines, Spedding, K-O, Considine
8. Spedding
9. Considine, Spedding

References for Specific Control Methods

ILO was the only reference used in all of the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Yttrium and compounds

D. O. L. STANDARD: 1 mg/M3 (as Yttrium)

Eye Irritation Level: Yttrium is not known to be an eye irritant.

IDLH: From the information given in the Documentation of TLV's (quoted below), it does not appear that exposure to a high concentration of yttrium could impede escape within one-half hour. For the purposes of this standard, therefore, respirators have been selected on the basis of the protection factor afforded by each device up to 500 X the permissible exposure limit.

Other Toxicological Information: Patty states that "on available evidence, which is incomplete, the acute toxicity of the lanthanons, including Y, is low orally; high, parenterally. No sound judgement can be made regarding the toxicity by inhalation."

According to the Documentation of TLV's, "yttrium nitrate, chloride and oxide possess intraperitoneal LD50's for rats of 350, 450 and 500 mg/kg body weight respectively, indicating a relatively low order of toxicity by this route. A subsequent study was made of the skeletal deposition of yttrium in which rats were injected every other day for five months with a dose of 60 mg/kg yttrium. No fatalities were observed and no accumulation of yttrium occurred in the bones, although a total dosage of 936 mg/rat was administered. Deposition slowed to an insignificant rate when the bone burden reached 150 - 200 ppm yttrium.

"More recently, a comparative study of the effects of yttrium, neodymium and cerium oxides revealed that yttrium produced the most

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pronounced pulmonary changes (diffuse sclerosis) in rats. The oxides were administered intratracheally in a single large dose of 50 mg. Cerium oxide did not elicit either diffuse or nodular fibrosis as did yttrium. The pronounced fibrogenic activity of yttrium could not be accounted for on the basis of tissue solubility, and was accordingly attributed to the response to the specific chemical action of yttrium.

"This information, derived from direct application of yttrium to the respiratory tract, strongly indicates the need for a downward revision of the former TLV of 5 mg/M3 to a value no higher than 1 mg/M3.

"Tebrock and Machle studied a group of workers exposed to the dust of yttrium europium vanadate. The average concentration of yttrium was 1.4 mg/M3. The only effects noted were mild irritation of the eyes, upper respiratory passages, and skin, which they attributed to vanadium."

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YTTRIUM COMPOUNDS

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of dust or fume and skin contact with dust or fume during purification and packaging of yttrium (sponge, ingot, powder, turnings, lumps)	A	Local exhaust ventilation; good personal hygiene; personal protective equipment (gloves)
2.	Inhalation of dust or fume and skin contact with dust or fume during manufacture of alloys (added to iron, magnesium, vanadium, nickel, cobalt, and chromium alloys)	A	Local exhaust ventilation; good personal hygiene; personal protective equipment (gloves)
3.	Inhalation of dust or fume and skin contact with dust or fume during use in manufacture of red phosphors (europium-activated yttrium oxide) used in color TV picture tubes, fluorescent and mercury vapor lamps	A	Local exhaust ventilation; good personal hygiene; personal protective equipment (gloves)
4.	Inhalation of dust or fume and skin contact with dust or fume during use in manufacture of yttrium-iron-garnet (YIG) and yttrium-aluminum - garnet (YAG) used in electronic components for telephone, radar, and space communication networks and as simulated diamonds	A	Local exhaust ventilation; good personal hygiene; personal protective equipment (gloves)
5.	Inhalation of dust or fume and skin contact with dust or fume during manufacture of yttrium compounds. Virtually all yttrium is used in the form of oxide or other compounds.	A	Local exhaust ventilation; good personal hygiene; personal protective equipment (gloves)

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| 6. | Inhalation of dust or fume and skin contact with dust or fume during use in manufacture of ceramics (windows in high temperature furnaces, microscope lenses for high temperature studies, high intensity incandescent and discharge lamps, crucibles) | A | Local exhaust ventilation; good personal hygiene; personal protective equipment (gloves) |
| 7. | Inhalation of dust or fume and skin contact with dust or fume during use in manufacture of refractories (yttrium oxide added to zirconia forms a very stable, high temperature, high strength composition available as cloth, fiber, or solid) | A | Local exhaust ventilation; good personal hygiene; personal protective equipment (gloves) |
| 8. | Inhalation of dust or fume and skin contact with dust or fume during fabrication of yttrium and alloys (extrusion, forging, joining, machining, rolling) | A | Local exhaust ventilation; good personal hygiene; personal protective equipment (gloves) |
| 9. | Inhalation of dust or fume and skin contact with dust or fume during use in manufacture of lasers | A | Local exhaust ventilation; good personal hygiene; personal protective equipment (gloves) |

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

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

1,191 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

[illegible]