# Occupational Health Guideline for Ozone

## 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.

## SUBSTANCE IDENTIFICATION

- Formula: $O_3$
- Synonyms: None
- Appearance and odor: Colorless gas with a sharp, characteristic odor; it can be smelled at concentrations below the permissible exposure level.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for ozone is 0.1 part of ozone per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 0.2 milligram of ozone per cubic meter of air ($mg/m^3$).

## HEALTH HAZARD INFORMATION

- **Routes of exposure**

Ozone affects the body by being inhaled or by irritating the eyes, nose, and throat.

- **Effects of overexposure**

When a person is exposed to very low concentrations of ozone for even a brief period of time, the person may notice a sharp, irritating odor. As the concentration of ozone increases, the ability to smell it may decrease. Irritation of the eyes, dryness of the nose and throat, and cough may be experienced. If the ozone concentration continues to rise, more severe symptoms may develop. These may include headache, upset stomach, or vomiting, pain or tightness in the chest, shortness of breath or tiredness, which may last for several days to weeks. Finally, with higher levels of exposure, the lungs may be damaged and death may occur.

- **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 ozone.

- **Recommended medical surveillance**

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

*1. Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the heart and lungs should be stressed.

—14" x 17" chest roentgenogram: Ozone may cause lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Ozone is reported to cause decreased pulmonary function. Periodic surveillance is indicated.

*2. Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is considered necessary only when indicated by the results of pulmonary function testing.

- **Summary of toxicology**

Ozone is extremely irritating to the upper and lower respiratory tract. The characteristic odor is readily detectable at low concentrations (0.01 ppm to 0.05 ppm). Ozone produces local irritation of the eyes and mucous membranes and may cause pulmonary edema at high exposure. Systemically, ozone has been reported to mimic the effects of ionizing radiation, and may cause damage to chromosomal structures. A partial tolerance appears to develop with repeated exposures. Although most effects are acute, the possibility of chronic lung impairment should be considered, based upon animal experimentation.

## CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**



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

1. Molecular weight: 48
2. Boiling point (760 mm Hg): −112 C (−169.6 F)
3. Specific gravity (water = 1): Not applicable
4. Vapor density (air = 1 at boiling point of ozone): 1.65
5. Melting point: −192 C (−313 F)
6. Vapor pressure at 20 C (68 F): Not applicable
7. Solubility in water, g/100 g water at 20 C (68 F): 0.00003 (3 ppm)
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**

1. Conditions contributing to instability: Ozone spontaneously decomposes under all ordinary conditions, so that it is not encountered except in the immediate vicinity of where it was formed. The decomposition is speeded by solid surfaces and by many chemical substances.
2. Incompatibilities: Ozone is a powerful oxidizing agent and reacts with all oxidizable materials, both organic and inorganic. Some reaction products are highly explosive.
3. Hazardous decomposition products: None
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: Use large amounts of water spray.

• **Warning properties**

1. Odor Threshold: Both Summer and May report an odor threshold for ozone of 0.1 ppm.
2. Irritation Levels: Grant reports that "at concentrations greater than 1 ppm in air, ozone has been found irritating to the eyes and nose and injurious to the respiratory tract. Concentrations of 2 to 3.7 ppm caused sensation of irritation to normal human eyes within 6 minutes."
3. Evaluation of Warning Properties: Since the odor threshold of ozone is at the permissible exposure limit, it is treated as a material with adequate warning properties.

## 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 of ozone in an impinger containing potassium iodide in sodium hydroxide, followed by treatment with phosphoric-sulfamic acid reagent, and spectrophotometric analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure ozone may be used. An analytical method for ozone is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

## RESPIRATORS

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

## COMMON OPERATIONS AND CONTROLS

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

| Operation | Controls |
|---|---|
| Liberation during welding operations with inert gas-shielded arc welding devices | Local exhaust ventilation; canister respirator; shielding (to block rays) |
| Liberation during welding operations with argon-shielded, bare-wire arc welding (especially stainless steel, aluminum, and aluminum alloy containing silicon) | Large-volume local exhaust; general dilution ventilation; direct fresh air supply; shielding (to block rays) |
| Liberation during arc welding operations in confined spaces | Direct fresh air supply |
| Liberation during production of ozone | Process enclosure; local exhaust ventilation |

| Operation | Controls |
|---|---|
| Liberation during oxidizing process of fine organic chemicals production (primarily ozolaic acid) | Process enclosure; local exhaust ventilation |
| Liberation during operations involving high-intensity ultraviolet light (plasma torch operations, glass blowing, hot metal operations, photoengraving operations, and use of mercury vapor lamps, direct copying machines, and projecting equipment) | Process enclosure; local exhaust ventilation; general dilution ventilation |
| Liberation during operations involving high-voltage electrical equipment (spectrographic and fluorometric apparatus, electroplating operations, high-volt linear accelerators, and electrostatic precipitators) | Local exhaust ventilation |
| Liberation during operations involving ozonizing process in treatment of water, industrial waste, and sewage; during air purification | Local exhaust ventilation; process enclosure; respiratory protective equipment |
| Liberation during drilling, cutting, and welding operations utilizing laser radiation | Local exhaust or general dilution ventilation |
| Liberaton during bleaching operations (textiles, paper, pulp, waxes, starch, sugar, teflon, and synthetic fibers); during refining of mineral oils and their derivatives; during processing of perfumes, vanilin, amd camphor; during aging and drying operations (wood, wines, whiskies, varnishes, and printing inks) | Process enclosure; local exhaust ventilation |
| Liberation during food preserving operations for mold and bacteria control in food storage and deodorization | Exhaust ventilation |

## 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 ozone gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as possible.

- **Breathing**

If a person breathes in large amounts of ozone, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. When breathing is difficult, properly trained personnel may assist the affected person by administering 100% oxygen. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **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.

## LEAK PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of leaks until cleanup has been completed.
- If ozone is leaked, the following steps should be taken:

1. Ventilate area of leak to disperse gas.
2. Stop flow of gas.

## REFERENCES


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## RESPIRATORY PROTECTION FOR OZONE

| Condition | Minimum Respiratory Protection* Required Above 0.1 ppm |
|---|---|
| Vapor Concentration | |
| 1 ppm or less | Any chemical cartridge respirator with a cartridge(s) containing non-oxidizable sorbents and providing protection against ozone.<br><br>Any supplied-air respirator.<br><br>Any self-contained breathing apparatus. |
| 5 ppm or less | A chemical cartridge respirator with a full facepiece and a cartridge(s) containing non-oxidizable sorbents and providing protection against ozone.<br><br>A gas mask with a chin-style or a front- or back-mounted canister containing non-oxidizable sorbents and providing protection against ozone.<br><br>Any supplied-air respirator with a full facepiece, helmet, or hood.<br><br>Any self-contained breathing apparatus with a full facepiece. |
| 10 ppm 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 10 ppm or entry and escape from unknown concentrations | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.<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 containing non-oxidizable sorbents and providing protection against ozone.<br><br>Any escape self-contained breathing apparatus. |

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