

Safety In Portable UV Curing Equipment

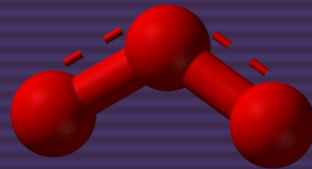
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Main Dangers of UV Curing Equipment

* Ultraviolet Radiation



* Ozone



* Lamp Handling



* Poor Judgment

A Note About Safety

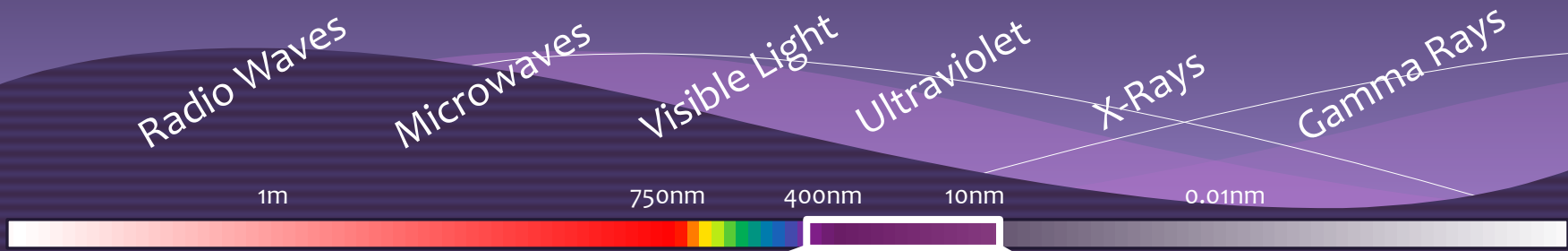
- * The first and most important thing to remember about safety is *common sense*.
- * UV technology has some level of inherent danger to it, like operating a chainsaw.

