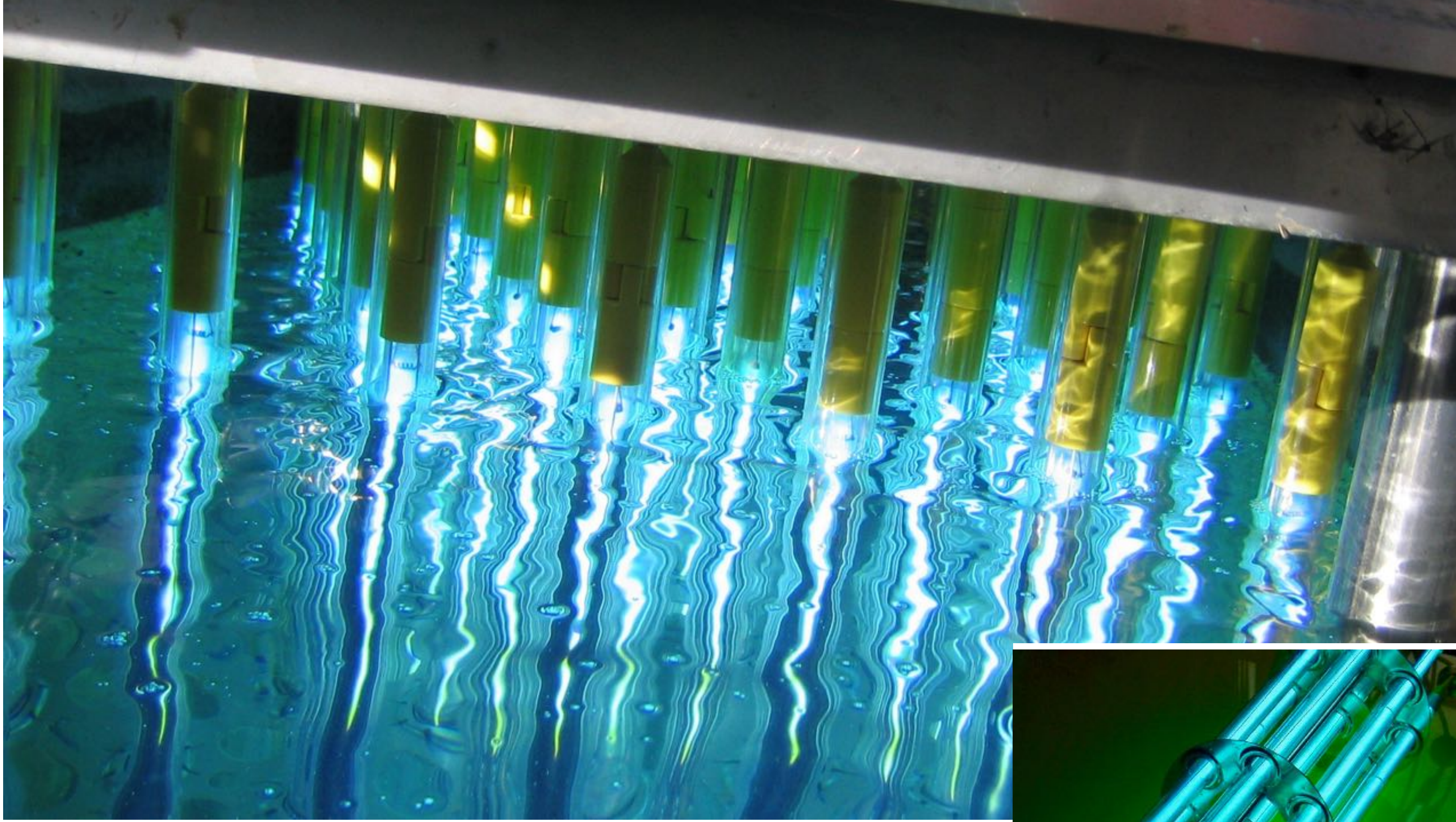


ULTRAVIOLET LAMPS

Low-pressure 254 nanometer style

Technical Data, Real World Use and Video Links

Low-pressure mercury vapor UV lamps produce UVC radiation with > 90% of energy generated at 254 nanometers (nm).

GE **Type 219** fused quartz is used to ensure the lamp's emission will be in the 254 nm wavelength.

Light is broken into colors and measured by wavelength in nm. 254 nm is proven to disable microorganism reproduction.

"L" or "Low ozone" generating lamps transmit up to 90% of their energy at the 254 nm wavelength and integrate doped fused quartz that blocks the emission of 185 nm energy.

