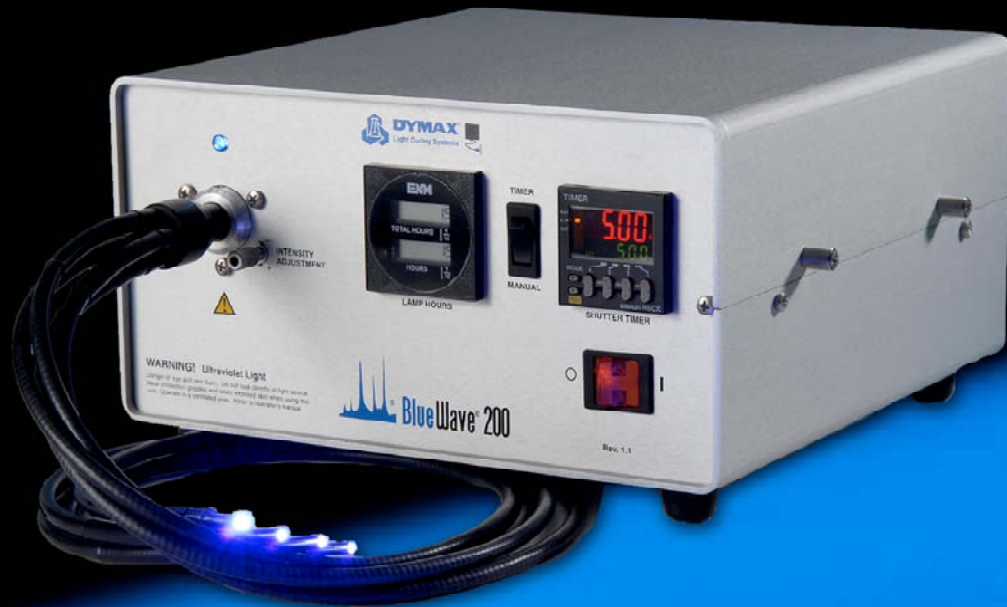


Guide to Selecting and Using **DYMAX**
UV LIGHT
CURING SYSTEMS



Making Manufacturers More Efficient

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BENEFITS of UV LIGHT CURING

Light-curing technology has allowed manufacturers to lower processing costs, produce higher quality products, and eliminate the use of harmful chemicals from the workplace for over 30 years. Although each manufacturer will perceive and realize a unique set of benefits from light curing, there are a few features/benefits that DYMAX customers consistently cite:

Light-Curing Features	Light-Curing Benefits
Fast Light Cures "On Demand"	■ <i>Reduced labor costs</i>
	■ <i>Simplified automation</i>
	■ <i>Easier alignment of parts before cure</i>
	■ <i>Improved in-line inspection</i>
	■ <i>Reduced work-in-progress</i>
	■ <i>Shorter cycle times</i>
	■ <i>Shorter lead times to customers</i>
	■ <i>Fewer assembly stations required</i>
	■ <i>No racking during cure</i>
	■ <i>No ovens/heat curing</i>
One Component	■ <i>No mixing</i>
	■ <i>No pot life issues, less waste</i>
	■ <i>Less expensive dispensing</i>
	■ <i>No hazardous waste due to purging/poor mixing</i>
	■ <i>No static mixers</i>
	■ <i>Easier to operate/maintain dispensing systems</i>
Environmentally and Worker Friendly	■ <i>Better work acceptance</i>
	■ <i>No explosion-proof equipment</i>
	■ <i>Fewer health issues</i>
	■ <i>Reduced regulatory costs</i>
	■ <i>Reduced disposal costs</i>

MAKING MANUFACTURERS MORE EFFICIENT

Realizing the tremendous opportunity for cost savings, expanded design capabilities, and environmentally "friendly" bonding and sealing solutions, DYMAX introduced UV light-curable adhesives and coatings to manufacturers in the early 1980's. Since that time the company has specialized in UV light-curing assembly solutions and now offers the broadest range of UV light-curable materials available and a complete line of UV light-curing equipment. Our materials and curing equipment are used in a wide range of medical, electronic, industrial, aerospace, optical, automotive, packaging, and appliance applications. As the

only major manufacturer of both UV light-curable adhesives and UV light-curing equipment, we are acutely aware of the need to match the curing system with the curing chemistry.