* **PAY ATTENTION**

* **&**

* **BE CAREFUL**

EM Radiation



400nm

315nm

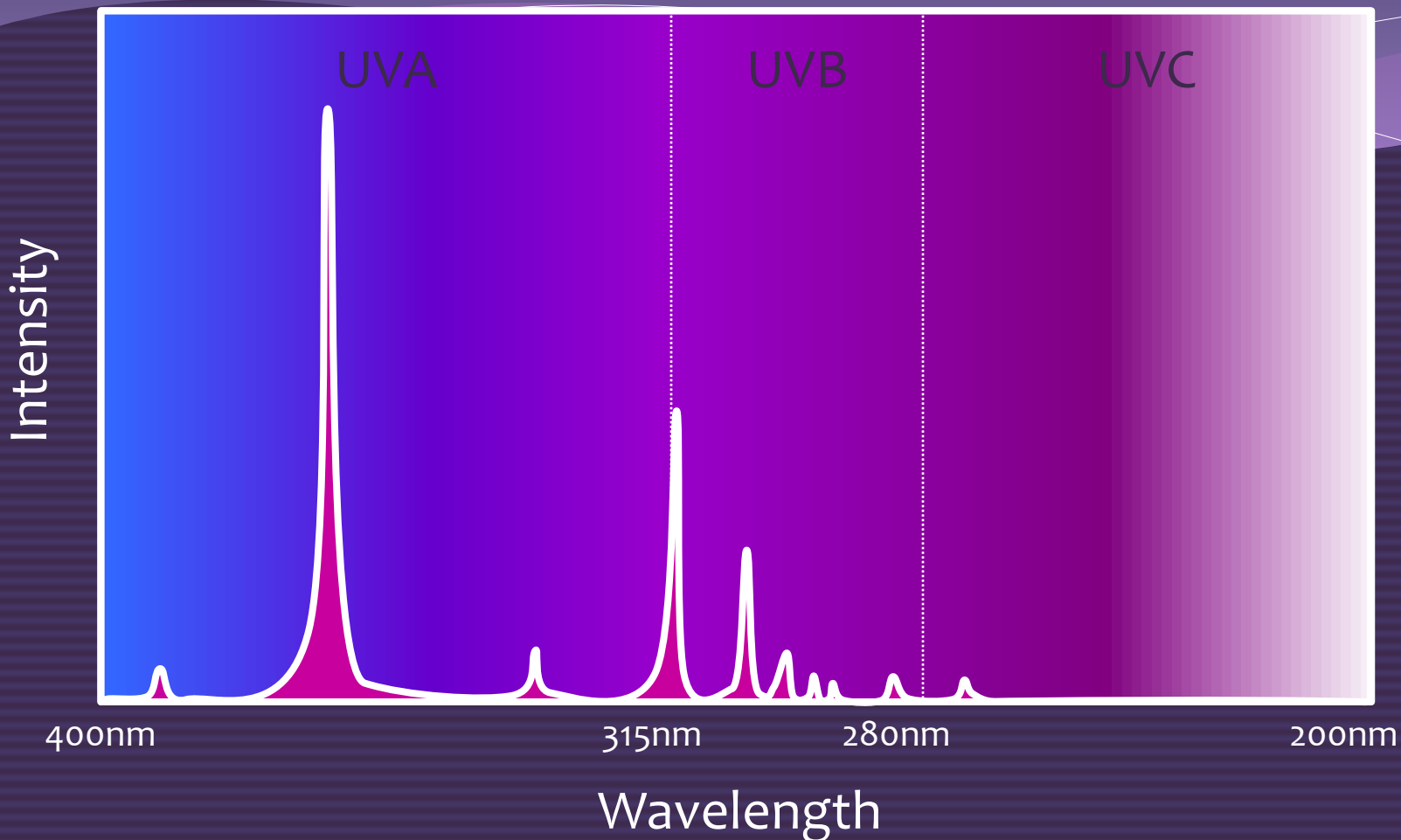
280nm

100nm

10nm

Lamp Output

Typical Spectral Output of continuous wave Xenon-Mercury HID Lamp



Dangers of UV Exposure

- * Photokeratitis (Arc eye) and Photoconjunctivitis may result from overexposure to UV radiation.
- * These conditions can be very painful and lead to temporary blindness while the eye heals itself.
- * Onset may be delayed by several hours after exposure.
- * Long term exposure to UVA may contribute to the formation of cataracts.
- * Certain prescription drugs can render people more sensitive to UV exposure.

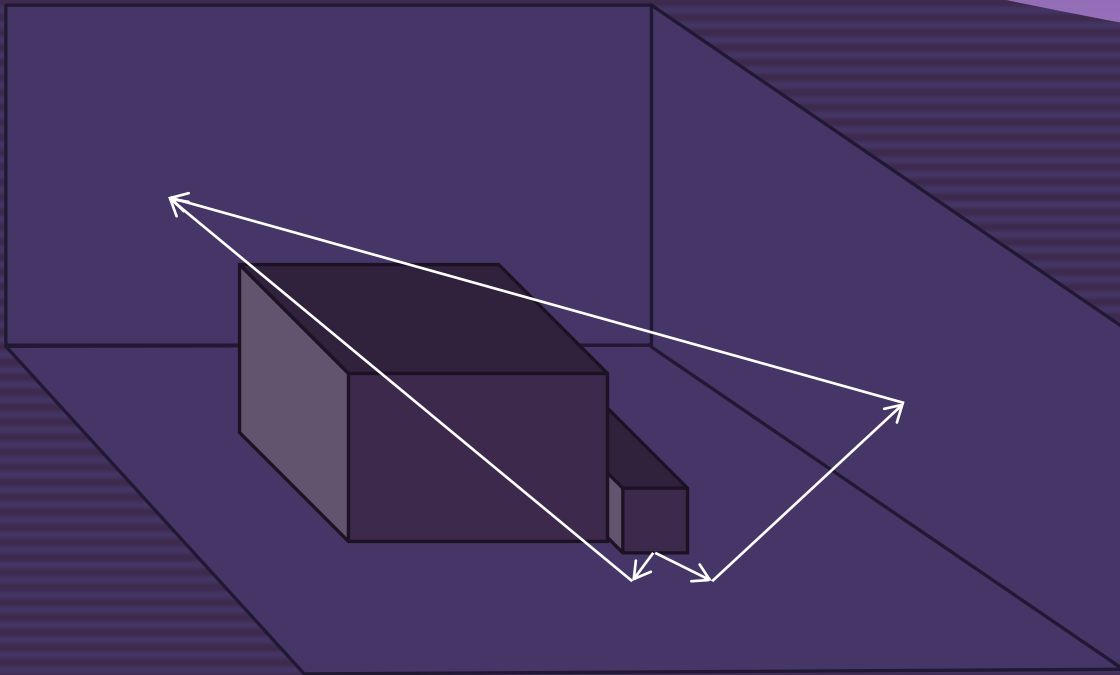
Dangers of UV Exposure

- * Each UV band penetrates the skin differently.
- * UVA will penetrate the deepest, and overexposure can lead to cosmetic damage (aging effects)
- * UVC won't penetrate deeply past layers of dead skin, but can still cause damage to the top layer of live cells.
- * Each band can cause skin cancer.

Dangers of UV Exposure

	UVA	UVB	UVC
Eye – Cornea	-	Photokeratitis (Arc Eye)	Photokeratitis (Arc Eye)
Eye – Aqueous	Absorption	Absorption	-
Eye – Lens	Cataracts	Cataracts	-
Skin	Skin Cancer, Aging Effects	Sunburn, Skin Cancer	Skin Cancer

UV Reflection



Secondary reflections off of walls can result in 30x unwanted UV exposure when next to walls, making side guards on glasses important.

