E. L. Foust Co., Inc.

The E.L. Foust Co., Inc. does NOT manufacture or distribute ion generators for several reasons. Those reasons may be found in the following paragraphs.

An article in the November 2000 issue of Today's A/C & Refrigeration News, titled "Due Diligence Urged When Looking for Solutions To Your Indoor Air Quality Concerns" written by Tom Griffin, O.M.E., S.E., C.I.E. addresses issues with ion generators and other Electronic Air Cleaners.

"Some of these units use high-voltage currents and produce ozone. Ozone, or tri-atomic oxygen, is a potent lung irritant and exposure to elevated levels is a contributor to the exacerbation of lung disease; it is especially dangerous for persons with asthma and other chronic lung diseased, children and the elderly. Residential indoor ozone is produced directly by ozone generators (see Federal Trade Commission Report), and indirectly by ion generators and some other electronic air cleaners. There is no difference, despite some manufacturers claims, between outdoor ozone and ozone produced by these devices (The American Lung Association: Residential Air Cleaning Devices: Types, Effectiveness and Health Impact, January 1997). Current evidence of the health effects of ozone suggests that there is no "safe" threshold concentration for the onset of health responses due to exposure above background ozone concentrations (Burnett, et al., 1994; U.S. EPA CASAC letter, 1995). Also, simultaneous exposure to ozone and other compounds may produce additive or synergistic effects. In addition, persons with asthma have increased susceptibility to ozone and exposure to low concentrations results in increased symptoms, medications use and hospitalization.....ozone generators, negative ion generators, and certain other electronic air cleaners that are not listed By the FDA, or cannot otherwise prove that their ozone emission levels are lower than 0.05 ppm, may produce levels of ozone recognized as unsafe for humans and are not recommended for use in occupied spaces because of the risk of ozone generation. For similar reasons, the American Lung Association does not suggest the use of these products. Ozone generating devices are illegal to produce in some countries such as Canada."

The following information is taken directly from "Residential Air-Cleaning Devices; A Summary of available Information", A publication put out by the US Environmental Protection Agency (EPA), Feb. 1990.

Ion generators use static chargers to remove particles from indoor air. These devices come in portable units only. They act by charging PARTICLES in a room, so they are ATTRACTED TO WALLS, FLOORS, TABLE TOPS, DRAPERIES, OCCUPANTS, etc. In some cases, these devices contain a collector to attract the charged particles back to the unit.

Another consideration is whether some units will produce new pollutants or re-disperse old ones. The potential for ion generators and electronic air cleaners to PRODUCE OZONE, a lung irritant, may be of concern.

Another factor with respect to ion generators, particularly those that do not trap some of the charged particles is the effect of particle charging on DEPOSITION IN THE RESPIRATORY TRACT. Experiments have shown a linear increase in particle deposition with charge; therefore, the use of ion generators may not reduce the dose of particles to the lung.

Ion generators are generally designed not to remove particles from the air but to deposit them on surfaces around the room. This results in soiling of walls and other surfaces, especially if the particles charged by the apparatus are not collected on a filter.

You can find a more in-depth analysis of air cleaners in the EPA document "Residential Air-Cleaning Devices: A Summary of Available Information. For this document and other EPA indoor air publications, contact:

US Environmental Protection Agency
Public Information Center
Mail Code PM-211B
401 M St., SW
Washington, DC 20460

http://www.epa.gov/ebtpages/air.html
http://www.epa.gov/iaq/pubs/ozonegen.html

Ozone Generators that are Sold as Air Cleaners:

An Assessment of Effectiveness and Health Consequences

Introduction and Purpose

Ozone generators that are sold as air cleaners intentionally produce the gas ozone. Often the vendors of ozone generators make statements and distribute material that lead the public to believe that these devices are always safe and effective in controlling indoor air pollution. For almost a century, health professionals have refuted these claims (Sawyer, et. al 1913; Salls, 1927; Boeniger, 1995; American Lung Association, 1997; Al-Ahmady, 1997). The purpose of this document is to provide accurate information regarding the use of ozone-generating devices in indoor occupied spaces. This information is based on the most credible scientific evidence currently available.

Some vendors suggest that these devices have been approved by the federal government for use in occupied spaces. To the contrary, **NO** agency of the federal government has approved these devices for use in occupied spaces. Because of these claims, and because ozone can cause health problems at high concentrations, several federal government agencies have worked in consultation with the U.S. Environmental Protection Agency to produce this public information document.

What is Ozone?

Ozone is a molecule composed of three atoms of oxygen. Two atoms of oxygen form the basic oxygen molecule--the oxygen we breathe that is essential to life. The third oxygen atom can detach from the ozone molecule, and re-attach to molecules of other substances, thereby altering their chemical composition. It is this ability to react with other substances that forms the basis of manufacturers' claims.