Adhesive samples and light-curing equipment trials allow our customers to fully evaluate DYMAX products prior to purchase. In addition, our Applications Engineering Group is available to help recommend a light-curable material, a curing system, and a curing process for your specific application. Whenever possible, DYMAX Applications Engineers will conduct testing on your specific parts. If testing indicates our current line of over 3,000 formulations or complete line of UV light-curing systems are not suitable, we can help you search for a solution for your assembly process.

This ["Guide to Selecting and Using DYMAX UV Light-Curing Systems"](#) will assist you in selecting the best UV light-curing system for your application. It will also help you set up an efficient and controlled UV light-curing process. For more information on DYMAX UV light-curing equipment and adhesives, please contact our Applications Engineers by phone at 860-482-1010 or visit us on the Web at www.dymax.com. Your complete and on-going satisfaction with your DYMAX UV light-curing process is our commitment and our mission.



Visit the DYMAX Web site at www.dymax.com to learn more about our UV light-curing systems and compatible adhesives.

OVERVIEW of UV LIGHT-CURING SYSTEMS

SPOT-LAMP SYSTEMS

DYMAX spot-curing systems provide very high intensity (3,000-8,000 mW/cm² (320-395 nm)) over a small area (typically $\frac{1}{2}$", 5 mm diameter). These intensities usually result in a 0.5-5 second cure time. DYMAX spot-curing systems utilize an integral timed/manual shutter and typically require little external shielding. An intensity adjustment feature aids users in both validating and controlling a UV light-curing process.

Spot lamp systems are ideal for curing small areas quickly and can be easily integrated into an automated assembly process or used as a turnkey bench-top system. Learn more about DYMAX UV spot-curing lamps on pages 8-11.



BlueWave[®] 200 Spot-Curing System with Intensity Adjustment

LIGHT-CURING FLOOD-LAMP SYSTEMS

DYMAX UV light-curing flood-lamp systems offer moderate to high intensity (75-225 mW/cm²) over a large area (5" x 5" or 8" x 8" (127 mm x 127 mm or 203 mm x 203 mm)). These lamps are ideal for curing areas larger than $\frac{1}{2}$ " (12.7 mm) in diameter or curing many small parts simultaneously.

DYMAX UV light-curing flood-lamp systems can be incorporated into conveyors, automated assembly systems, or used as turnkey bench-top units. Learn more about DYMAX UV light-curing flood-lamp systems on pages 12-13 of this guide.



5000-EC Flood Lamp with Light Shield and Shutter

CONVEYORS

DYMAX conveyors incorporate either flood or focused-beam curing systems. The benefits of light-curing conveyors include consistent cure times and the ability to cure larger parts. Another benefit of conveyors is that they completely shield operators from UV light. DYMAX conveyors have 12" wide belts, and can be configured for 6" and 12" width curing. Conveyor speed is tightly controlled and typically ranges from 1-27.5 feet per minute (although faster conveyors are available). DYMAX light-curing conveyors can be outfitted with different types of lamps and up to four lamps on a single conveyor. Learn more about DYMAX UV light-curing conveyors on page 15.



UVCS 12" Wide UV Light-Curing Conveyor with Two DYMAX 5000-EC Flood Lamps

OVERVIEW of UV LIGHT-CURING SYSTEMS

RADIOMETERS

A radiometer is a device that measures the intensity and/or dose associated with light of specified wavelengths. UV light is, by definition, not visible and so a radiometer is required to determine UV intensity. The ACCU-CAL™ 50 radiometer is ideal for measuring the UV intensity of UV spot lamps, flood lamps, and conveyors. This radiometer measures intensity and dose in the UVA (320-395 nm) range. The ability to measure light intensity is useful for three reasons: maintaining a controlled light-curing process, providing a “worker friendly” light-curing process, and measuring light-transmission rates through substrates. Learn more about DYMAX radiometers on page 16 of this guide.