Features – key issues

- Low pressure style (gas pressure)
- High purity **Type 219** tubing
- > 90% end of lamp life
- > 90% in 254 nm UVC range
- 12,000 hour minimum (8,760 is year)
- Manufactured in USA / Germany
- Requires replacement
- Range from 5 watts to 1,000 watts

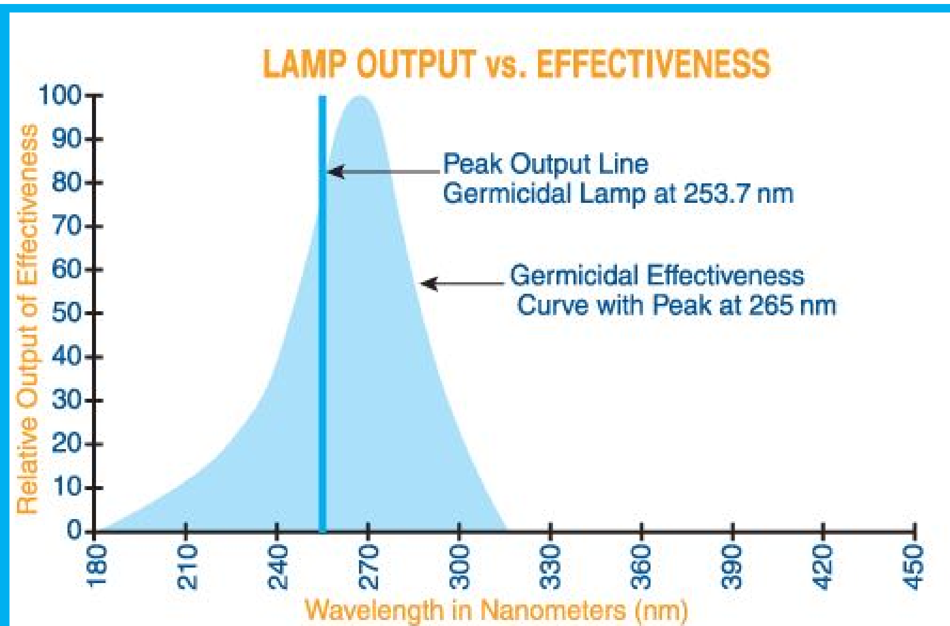
UVSYSCO
LIGHT TECHNOLOGIES

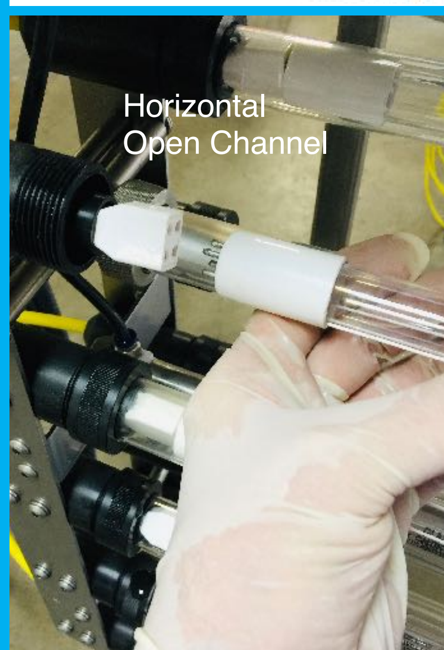
Applications, Installations and Operation

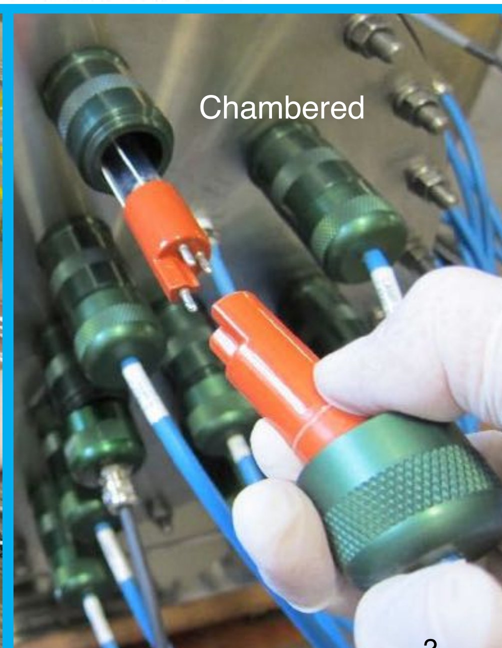
UV disinfection targets genetic material, nucleic acid (DNA). As UVC light penetrates the cell and is absorbed by the DNA/RNA, a rearrangement of the genetic information occurs, interfering with the cell's ability to reproduce. A cell that cannot reproduce is considered dead because it is unable to multiply.