Similarly, exposure is higher when on approach to walls.

Remember: You can't see ultraviolet, and it does reflect!

Shielding



A shield extending $\frac{1}{4}$ " off the floor reduces UV leakage by 90%

Traps ozone, so that it's destroyed by the high temperature around the lamp.

Properly designed equipment should have some form of shield to prevent a direct line of sight to the lamp.

Skin Protection



- ✦ Full skin protection is recommended around portable UV curing equipment.
- ✦ Full Face shields will protect both the eyes and the skin of the face.
- ✦ Plain cotton clothing will typically reduce the UVB and UVC exposure by 80+%, but won't block UVA very well.
- ✦ Dyed fabrics will usually block UV better, but the only way to be certain about protection is dedicated UV safety gear.
- ✦ Many companies sell UV stabilized Tyvek suits for use in UV curing. They block 98% of UV.

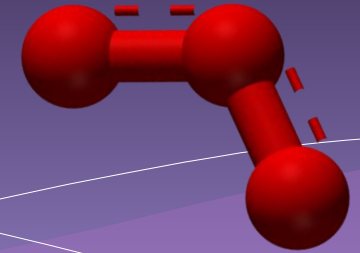


Eye Protection



- * Any eyewear must protect from the sides: even indirect UV exposure is hazardous.
- * Anyone in the area being cured must be wearing protection. A user standing along side the machine may receive more exposure than the operator!
- * Eye protection must have side guards, to provide full protection.
- * ANSI Z87.1 and EN 166:2002 set standards for eye protection, including UV safety equipment. To be certain of the effectiveness of eye protection, it should reference ANSI Z87.1 or EN 166:2002

What Is Ozone?



- * Ozone is a colorless gas in normal concentrations, a very strong oxidizer, and a pollutant at ground level.
- * After a thunderstorm, the sharp ‘fresh’ smell produced by the lightning is ozone.
- * Ozone is found in the upper atmosphere to block out UV (The Ozone layer)
- * It is detectable by most people in concentrations as low as 10ppb.

Ozone

- * Some people can be adversely effected (respiratory problems) by ozone in concentrations down to 40ppb.
- * Exposure to concentrations above 105ppb for 8 hours is considered “unhealthy” by the EPA. Above 125ppb is considered “very unhealthy”.
- * OSHA regulations limit exposure to 100ppb averaged over 8 hours.
- * The National Institute for Occupational Safety and Health has established concentrations of 500ppb as Immediately Dangerous to Life and Health.

Health Effects of Ozone

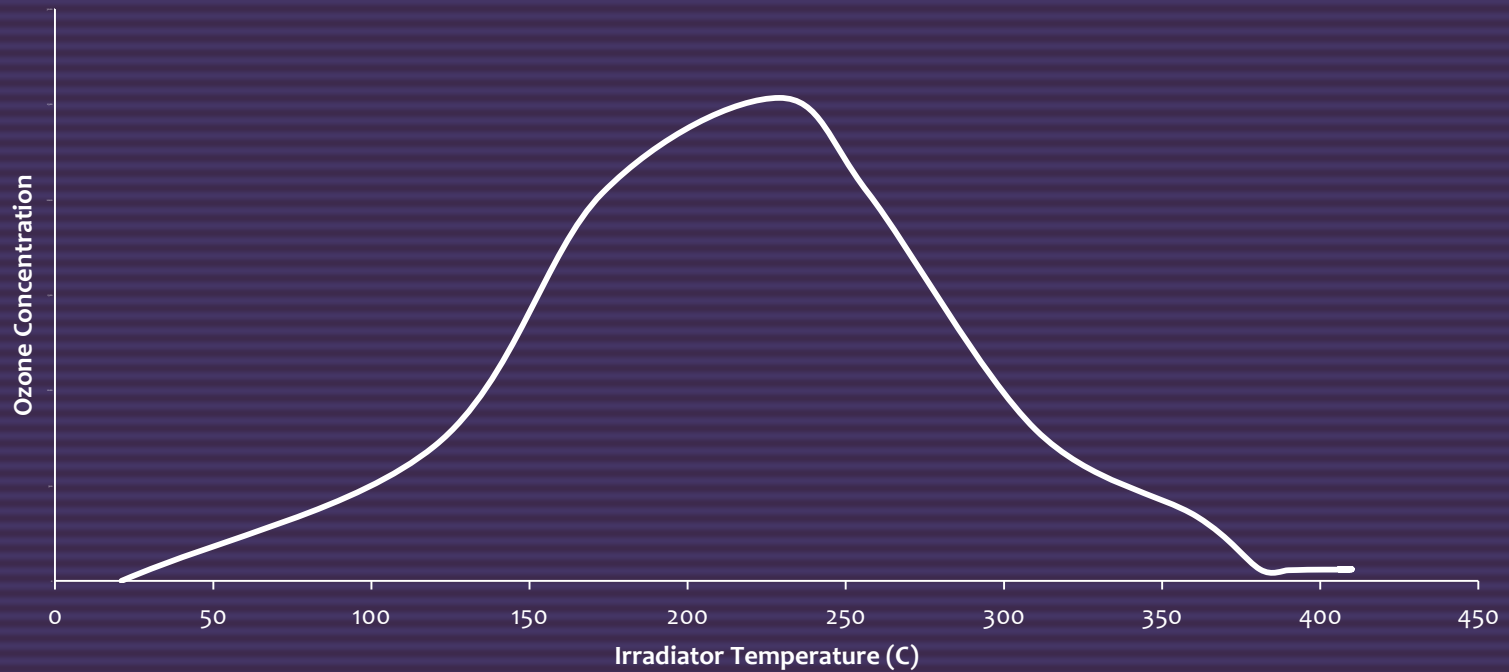
- * Ozone exposure has been linked to many cardiopulmonary problems, including asthma, bronchitis, heart attacks and premature death.
- * Ozone can cause eye irritation.
- * Ozone can convert cholesterol in the blood into plaque, hardening arteries and causing heart disease.