ACCU-CAL™ 50 Radiometer

ADDITIONAL CUSTOM EQUIPMENT

This guide contains the most popular DYMAX UV light-curing systems and radiometers. Additional turnkey equipment and accessories are available including additional conveyors (wider, shorter, faster, or higher clearance), dispensing systems (time/pressure syringe dispensers, and valve/pressure pot systems), dispensing needles, and more.

In some cases, DYMAX will custom design a UV light-curing system to fit your specific needs. Contact DYMAX directly at 860-482-1010 for more information regarding custom equipment or additional equipment not contained in this guide.



30" Wide UV Light-Curing Conveyor

FUNDAMENTALS of UV LIGHT CURING

Developing a successful light-curing process requires knowledge of the following key concepts.

Higher Intensity = Faster Cures – Intensity is the light energy reaching a surface per time and it is often measured in mW/cm². Higher intensity light (of the proper wavelengths) will generally provide faster cure.

Shortwave and Longwave Bulbs – DYMAX UV light-curing systems can be outfitted with either shortwave bulbs (emphasizing UVB and UVC) or longwave bulbs (emphasizing UVA and visible light). Longwave bulbs are recommended for curing most DYMAX (and similar) light-curing materials due to their superior depth of cure and substantial visible-light intensity. The chart at the bottom of this page describes the portion of the electromagnetic spectrum emitted by standard DYMAX longwave bulbs.

Distance and Substrates Affect Intensity – Distance from a light-curing lamp always affects intensity. Intensity decreases with increasing distance from both spot lamps and flood-curing systems, especially spot lamps. Intensity decreases with increasing distance from the focal point for focused-beam systems. Intensity is also reduced when curing through substrates that transmit less than 100% of the light used for curing. Advances in light-curable adhesive technology now allow curing through most translucent substrates, even those that block UV completely.

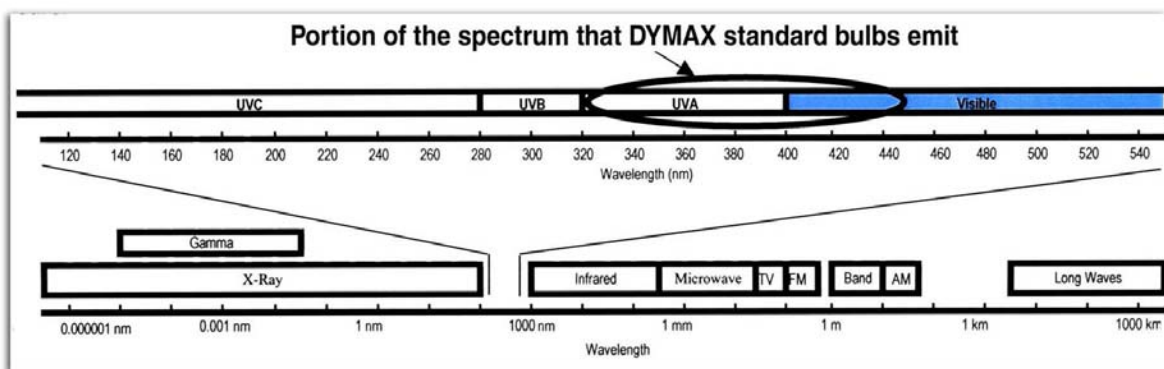
Limited Depth of Cure – Since light-curable materials themselves absorb light, each has a maximum depth of cure. For most DYMAX products, this depth is between ¼" (6.35 mm) and ½" (12.7 mm).

Determining Complete Cure – Changing from a liquid to a solid is a simple definition of cure. A more complete definition is that curing is complete when further light exposure no longer improves product properties. Quantitative testing of cured specimens can be used to determine the minimum exposure time and/or minimum intensity required for complete cure. The graph on page 18 shows how this method could be used in a bonding application.

