MOBILE UV—Market Review and Safety Guidelines

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Figure 1—Examples of UV coated products.

Ultraviolet (UV) technology has been utilized by manufacturing for the past several decades, with applications ranging from wood flooring to the graphic ink marketplace. Many other markets utilize UV coatings to increase production, reduce energy costs and floor space, and provide an overall cleaner solution. In 2009 alone, 105,000 tons of UV coatings were shipped in the United States, with many times that amount worldwide. *Figure* 1 provides some examples of UV applications.

For the past several years, UV lighting technology has become mobile and new field-applied markets have evolved—commonly referred to as Mobile UV. This article will review the

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Figure 2—(a) Coated floor and (b) closeup of UV coated floor/clearcoat.

Figure 3—Safety signage (courtesy of Jelight).

Mobile UV marketplace, provide specific examples, and examine the safety guidelines that should be followed when utilizing this technology.

Mobile UV applications have evolved and include such areas as bathtub refinishing, countertop and tile refinishing, flooring (including concrete, VCT, and wood), as well as touch-up applications for furniture, in-line manufacturing repair, composites, etc. (*Figure* 2). UV is also used for coatings in the anti-graffiti, marine, architectural, and autobody/headlight refinishing segments.

ECONOMICS OF UV

One of the primary reasons that UV technology is being utilized in mobile applications relates to economics. A benefit of Mobile UV is the elimination of wasted application time. UV-curable coatings typically cure in less than a few seconds. This dramatically reduces the amount of time spent on-site at a customer's location, providing for significant manpower cost savings and a dramatic reduction in downtime for the customer. It also typically eliminates return visits to the customer's location—again, reducing wasted hours and allowing the applicator to be much more productive.

SAFETY ENHANCEMENTS

UV equipment manufacturers have worked diligently with end-use customers to improve the safety aspects of their hand-held and floor curing units.

With each UV light it ships, Jelight always includes a complete safety package, which includes UV face-shield protection, UV-resistant clothing, UV-resistant gloves, and a large "Caution" sign (*Figure* 3). In addition, Jelight's UV bulbs are doped quartz, which reduces ozone output by a minimum of 95%.

HIDUV has equipped their hand-held devices with distance sensors, which provide feedback to the operator about the unit's distance from the curing surface (*Figure* 4). This helps to keep focus for optimal curing speed. If the machine detects that it is not being operated next to a surface, the lamp is automatically shut off. A complete review of the functionality of the unit and the safety features is very important and should be undertaken when the purchase of UV equipment is being considered. In addition, since these UV applications are mobile, the UV-curing equipment must be easily transportable and continue to function correctly (*Figure* 5).

COATINGS TECHNOLOGY

While UV coatings technologies have continued to improve over the years, there has been a migration of this technology to meet the needs of the mobile type markets. The coatings formulators have listened and have delivered coatings to meet specific application and specification requirements. One example is the bathtub refinishing marketplace. This market is served by a variety of different solvent and catalyzed coating solutions—all of which have positives and negatives. Specific coating and application requirements were defined by key leaders in the bathtub refinishing market and, in partnership, a unique UV solution was developed. Based on these defined requirements, a two-component catalyzed UV color solution was developed, delivering the benefits, as noted in *Table* 1.

Figure 4—Mako T with range finder, emergency shut off, and detachable handle (courtesy of HIDUV).

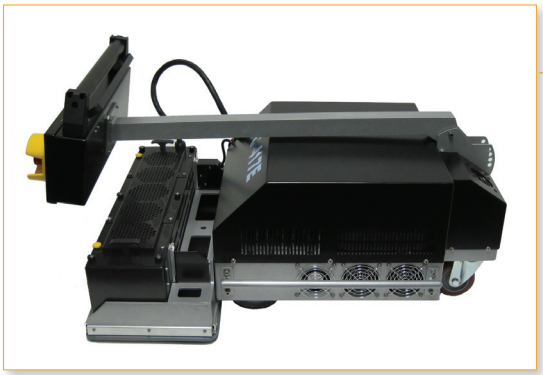

Figure 5—Transportable JFC-417E UV-curing equipment (courtesy of Jelight).

Table 1—Coating Requirements Met with 2K Catalyzed UV Color Solution

Application	Benefit
Multiple colors	Flexible offering to meet customers' needs
One-coat application	No intercoat adhesion issues
Fully opaque	No multiple coats required
Quick cure	Tub is operational within hours

SUSTAINABILITY ('GREEN') REQUIREMENTS

UV formulations are 100% solids, and have no volatile organic compounds (VOC), no hazardous air pollutants (HAP), and no n-vinyl pyrollidines (NVP). They do not contain solvents and are shipped with minimal issues. Typically, safer work conditions apply to the use of UV-cured coatings. Also, minimal reporting to local environmental entities will occur with the use of this technology.

SAFETY, SAFETY, SAFETY

UV curing should be regarded as a technology that requires respectful caution. The main concerns include ultraviolet radiation, ozone, lamp handling, and user judgment.

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 and BE CAREFUL.* Safety is key with any technology. Persistent and consistent awareness to safety is critical to business success. Outlined below are the important safety considerations to be understood.

Ultraviolet Radiation

ElectroMagnetic Radiation provides a graphical review of the broad span of the EM Radiation spectrum (*Figures* 6–7). Ultraviolet radiation includes the following spectrums: UVA, UVB, UVC, and UVV.

