Ozone is a very reactive form of oxygen gas. Ozone has three atoms of oxygen (O₃) while normal oxygen has two atoms (O₂). Ozone is created naturally in the atmosphere from the action of solar ultraviolet radiation on normal oxygen, and also when lightning (high voltage) discharges occur. Ozone decays to normal oxygen within about half an hour after forming, but within this time frame it reacts readily with nearby molecules to form various oxides. At concentrations below about 1 part per million (ppm), ozone has a pleasant and characteristic odor, described as the “charged” odor of the air following a thunderstorm. Concentrations above 2 ppm have a very pungent, chlorine-like odor. The typical level of ozone in the atmosphere at sea level is about 0.05 ppm.

Hazards
In the upper atmosphere, ozone plays an essential role by absorbing radiation that would be injurious to life on earth. At ground level, however, ozone can become an irritating pollutant. Concentrations just over 1 ppm can cause headaches, decreased pulse rate and blood pressure, lacrimation, dermatitis, and irritation of the eye, nose and respiratory system. Increasing concentrations cause increasing severity of symptoms, ultimately resulting in pulmonary edema and chronic respiratory disease. Unfortunately, people who suffer from asthma, respiratory allergies, or chemical sensitivity can experience symptoms at much lower concentrations than other people can.

Exposure Pathways
The primary route of exposure is inhalation, although skin exposure to ozone may rarely result in dermatitis. The California Occupational Safety and Health administration (Cal-OSHA) permissible exposure limit (PEL) for ozone is 0.1 ppm. This is a time-weighted average over an 8-hour workday, which means the average concentration over the workday should not exceed 0.1ppm. This PEL is 50 times lower than the “immediately dangerous to life or health” level of 5 ppm for ozone set by the National Institute for Occupational Safety and Health (NIOSH).

Sources of Ozone in the Workplace
Laser printers, copy machines, and plain-paper fax machines can all generate small amounts of ozone if high voltage corona wires are used as part of the image fusing operation.
Manufacturers state that ozone emissions from these machines are still well below the OSHA PEL concentrations. Measurements of ozone emissions from laser printers, copy machines, and plain-paper fax machines on campus have confirmed these claims. Most of the better machines have filters to trap and decay any generated ozone, but these filters need to be maintained and cleaned periodically to remain effective. Newer machines are increasingly using a different fusing technology that produces no ozone.

**Recommended Protection**

Although measurements indicate that ozone concentrations from these machines are below regulatory limits, these low levels may be irritating to sensitive people. Departments must carefully plan the location of laser printers, copy machines, and plain paper fax machines to minimize the potential for irritation. In general, these machines should be located so that:

- They are at least 3 feet from the breathing zone of the closest person,
- The fan discharge ports are not directed towards employees,
- Ventilation is adequate around the machine and,
- Multiple printers or copiers are not concentrated in one area unless there are ventilation and temperature controls appropriate for the number of machines.

Additionally, departments should:

- Avoid the simultaneous operation of multiple machines in a given area and,
- Diligently follow the manufacturer’s recommendations for maintenance and replacement of the ozone filters. This may require a service contract for copiers since their filters are not user replaceable.

**Contact**

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**More information**