Shadows – Light-curable materials will not cure unless exposed to light of appropriate wavelength, intensity, and duration. Some DYMAX light-curable materials can be cured with heat in "shadowed" areas.

Oxygen Inhibition – In some cases, UV adhesive surfaces exposed to oxygen during curing may remain tacky after cure. This is caused by oxygen inhibition. Oxygen in the air actually slows the cure at the top-most layer of an air-exposed coating surface. This tackiness does not necessarily indicate incomplete cure and can be observed with some materials, even after complete cure. In general, there are four ways to minimize or eliminate the tackiness associated with oxygen inhibition:

- **Longer and/or Higher Intensity Cure** – In many cases, curing longer or with higher intensity will minimize or eliminate a tacky surface.
- **Use of "Shortwave" Bulb** – Use of a UVB (shortwave) bulb instead of a UVA (longwave) bulb may also help to eliminate surface tack. A UVB bulb may, however, result in a limited depth of cure.
- **Choose an Alternate DYMAX Material** – An alternate formulation may cure "tack free" more readily.
- **Blanket with Inert Gas** – Blanketing exposed resin surfaces with inert gas (like nitrogen or argon) during cure can often eliminate the problem of oxygen inhibition completely.



DESIGNING a UV LIGHT-CURING PROCESS

There are several factors to consider when designing a UV light-curing process.

Intensity – A well-designed UV light-curing process incorporates a curing system with excess intensity. Excess intensity provides both a safety margin and long bulb life. See page 18 "[Setting Up and Monitoring a Light-Curing Process](#)" for specific intensity and safety margin guidelines.

Spectral Output – It is important to match the spectral output of the lamp to the material and application. DYMAX supplies both shortwave bulbs (also called Mercury or "H") and longwave bulbs (also called Metal Halide or "D" bulbs). In general, longwave bulbs emit primarily UVA providing superior depth of cure, while shortwave bulbs emit primarily UVB/UVC providing superior surface cure for coatings and inks. Longwave bulbs are recommended for most applications involving DYMAX materials.

Curing Area – The size of the area to be cured may dictate which type of lamp is appropriate. Spot lamps are typically used to cure areas less than ½" (12.7mm) in diameter. Flood or focused-beam lamps are used when curing large areas (up to 8" x 8" (203.2 mm x 203.2 mm)). Multiple flood lamps or conveyors can be used to cure even larger areas.

Avoid Creating a "Bottleneck" – Ideally, the UV light-curing process is designed to be faster than the limiting or "bottleneck" step in the overall manufacturing process. Dispensing, assembling, testing, or packaging parts while other parts are curing, will maximize efficiency.

Curing Multiple Parts Simultaneously – In some cases, it is more efficient to cure many small parts simultaneously using a flood or conveyor than to cure each part individually. For example, a spot lamp may cure one small part every three seconds (or 20 parts-per-minute) whereas a flood lamp may cure 20 small parts every 15 seconds (or 80 parts-per-minute).

Multiple Cure Stations – On an automated production line where the required cure time exceeds the index/cycle time, multiple cure stations can be used. For example, if a part requires nine seconds

to cure and the index/cycle time is only three seconds, each part can be cured for three seconds beneath three separate lamps. Brief interruptions during cure are acceptable.

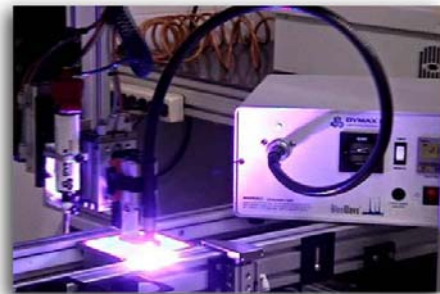
Safety – Proper equipment set-up and operator training are the keys to developing a safe light-curing process. Always follow the operation manual to ensure safe installation. Proper shielding, protective equipment, and eye protection are required to ensure a safe UV light-curing process.