The maximum absorption of UV light by the nucleic acid, DNA, occurs at 260 nm. The “nature” of fused quartz material is that it allows 254 nm, which happens to be very close to the optimized wavelength for maximum absorption by nucleic acids.

UV lamps look like fluorescent lamps, but the tube contains no fluorescent phosphor. The tube is made of fused quartz which allow the 253.7 nm to pass out of the lamp unmodified. UV germicidal lamps still produce a small amount of visible light due to other wavelength bands.







Need to Know - *Engineers & Operators*

Engineers and System Designers

UV lamps were introduced by Westinghouse in the early 1960s. Early uses were for industrial and commercial applications. The first lamp was considered a low-pressure standard output. In 2000, the industry saw the addition of low-pressure high output and low-pressure amalgam lamps.

Our Experience

- Westinghouse (1965)
- Light Sources. USA (1983 – current)
- Heraeus. Germany (2003 – current)

The UV lamp section of any equipment specification is important. It can also be a source of confusion. Decades of UV disinfection system information is no longer relevant or accurate. Engineers are challenged by having to compare different Manufacturer's lamp types and their corresponding systems / orientations. This is not a 1 lamp to 1 lamp ratio and writing a competitive specification can be difficult.

UV lamps convert watts to UVC watts. The standard low-pressure lamp is the most efficient at 40% and the low-pressure amalgam lamps convert 35%. Higher conversion percentages are typically not seen in test results. A 320-watt amalgam lamp = 110 UVC .

Lamps are warranted for 12,000 hours (min.) and most should still produce 90% of the output at end of lamp life (**EOLL**). Higher **EOLL** outputs are typically not seen in test results.

Our Experience

The multi-level "step lamp" was first patented by Ultra Dynamics Corporation in 1992.

Operation and Ownership

Lamps need to be changed after a year (8,760 to 16,000 hours) and system orientation will dictate how difficult and the duration of lamp replacement.

Lamp costs and availability will vary so it is important to understand the replacement costs and access to spare components (ballasts, quartz, sensors). This includes needing multiple sources for UV lamps.

As lamps age, mercury embeds itself, discoloration occurs and lamps produce less UVC. Internal coatings help prevent this "solarization".

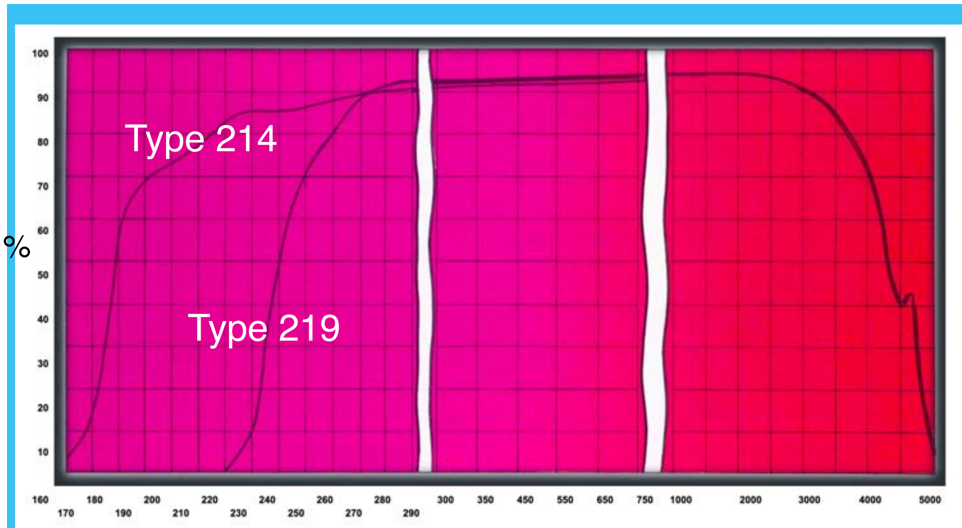
Transmission Range – *Ultraviolet Lamps*