How is Ozone Harmful?

The same chemical properties that allow high concentrations of ozone to react with organic

material outside the body give it the ability to react with similar organic material that makes up the body, and potentially cause harmful health consequences. When inhaled, ozone can damage the lungs. Relatively low amounts can cause chest pain, coughing, shortness of breath, and, throat irritation. Ozone may also worsen chronic respiratory diseases such as asthma and compromise the ability of the body to fight respiratory infections. People vary widely in their susceptibility to ozone. Healthy people, as well as those with respiratory difficulty, can experience breathing problems when exposed to ozone. Exercise during exposure to ozone causes a greater amount of ozone to be inhaled, and increases the risk of harmful respiratory effects. Recovery from the harmful effects can occur following short-term exposure to low levels of ozone, but health effects may become more damaging and recovery less certain at higher levels or from longer exposures (US EPA, 1996a, 1996b).

Manufacturers and vendors of ozone devices often use misleading terms to describe ozone. Terms such as "energized oxygen" or "pure air" suggest that ozone is a healthy kind of oxygen. Ozone is a toxic gas with vastly different chemical and toxicological properties from oxygen. Several federal agencies have established health standards or recommendations to limit human exposure to ozone. These exposure limits are summarized in Table 1.

Table 1. Ozone Heath Effects and Standards

Health Effects	Risk Factors	Health Standards*
Potential risk of experiencing: Decreases in lung function Aggravation of asthma Throat irritation and cough Chest pain and shortness of breath Inflammation of lung tissue Higher susceptibility	**Factors expected to increase risk and severity of health effects are:** Increase in ozone air concentration Greater duration of exposure for some health effects Activities that raise the breathing rate (e.g., exercise) Certain pre-existing	The **Food and Drug Administration** (FDA) requires ozone output of indoor medical devices to be no more than 0.05 ppm. The **Occupational Safety and Health Administration** (OSHA) requires that workers not be exposed to an average concentration of more than 0.10 ppm for 8 hours. The **National Institute of Occupational Safety and Health** (NIOSH) recommends an upper limit of 0.10 ppm, not to be exceeded at any time. The **Environmental Protection Agency** (EPA)’s National Ambient Air Quality

to respiratory infection	lung diseases (e.g., asthma)	Standard for ozone is a maximum 8 hour average outdoor concentration of 0.08 ppm.
(* ppm = parts per million)		

Is There Such a Thing as "Good Ozone" and "Bad Ozone"?

The phrase "good up high - bad nearby" has been used by the U.S. Environmental Protection Agency (EPA) to make the distinction between ozone in the upper and lower atmosphere. Ozone in the upper atmosphere--referred to as "stratospheric ozone"--helps filter out damaging ultraviolet radiation from the sun. Though ozone in the stratosphere is protective, ozone in the atmosphere - which is the air we breathe - can be harmful to the respiratory system. Harmful levels of ozone can be produced by the interaction of sunlight with certain chemicals emitted to the environment (e.g., automobile emissions and chemical emissions of industrial plants). These harmful concentrations of ozone in the atmosphere are often accompanied by high concentrations of other pollutants, including nitrogen dioxide, fine particles, and hydrocarbons. ***Whether pure or mixed with other chemicals, ozone can be harmful to health.***

Are Ozone Generators Effective in Controlling Indoor Air Pollution?

Available scientific evidence shows that at concentrations that do not exceed public health standards, ozone has little potential to remove indoor air contaminants.
Some manufacturers or vendors suggest that ozone will render almost every chemical contaminant harmless by producing a chemical reaction whose only by-products are carbon dioxide, oxygen and water. This is misleading.

- First, a review of scientific research shows that, for many of the chemicals commonly found in indoor environments, the reaction process with ozone may take months or years (Boeniger, 1995). For all practical purposes, ozone does not react at all with such chemicals. And contrary to specific claims by some vendors, ozone generators are not effective in removing carbon monoxide (Salls, 1927; Shaughnessy et al., 1994) or formaldehyde (Esswein and Boeniger, 1994).

- Second, for many of the chemicals with which ozone does readily react, the reaction can form a variety of harmful or irritating by-products (Weschler et al., 1992a, 1992b, 1996; Zhang and Lioy, 1994). For example, in a laboratory experiment that mixed ozone with chemicals from new carpet, ozone reduced many of these chemicals, including those which can produce new carpet odor. However, in the process, the reaction produced a variety of aldehydes, and the total concentration of organic chemicals in the air increased rather than decreased after the introduction of ozone (Weschler, et. al., 1992b). In addition to aldehydes, ozone may also increase indoor concentrations of formic acid (Zhang and Lioy, 1994), both of which can irritate the lungs if produced in sufficient amounts. Some of the potential by-products produced by ozone's reactions with other chemicals are themselves very reactive and capable of producing irritating and corrosive by-products (Weschler and Shields, 1996, 1997a, 1997b). Given the complexity of the chemical reactions that occur, additional research is needed to more completely understand the complex interactions of indoor chemicals in the presence of ozone.