Controls – Unless exposed to light of sufficient wavelength, intensity, and duration, most light-curing materials will remain uncured. To insure a consistent exposure time, timed shutters are standard on spot lamps and available for most flood and focused-beam systems. A digital speed controller on DYMAX conveyors insures consistent exposure times.

Lamp intensity should be regularly monitored with a radiometer. Bulb replacement and/or appropriate lamp maintenance should be conducted when intensity dips below a pre-determined minimum value.

Bulb Life – The cost of replacement parts can be an important consideration when selecting a light-curing system. Generally, low bulb-replacement costs are achieved by selecting a lamp with intensity to spare, thereby extending allowable bulb life.

$$\text{price per bulb} \times \text{frequency} = \text{bulb replacement cost}$$



**DYMAX UV Light-Curing Spot Lamps are
Ideal for Automation!**

UV LIGHT-CURING SPOT-LAMP SYSTEMS

BlueWave® 200 WITH INTENSITY ADJUSTMENT

The BlueWave® 200 UV light-curing spot lamp offers the highest intensity and most user-friendly operation in the industry. The *BlueWave 200* spot lamp primarily emits UVA and blue visible light (300-450 nm) and is designed for UV light-curing of adhesives, coatings, and encapsulants. With over 17 W/cm² in initial bulb UVA curing intensity, 0.5-5 second cures are typical.

Bulbs used in UV light-curing spot lamps degrade with use, emitting less and less intensity (see Chart 1). Prior to production, the intensity adjustment feature aids users in determining an acceptable intensity range. Once in production, this feature can be used to maintain the intensity within the acceptable range.

Intensity Adjustment Options:



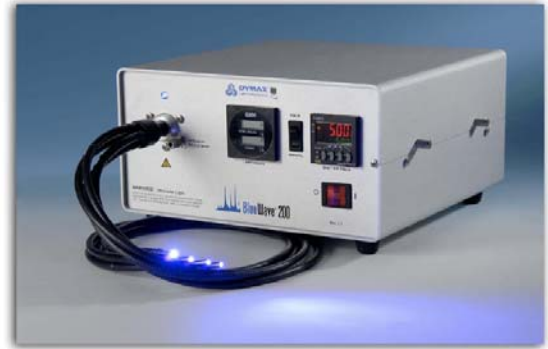
Intensity adjustment knob for fingertip adjustment



Intensity adjustment, with knob removed, performed with adjustment tool

Intensity measurement is easily accomplished with the DYMAX ACCU-CAL™ 50 radiometer. Scheduled intensity measurements taken during the production process will indicate whether additional intensity adjustments are required. This method of measurement provides the most accurate readings as they are taken through the lightguide in the actual production setting. Please refer to page 16 for more information on the ACCU-CAL 50 radiometer.

The *BlueWave 200* contains an integral shutter which can be actuated by a foot pedal or PLC making it ideal for both manual and automated processes. A universal power input provides consistent performance at any voltage (90-264V, 47-63 Hz). For more information on the *BlueWave 200*, please see DYMAX literature #Lit218.



BlueWave® 200 Spot-Curing System with Intensity Adjustment

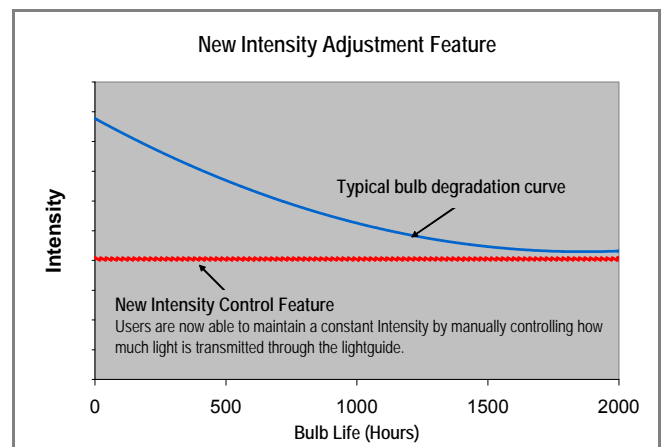
BlueWave® 200 UV Light-Curing Spot Lamp Features