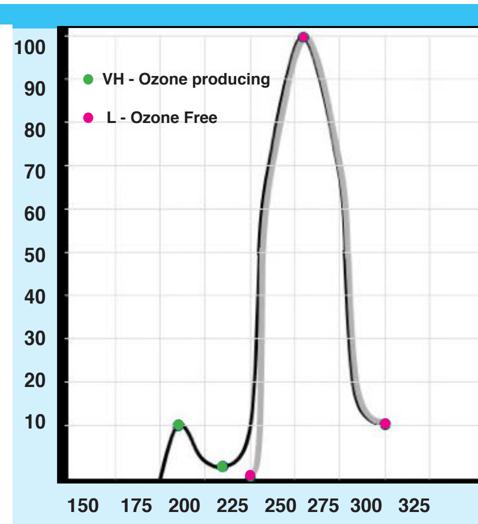
UV lamp tubing (**Type 219**), which contains approximately 100 ppm Ti, has a UV cutoff at ~ 230 nm for a 1 mm thick sample. This blocks lower ozone wavelengths.

Quartz sleeves that protect the lamps - **Type 214** have a UV cutoff at < 160 nm, small absorption at 245 nm and no appreciable absorption due to hydroxyl ions.

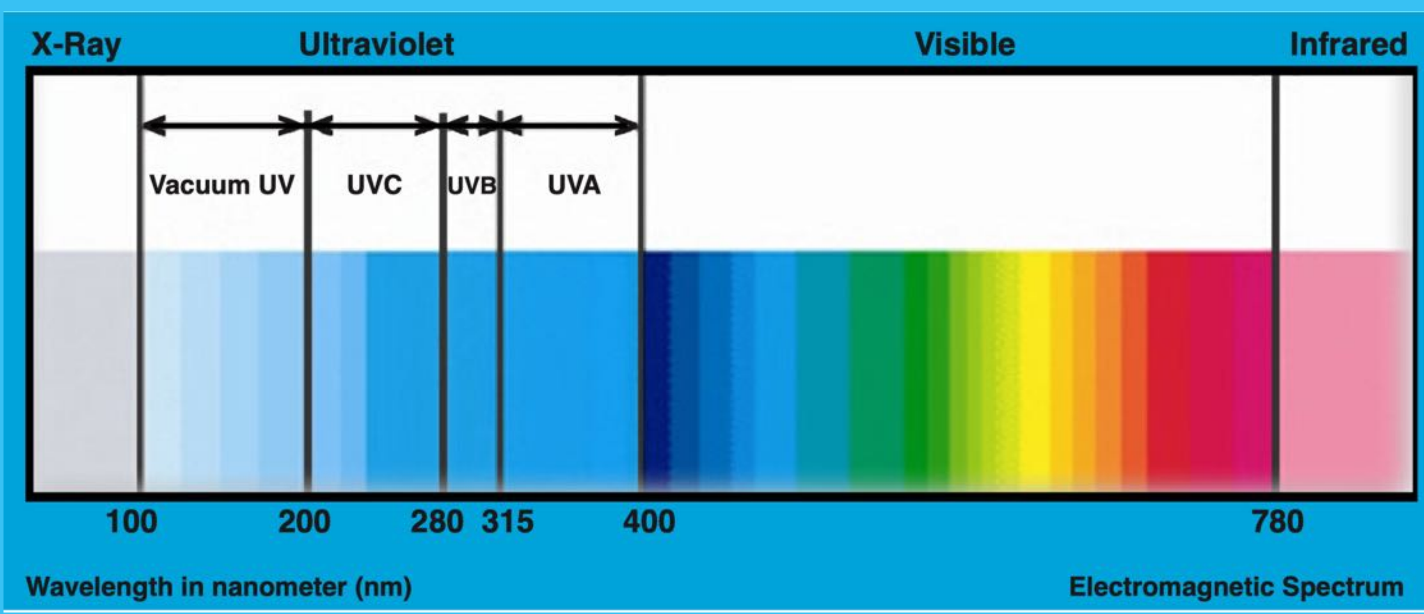
The quartz chart details the percent transmittance for **Types 214** and **219** fused quartz, including the losses caused by reflections at both surfaces. The other graphic displays the electromagnetic spectrum and shows the Ultraviolet range.

%





Wavelength in Nanometers (nm)



Material Properties - ***History***

”Low Pressure” is a term associated with the lamp’s internal gas pressure in the manufacturing process (**medium pressure** UV lamp technology is different).

Low-pressure standard output lamps have been used for 50 years. While lower in wattage, these lamps are still used because they offer the best efficiency and UV conversion. 40% of the energy is converted to UV. Downside is that they are susceptible to heat which causes lower UV output. In 1980s, they were used in the first wastewater systems and known as G36T5L and G64T5L style (30” – 40 watt and 60” – 80 watt).