Ozone Sources

- * UV sources will typically produce some quantity of ozone, as UV light interacts with oxygen in the air.
- * Stationary, hot lamps will generate the least ozone due to thermal decomposition. Immediately after the ozone is created by the UV radiation, it is destroyed by the extremely high temperature of the lamp.
- * Shielding around the lamp may help to contain some ozone, so that the hot lamp can destroy it.

Ozone Production

Ozone Concentration Around Irradiator During Warm-Up



Safety Equipment for Ozone

- ✧ Various companies sell portable ozone detectors.
- ✧ Versions exist which tell you the level of ozone, and less expensive versions just light up to tell you when you're over the safe limit.
- ✧ Cards or badges, which change color depending on the ozone concentration also exist, but are typically only good for a single use.



Mercury

- * Lamps are dosed with an element like mercury to generate UV.
- * Mercury is toxic.
- * UV Lamps typically contain up to 250mg of mercury.
- * Mercury poisoning causes damage to the central nervous system, kidneys, and many other organs.

Lamps

- * Never let your skin touch a lamp: Oil from hands will damage a lamp, eventually causing it to burst. If accidentally handled by bare skin, wipe the lamp off with high percentage isopropyl alcohol.
- * Lamps **must** be disposed of properly.
- * Regulations can vary from state to state. Check before throwing out a lamp.
- * If no proper disposal site is available, the EPA recommends double bagging the lamp before disposal.

What To Do If A Lamp Breaks

- ✦ Evacuate the area and allow it to air out before cleanup.
- ✦ Cleanup as recommended by the EPA:
 - ✦ ***Do not vacuum.***
 - ✦ ***Do not use a broom.***
 - ✦ ***Be mindful of treading mercury around with your shoes.***
 - ✦ Wearing rubber or latex gloves, carefully pick up any large pieces of glass. Fold them into paper towels, and seal in a plastic zip lock bag.
 - ✦ If the lamp contains a large mercury dose, there may be drops of mercury on the floor. Using a piece of cardboard, *carefully* sweep the spill into a single location. Mercury droplets can slide very far on smooth surfaces.
 - ✦ To collect the mercury, you can use an eyedropper (If there is a single large droplet), or duct tape to pick up tiny droplets.
 - ✦ Seal the mercury in a plastic bag.

Safety Regulations

- * Ozone and mercury are regulated, but as of today, in the US, UV radiation exposure is not controlled by OSHA.
- * Given the sudden rise in site-applied UV coatings, this may change in the near future.
- * UV curing equipment is typically classified IEC12198-1 Category 2, due to the high amount of UV emitted, which indicates that special measures must be taken during use, and protective equipment must be worn.

HID Ultraviolet, LLC



Range Finder

Instant On, Instant Off

Very low dose mercury (25mg vs 250mg)

Material choice to minimize secondary reflections

Light Shield to prevent radiation leakage
and encourage ozone decomposition

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A Note About Safety, Again

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Conclusion

- * UV Radiation
 - * Wear eye and skin protective equipment at all times.
- * Ozone
 - * Be careful in closed, unventilated areas.
- * Mercury
 - * Handle and dispose of lamps safely.