- Third, ozone does not remove particles (e.g., dust and pollen) from the air, including the particles that cause most allergies. However, some ozone generators are manufactured with an "ion generator" or "ionizer" in the same unit. An ionizer is a device that disperses negatively (and/or positively) charged ions into the air. These ions attach to particles in the air giving them a negative (or positive) charge so that the particles may attach to nearby surfaces such as walls or furniture, or attach to one another and settle out of the air. In recent experiments, ionizers were found to be less effective in removing particles of dust, tobacco smoke, pollen or fungal spores than either high efficiency particle filters or electrostatic precipitators. (Shaughnessy et al., 1994; Pierce, et al., 1996). However, it is apparent from other experiments that the effectiveness of particle air cleaners, including electrostatic precipitators, ion generators, or pleated filters varies widely (U.S. EPA, 1995).

There is evidence to show that at concentrations that do not exceed public health standards, ozone is not effective at removing many odor-causing chemicals.

- In an experiment designed to produce formaldehyde concentrations representative of an embalming studio, where formaldehyde is the main odor producer, ozone showed no effect in reducing formaldehyde concentration (Esswein and Boeniger, 1994). Other experiments suggest that body odor may be masked by the smell of ozone but is not removed by ozone (Witheridge and Yaglou, 1939). Ozone is not considered useful for odor removal in building ventilation systems (ASHRAE, 1989).

- While there are few scientific studies to support the claim that ozone effectively removes odors, it is plausible that some odorous chemicals will react with ozone. For example, in some experiments, ozone appeared to react readily with certain chemicals, including some chemicals that contribute to the smell of new carpet (Weschler, 1992b; Zhang and Lioy, 1994). Ozone is also believed to react with acrolein, one of the many odorous and irritating chemicals found in

secondhand tobacco smoke (US EPA, 1995).

If used at concentrations that do not exceed public health standards, ozone applied to indoor air does not effectively remove viruses, bacteria, mold, or other biological pollutants.

- Some data suggest that low levels of ozone may reduce airborne concentrations and inhibit the growth of some biological organisms while ozone is present, but ozone concentrations would have to be 5 - 10 times higher than public health standards allow before the ozone could decontaminate the air sufficiently to prevent survival and regeneration of the organisms once the ozone is removed (Dyas, et al.,1983; Foarde et al., 1997).

- Even at high concentrations, ozone may have no effect on biological contaminants embedded in porous material such as duct lining or ceiling tiles (Foarde et al, 1997). In other words, ozone produced by ozone generators may inhibit the growth of some biological agents while it is present, but it is unlikely to fully decontaminate the air unless concentrations are high enough to be a health concern if people are present. Even with high levels of ozone, contaminants embedded in porous material may not be affected at all.

If I Follow Manufacturers' Directions, Can I be Harmed?

Results of some controlled studies show that concentrations of ozone considerably higher than these standards are possible even when a user follows the manufacturer's operating instructions. There are many brands and models of ozone generators on the market. They vary in the amount of ozone they can produce. In many circumstances, the use of an ozone generator may not result in ozone concentrations that exceed public health standards. But many factors affect the indoor concentration of ozone so that under some conditions ozone concentrations may exceed public health standards.

- In one study (Shaughnessy and Oatman, 1991), a large ozone generator recommended by the manufacturer for spaces "up to 3,000 square feet," was placed in a 350 square foot room and run at a high setting. The ozone in the room quickly reached concentrations that were exceptionally high--0.50 to 0.80 ppm which is 5-10 times higher than public health limits (see Table 1).

- In an EPA study, several different devices were placed in a home environment, in various rooms, with doors alternately opened and closed, and with the central ventilation system fan alternately turned on and off. The results showed that some ozone generators, when run at a high setting with interior doors closed, would frequently produce concentrations of 0.20 - 0.30 ppm. A powerful unit set on high with the interior doors opened achieved values of 0.12 to 0.20 ppm in adjacent rooms. When units were not run on high, and interior doors were open, concentrations

generally did not exceed public health standards (US EPA, 1995).

- The concentrations reported above were adjusted to exclude that portion of the ozone concentration brought in from the outdoors. Indoor concentrations of ozone brought in from outside are typically 0.01- 0.02 ppm, but could be as high as 0.03 - 0.05 ppm (Hayes, 1991; U.S. EPA, 1996b; Weschler et al., 1989, 1996; Zhang and Lioy; 1994). *If the outdoor portion of ozone were included in the indoor concentrations reported above, the concentrations inside would have been correspondingly higher, increasing the risk of excessive ozone exposure*.