Part Number	38905 (NA version, standard 115V plug) 38605 (International version, no plug)
Peak Intensity	>17,000 ¹ mW/cm ²
Intensity Adjustment	Manual, 1-100%
Lightguides	See Table 1. on page 11
Curing Area	<½" (12.7 mm)
Shutter	Timed and manual modes; foot pedal or PLC controlled
Bulb Warranty	2,000 hours (ignition)
Power Requirements	Auto-switching 90-264V, 47-63 Hz

¹ As measured through a 5-mm liquid lightguide with a DYMAX ACCU-CAL™ 50 radiometer (320-395 nm)

DYMAX also offers a wide range of long-lasting lightguides and the *BlueWave 200's* high intensity makes the lamp ideal for use with multi-pole lightguides (see Table 1. on page 10).

Chart 1.



UV LIGHT-CURING SPOT-LAMP SYSTEMS

DYMAX BLUEWAVE® LED PRIME UVA

The BlueWave® LED Prime UVA high-intensity spot-curing lamp is designed for rapid curing of various coatings as well as adhesive bonding of metal, glass, polycarbonate, PVC, PET, and many other substrates. This simple-to-operate spot lamp emits over 15 W/cm² of UV curing intensity and features an intensity adjustment feature from 0-100%. The *BlueWave LED Prime UVA* is compatible with a wide array of lightguide options (see Table 1 on page 11).

The *BlueWave LED Prime UVA* spot-curing lamp includes an electronic exposure control circuit that can be actuated by foot pedal or PLC. A solid-state power supply ensures consistent operation despite fluctuations in input voltage. Low initial cost, long-lasting lightguides, and up to 50,000-hour LED life makes the *BlueWave LED Prime UVA* an extremely economical spot-curing system. Please refer to DYMAX literature # Lit267 for more information on the *BlueWave LED Prime UVA* spot-curing system.



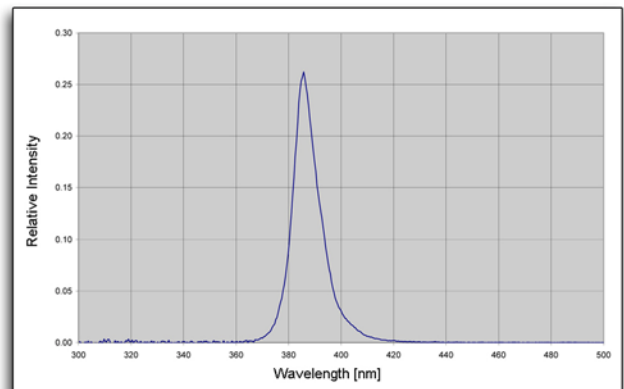
BlueWave® LED Prime UVA Spot-Curing Lamp System

CURING WITH LIGHT EMITTING DIODES (LEDs)

The BlueWave® LED Prime UVA spot-curing lamp generates curing energy using high-intensity LEDs. LEDs offer many advantages over conventional bulbs including constant intensity, no required warm-up time, and a life span of up to 50,000 hours. The relatively narrow frequency band produced by LEDs also generates cooler curing temperatures making this unit ideal for use with thermally sensitive substrates.