Introduced in 2000, **low-pressure high output** (800 mA) and then **low-pressure high intensity** (**amalgam**) gained attention. These more powerful lamps, allowed for smaller footprints, fewer lamps and increased flows. Improvements were allowed with a shift from magnetic to more sophisticated and efficient electronic ballasts.

Mercury vapor germicidal lamps operate at a very low gas pressure. They produce light when an electric current passes between two electrodes (also called cathodes) in a tube filled with low-pressure mercury vapor and inert gases. The electric current excites the mercury vapor in the tube, generating radiant energy, primarily in the ultraviolet (UV) range.

Typical mercury content ranges from 10 to 30 mg per lamp. This mercury is in both liquid and solid forms as well as being combined with other metals (amalgam).

Characteristic	Low Pressure	Low Pressure Amalgam	Medium Pressure
Emission	254 nm	254 nm	Polymchromatic
Gas vapor pressure	1 - 10 mbar	1 - 10 mbar	1 - 5 bar
Hg Operating Temp.	30 - 50 C	30 - 50 C	600 - 800 C
Arc length	6" to 60"	14" to 80"	14" to 30"
Germicidal efficency	35-40%	30-35%	12-16%
Typical wattages	5 to 155 watts	150 - 1000 watts	2,000 - 4,000 watts
Power density (W/cm)	0.3 - 0.5	1.0 - 2.0	50 - 250
Influence of temperature	High	Low	Negligible

Material Properties – *Composition*

The concentration of mercury atoms in the discharge (the mercury vapor pressure) must be controlled in order to optimize the conversion of electrical power to UV radiation.

Typical mercury content ranges from 10 to 30 mg per lamp. This mercury is in both liquid and solid forms as well as being combined with other metals (amalgam).

Lamps produce maximum output when the mercury vapor pressure is approx. 6 microns (.006 Torr). At low vapor pressures the lamp output is low since there are not enough available atoms. At high vapor pressures, the majority of available atoms are in the ground state (not excited) and can absorb as many 254 nm photons as produced.

A way to control mercury vapor pressure is by incorporate an amalgam. Amalgams are alloys of mercury and other metals such as indium, lead or zinc and can be formulated to act as a reservoirs for mercury Amalgams release only enough mercury to hold mercury vapor pressure.

All are essentially high vacuum lamps, filled to a very low pressure with one or more inert gases. The gas performs several key functions in lamp operation:

- Reduces the required starting voltage for the discharge, such that it can be easily struck on simple ballasts.
- Different gases have different effects - for instance with Argon the starting is very easy but with Krypton it is somewhat more difficult.
- It acts as a buffer gas to protect the electrodes, reducing the impact of ions which bombard them during the anode phase, and thereby reducing erosion of the electrode by sputtering and evaporation.
- This very greatly extends lamp life, the gases of higher molecular weight offering the greatest degree of protection of the electrodes.
- It is adjusted to provide the right balance between rate of ionization of mercury atoms (required to maintain the current flow through the lamp) and the excitation of mercury atoms so as to optimize the UV generation efficiency.
- Its presence randomizes the direction of motion of free elections in the discharge to control their mean free path length and velocity.

Depending on the lamp design and its intended application, the gas employed may be Argon, Neon or Xenon and/or a mixture of at least two of these components. In addition to the tubing and gas mixtures, UV lamps also integrate some other components. These include; ceramic bases, Teflon coated wiring, filaments and specialty emission coatings.

Additional Information - *Safety*

UVC light is dangerous. Eye protection is mandatory. Exposure will cause issues like welder's arc. Prolonged exposure can cause blindness. Symptoms manifest once eyes are closed. Extreme pain will require visit to hospital.

UV lamps contain a small amount of mercury (< 30 mg), are fragile and can break. The most important issue is safety. Lamps become razor sharp when broken. In the event of breakage, follow instructions on how to handle mercury.

Skin oils may harm lamp. Wear rubber or lint free gloves. When servicing older equipment, we recommend gloves, protective sleeves and eye protection. If dirty, wipe with lint free cloth and denatured alcohol.

Lamps should be recycled. Lamps can be recycled during hazardous waste days (like fluorescent).

Visit www.lamprecycle.com Manufacturers recycle if returned to their factory.

Typical standards: CE EN 166 & ANSI Z87+ Compliance Test as well as CE EN 166 Clause 7.2.2 Impact Test.

Mission: Data sheet information has been provided to help understand Ultraviolet Lamps and their use in various UV systems. Subject to changes. Suggestions welcome, please contact us.