- None of the studies reported above involved the simultaneous use of more than one device. The simultaneous use of multiple devices increases the total ozone output and therefore greatly increases the risk of excessive ozone exposure.

Why is it Difficult to Control Ozone Exposure with an Ozone Generator?

The actual concentration of ozone produced by an ozone generator depends on many factors. Concentrations will be higher if a more powerful device or more than one device is used, if a device is placed in a small space rather than a large space, if interior doors are closed rather than open and, if the room has fewer rather than more materials and furnishings that adsorb or react with ozone and, provided that outdoor concentrations of ozone are low, if there is less rather than more outdoor air ventilation.

The proximity of a person to the ozone generating device can also affect one’s exposure. The concentration is highest at the point where the ozone exits from the device, and generally decreases as one moves further away.

Manufacturers and vendors advise users to size the device properly to the space or spaces in which it is used. Unfortunately, some manufacturers’ recommendations about appropriate sizes for particular spaces have not been sufficiently precise to guarantee that ozone concentrations will not exceed public health limits. Further, some literature distributed by vendors suggests that users err on the side of operating a more powerful machine than would normally be appropriate for the intended space, the rationale being that the user may move in the future, or may want to use the machine in a larger space later on. Using a more powerful machine increases the risk of excessive ozone exposure.

Ozone generators typically provide a control setting by which the ozone output can be adjusted. The ozone output of these devices is usually **not** proportional to the control setting. That is, a setting at medium does not necessarily generate an ozone level that is halfway between the levels at low and high. The relationship between the control setting and the output varies considerably among devices, although most appear to elevate the ozone output

much more than one would expect as the control setting is increased from low to high. In experiments to date, the high setting in some devices generated 10 times the level obtained at the medium setting (US EPA, 1995). Manufacturer's instructions on some devices link the control setting to room size and thus indicate what setting is appropriate for different room sizes. However, room size is only one factor affecting ozone levels in the room.

In addition to adjusting the control setting to the size of the room, users have sometimes been advised to lower the ozone setting if they can smell the ozone. Unfortunately, the ability to detect ozone by smell varies considerably from person to person, and one's ability to smell ozone rapidly deteriorates in the presence of ozone. While the smell of ozone may indicate that the concentration is too high, lack of odor does not guarantee that levels are safe.

At least one manufacturer is offering units with an ozone sensor that turns the ozone generator on and off with the intent of maintaining ozone concentrations in the space below health standards. EPA is currently evaluating the effectiveness and reliability of these sensors, and plans to conduct further research to improve society's understanding of ozone chemistry indoors. EPA will report its findings as the results of this research become available.

Can Ozone be Used in Unoccupied Spaces?

Ozone has been extensively used for water purification, but ozone chemistry in water is not the same as ozone chemistry in air. High concentrations of ozone in air, **when people are not present**, are sometimes used to help decontaminate an unoccupied space from certain chemical or biological contaminants or odors (e.g., fire restoration). However, little is known about the chemical by-products left behind by these processes (Dunston and Spivak, 1997). While high concentrations of ozone in air may sometimes be appropriate in these circumstances, ***conditions should be sufficiently controlled to insure that no person or pet becomes exposed***. Ozone can adversely affect indoor plants, and damage materials such as rubber, electrical wire coatings, and fabrics and art work containing susceptible dyes and pigments (U.S. EPA, 1996a).

Conclusions

Whether in its pure form or mixed with other chemicals, ozone can be harmful to health.

> When inhaled, ozone can damage the lungs. Relatively low amounts of ozone can cause chest pain, coughing, shortness of breath and throat irritation. It may also worsen chronic respiratory diseases such as asthma as well as compromise the

ability of the body to fight respiratory infections.

Some studies show that ozone concentrations produced by ozone generators can exceed health standards even when one follows manufacturer's instructions.

Many factors affect ozone concentrations including the amount of ozone produced by the machine(s), the size of the indoor space, the amount of material in the room with which ozone reacts, the outdoor ozone concentration, and the amount of ventilation. These factors make it difficult to control the ozone concentration in all circumstances.

Available scientific evidence shows that, at concentrations that do not exceed public health standards, ozone is generally ineffective in controlling indoor air pollution.

The concentration of ozone would have to greatly exceed health standards to be effective in removing most indoor air contaminants. In the process of reacting with chemicals indoors, ozone can produce other chemicals that themselves can be irritating and corrosive.

Recommendation

The public is advised to use proven methods of controlling indoor air pollution. These methods include eliminating or controlling pollutant sources, increasing outdoor air ventilation, and using proven methods of air cleaning.

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