BlueWave® LED Prime UVA Spot-Curing Lamp Features	
Part Number	40321 (lightguide #5720 included) 40322 (lightguide not included)
Peak Intensity	>15 ¹ mW/cm ²
Intensity Adjustment	Manual, 0-100%
Lightguides	See Table 1. on page 11
Curing Area	<½" diameter (12.7 mm)
Shutter	Timed and manual modes; foot pedal or PLC controlled
LED Life	Up to 50,000 hours
Power Requirements	Auto-switching, 100-240 VAC, 47-63 Hz

¹ As measured through a 5-mm liquid lightguide with a DYMAX ACCU-CAL™ 50 LED radiometer



BlueWave® LED Prime UVA Spectral Distribution

UV LIGHT-CURING SPOT-LAMP SYSTEMS

DYMAX BLUEWAVE® 75 WITH INTENSITY ADJUSTMENT

The BlueWave® 75 UV light-curing spot lamp is simple to operate and is designed for use with light-curable adhesives, coatings, and encapsulants. The *BlueWave 75* is compatible with a wide array of lightguide options (see Table 1 on page 11). With over 9 W/cm² in initial UV curing intensity, 1-10 second cures are typical.

Bulbs used in UV light-curing spot lamps degrade with use, emitting less and less intensity. Prior to production, the intensity adjustment feature aids users in determining an acceptable intensity range. Once in production, this feature can be used to maintain the intensity within the acceptable range. The *BlueWave 75* has a typical bulb life of 2,000 hours.

This UV light-curing spot lamp includes an integral shutter that can be actuated by foot pedal. A solid-state power supply insures consistent operation despite fluctuations in input voltage. Please refer to DYMAX literature #Lit238 for more information on the *BlueWave 75* UV light-curing spot lamp.



BlueWave® 75 UV Light-Curing Spot-Lamp System

BlueWave® 75 UV Light-Curing Spot Lamp Features

Part Number	40078 (NA version, standard 115V plug) 40077 (International version, no plug)
Peak Intensity	>9,000 ¹ mW/cm ²
Intensity Adjustment	Manual, 1-100%
Lightguides	See Table 1. on page 11
Curing Area	<½" (12.7 mm)
Shutter	Timed and manual modes; foot pedal
Bulb Warranty	2,000 hours (ignition)
Power Requirements	Auto-switching 90-264V, 47-63 Hz

¹ As measured through a 5-mm liquid lightguide with a DYMAX ACCU-CAL™ 50 radiometer (320-395 nm)

LIGHTGUIDES for UV LIGHT-CURING SPOT-LAMP SYSTEMS

LIGHTGUIDES

Lightguides transmit UV and visible light from a source mounted inside of a spot-curing unit to the curing area. There are several factors to consider when choosing a lightguide.

Length – Lightguides are commonly one meter long although other lengths are available.

Diameter – Single-pole lightguides are available with 3-mm, 5-mm, or 8-mm inside diameters. Although the 5-mm lightguide will register a higher intensity, the 8-mm lightguide provides more curing power (intensity x area) because a larger lightguide opening captures more of the light emitted from the bulb. Each pole of a multi-pole lightguide has an inside diameter of 3 mm.

Multiple Poles – Light emitting from a spot lamp can be channeled through a single lightguide (single pole) or split between multiple lightguides (multiple poles). Each pole of a multi-pole lightguide emits equal intensity (typically $\pm 10\%$ for liquid-filled lightguides) and all share a common shutter. Both liquid-filled and quartz-fiber multi-pole lightguides are available from DYMAX.

Connection – There are basically two types of connectors used in the spot lamp industry, “Wolf” and “D” connectors. DYMAX provides lightguides with both connector types, although “D” connectors are an industry standard and compatible with current DYMAX lamp designs (older DYMAX designs utilized “Wolf” connectors).

Curing Area/Intensity vs. Distance – The UV and visible light emitted from a lightguide diverges. As a result, intensity decreases and curing area increases with distance from the end of the light guide. The chart below describes this relationship clearly for the 5-mm liquid lightguide.