Dangers of UV Exposure (*Table* 2): UV coatings technology has been utilized safely in fixed manufacturing for decades, in applications ranging from digital printing to wood flooring. Proper safety training programs have been implemented along with continued improvement and updates to ensure that safety is number one. However, it is important to understand that 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. In addition, long-term exposure to UVA may contribute to the formation of cataracts.

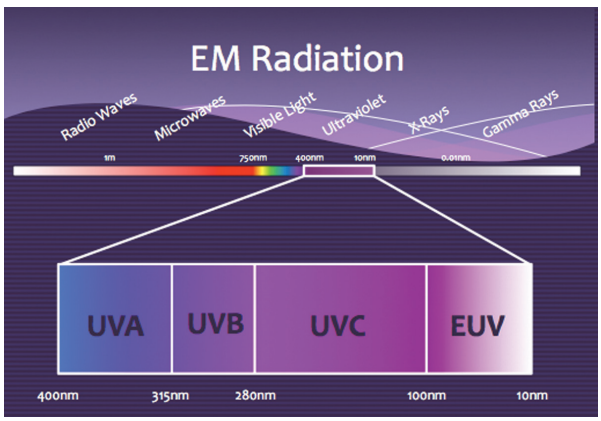

Figure 6—EM radiation overview.

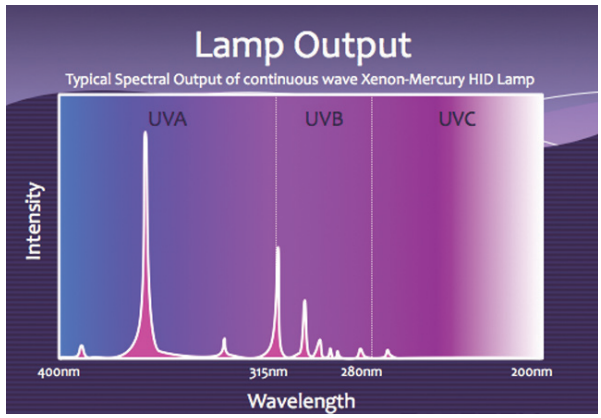

Figure 7—Lamp output example.

Table 2—UV Exposure Issues

	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

Certain prescription drugs can render people more sensitive to UV exposure.

Each UV band penetrates the skin differently. UVA will penetrate the deepest, and overexposure can lead to cosmetic damage (aging effects). UVC will not 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 without proper protection.

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. It is important to keep in mind that you cannot see ultraviolet, and it does reflect (*Figure* 8).

Skin Protection: Outlined below are requirements when curing with Mobile UV devices:

- 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 will not 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 (*Figure* 9).

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 (*Figure* 10). A user standing alongside the machine may receive more exposure than the operator. Eye protection must have a full face shield to ensure adequate protection from UV; safety glasses are not recommended. 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 these standards.

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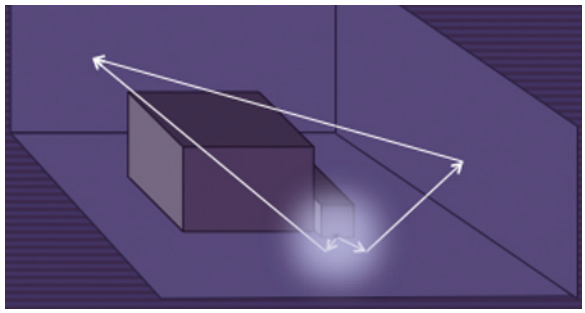

Figure 8—Graphical representation of reflected UV energy.

Figure 9—UV-stabilized Tyvek suits for full protection.

Figure 10—Full face shields are recommended to ensure adequate protection; safety glasses are not recommended.

Figure 11— Ozone sensor.

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 10 ppb.

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

Adverse 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. UV sources will typically produce some quantity of ozone, as UV light interacts with oxygen in the air. Some manufacturers, such as Jelight, utilized doped Mercury lamps, which can reduce ozone emissions up to 95%. 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.

Safety Equipment for Ozone: There are various companies that sell portable ozone detectors. There are versions that can indicate the level of ozone, and other less expensive versions that light up to alert the user that the ozone is 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 (*Figure* 11).

Safety Regulations: Ozone and mercury are regulated, but—as of today—in the United States, 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.

Handling UV Lamps

Proper handling of UV lamps is critical. Never let skin touch a lamp since oil from hands will damage a lamp, eventually causing it to burst. If the lamp is accidentally handled by bare skin, wipe the lamp off with a high percentage isopropyl alcohol. If the lamp requires cleaning, denatured alcohol and lint-free cloths should be used. Moreover, lamps must be disposed of properly. It is important to review local regulations since they 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.

User Judgment

The first and most important thing to remember about safety is common sense. As mentioned previously, UV technology has some level of inherent danger to it. Therefore, it is critical that workers using UV technology pay attention and use care at all times.

CONCLUSIONS

Used for decades in fixed manufacturing, UV coating technology is now expanding into the Mobile UV marketplace. The combination of UV coatings, Mobile UV curing equipment, and proper safety training has opened many new opportunities to the marketplace. Used properly, this Mobile UV technology offers greater economic savings, reduced overall manpower, and represents a true "green" solution. CT

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