

Occupational Health Guideline for Yttrium and Compounds (as Yttrium)

INTRODUCTION

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

APPLICABILITY

The general guidelines contained in this document apply to all yttrium and compounds. Physical and chemical properties of several specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

Yttrium metal

- Formula: Y
- Synonyms: None
- Appearance and odor: Odorless, silvery solid.

Yttrium nitrate hexahydrate

- Formula: $Y(NO_3)_3 \cdot 6H_2O$
- Synonyms: None
- Appearance and odor: Colorless to pink, odorless solid.

Yttrium chloride

- Formula: YCl_3
- Synonyms: None
- Appearance and odor: Colorless, odorless solid.

Yttrium oxide

- Formula: Y_2O_3
- Synonyms: None
- Appearance and odor: Colorless, odorless solid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for yttrium and compounds is 1 milligram of yttrium and compounds (as yttrium) per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

• Routes of exposure

Animal experiments suggest that yttrium and compounds can affect the body if they are inhaled or if they come in contact with the eyes. These experiments also suggest that they can also affect the body if they are swallowed.

• Effects of overexposure

Long-term exposure: Yttrium chloride particles which have become embedded in the eye have caused chemical eye damage in humans. Animal studies have shown the yttrium and compounds have caused irritation of the lungs, lung damage, and liver damage.

• Reporting signs and symptoms

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to yttrium and compounds.

• Recommended medical surveillance

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

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from yttrium and compounds exposure.

—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.

—Eye disease: Yttrium may cause severe eye damage. Those with pre-existing eye problems may be at increased risk from exposure.

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

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

• **Summary of toxicology**

Yttrium and compounds have caused pulmonary irritation in animals. Systemic absorption of the citrate complex of yttrium by animals 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.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data—Yttrium metal**

1. Molecular weight: 88.9
2. Boiling point (760 mm Hg): 2927 C (5300 F)
3. Specific gravity (water = 1): 4.47
4. Vapor density (air = 1 at boiling point of yttrium metal): Not applicable
5. Melting point: 1509 C (2748 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Yttrium nitrate hexahydrate**

1. Molecular weight: 383
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 2.68
4. Vapor density (air = 1 at boiling point of yttrium nitrate hexahydrate): Not applicable
5. Melting point: 100 C (212 F) (loses water)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 142
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Yttrium chloride**

1. Molecular weight: 195.3
2. Boiling point (760 mm Hg): 1510 C (2750 F)
3. Specific gravity (water = 1): 2.67
4. Vapor density (air = 1 at boiling point of yttrium chloride): Not applicable
5. Melting point: 720 C (1328 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 79
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Yttrium oxide**

1. Molecular weight: 225.8
2. Boiling point (760 mm Hg): 4300 C (7772 F)
3. Specific gravity (water = 1): 4.84
4. Vapor density (air = 1 at boiling point of yttrium oxide): Not applicable
5. Melting point: 2416 C (4380 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **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

• **Flammability**

1. Flash point: Not applicable
2. Autoignition temperature: Not applicable
3. Flammable limits in air, % by volume: Not applicable
4. Extinguishant: Not applicable

• **Warning properties**

Yttrium is not known to be an eye irritant.

MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on 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).

• **Method**

Sampling and analyses may be performed by collection on a cellulose membrane filter followed by treatment with nitric and perchloric acids, solution in hydrochloric acid, and analysis with an atomic absorption spectrophotometer. An analytical method for yttrium and compounds is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. How-

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

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use dust- and splash-proof safety goggles to prevent any possibility of eye contact with yttrium nitrate hexahydrate, yttrium chloride, yttrium oxide, or liquids containing these compounds.

- Where there is any possibility that employees' eyes may be exposed to yttrium nitrate hexahydrate, yttrium chloride, yttrium oxide, or liquids containing these compounds, an eye-wash fountain should be provided within the immediate work area for emergency use.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Liberation during purification; and during manufacture of alloys	Local exhaust ventilation; personal protective equipment
Use in manufacture of red phosphorus used in color TV picture tubes; fluorescent and mercury vapor lamps	Local exhaust ventilation; personal protective equipment
Use in manufacture of yttrium-iron-garnet (YIG) and YAG (aluminum) for use as electronic components in telephones, radar and space communications networks; and as simulated diamonds	Local exhaust ventilation; personal protective equipment

Operation

Use in manufacture of ceramics for use in high temperature furnaces and high intensity incandescent lamps

Use in manufacture of refractories for stable, high temperature, high strength composition

Use in manufacture of lasers

Controls

Local exhaust ventilation; personal protective equipment

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EMERGENCY FIRST AID PROCEDURES

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

• Eye Exposure

If yttrium and compounds get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with these chemicals.

• Skin Exposure

If yttrium and compounds get on the skin, wash the contaminated skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing

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

• Swallowing

When yttrium and compounds have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• Rescue

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

SPILL AND DISPOSAL PROCEDURES

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

• If 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.

• Waste disposal method:

Yttrium and compounds may be disposed of in sealed containers in a secured sanitary landfill.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Yttrium as Y," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.
- International Labour Office: *Encyclopedia of Occupational Health and Safety*, McGraw-Hill, New York, 1971.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.

RESPIRATORY PROTECTION FOR YTTRIUM AND COMPOUNDS (AS YTTRIUM)

Condition	Minimum Respiratory Protection* Required Above 1 mg/m ³
Particulate Concentration	
5 mg/m ³ or less	Any dust and mist respirator, except single-use.
10 mg/m ³ or less	Any dust and mist respirator, except single-use or quarter-mask respirator. Any fume respirator or high efficiency particulate filter respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
50 mg/m ³ 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/m ³ 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/m ³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

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