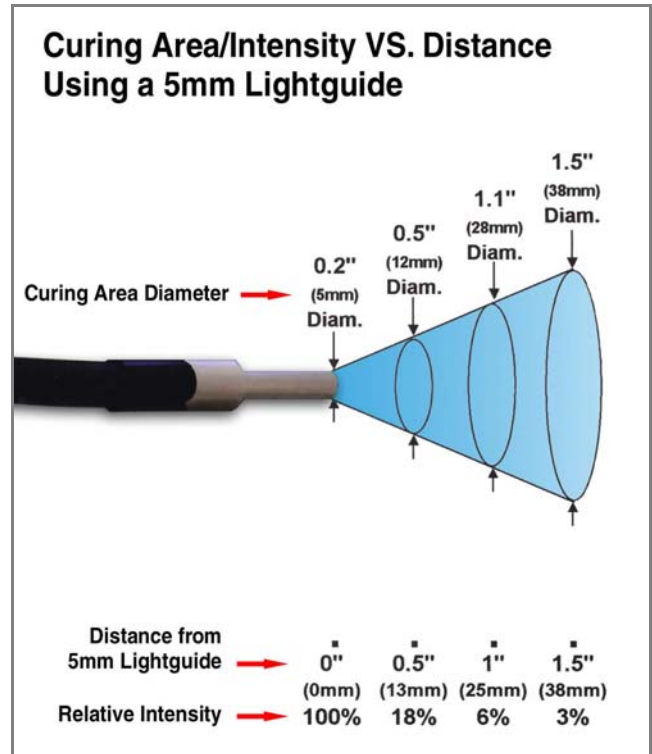


Table 1 – Lightguides Compatible with BlueWave® 75/200/LED Prime UVA

Part Number	Lightguide Description <i>(all noted are liquid filled; quartz fiber are also available)</i>	
5720	Single pole	5 mm x 1 Meter
5721	Single pole	5 mm x 1.5 Meters
5722	Single pole	8 mm x 1 Meter
38476	Two pole	3 mm x 1 Meter
38477	Three pole	3 mm x 1 Meter
38478	Four pole	3 mm x 1 Meter

ACCESSORIES for UV LIGHT-CURING SPOT-LAMP SYSTEMS

SPOT ACCESSORIES

There are a number of accessories available for the DYMAX BlueWave® 200, BlueWave® LED Prime UVA, and the BlueWave® 75 UV light-curing units. Please contact DYMAX Applications Engineering for more information on the accessories featured below.

LIGHTGUIDE MOUNTING STAND

The Lightguide Mounting Stand utilizes a 24" flexible arm for mounting 3-mm, 5-mm, and 8-mm lightguides. This stand offers a 5" x 5" (127 mm x 127 mm) working area and allows repeatable, hands-free spot curing. PN **39700**



LIGHTGUIDES

A lightguide (sold separately) is required to use a UV spot-cure unit. Lightguides are available in wide variety of configurations including 1-, 2-, 3-, and 4-pole lightguides of various lengths and diameters. The most popular configurations are listed on Table 1 on page 10.



ACCU-CAL™ 50 RADIOMETER



UV light is, by definition, invisible. A radiometer, like the ACCU-CAL™ 50, is used to measure the UV intensity emitted from spots, floods, and conveyors. For more information on the ACCU-CAL 50, see page 16. PN **39560** (for spots, floods, and conveyors).

UV-BLOCKING EYE PROTECTION

DYMAX recommends that operators using DYMAX equipment wear UV protective eyewear. All DYMAX eye protection blocks >99.9% of UV.



Description	Part Number
Clear	35284
Dark	35286
Tinted	35285

ROD LENSES

Turn a spot into a flood lamp with shutter! A rod lens re-focuses the UV light emitted from a spot lamp so as to create a very uniform (<5% variation) 2" x 2" (50.8 mm x 50.8 mm) or 5" x 5" (127 mm x 127 mm) curing area. These rod lenses attach to the UV light-curing spot system using an 8mm lightguide (sold separately). Intensities listed are those associated with the BlueWave® 200 UV light-curing spot lamp.



Description	Part Number
2" x 2" Area 50.8 x 50.8 mm (~100 mW/cm ²)	38699
5" x 5" Area 127 x 127 mm (~30 mW/cm ²)	38698

LIGHTGUIDE TERMINATORS

Lightguide terminators can be attached to the end of a lightguide to help users get UV light to those difficult-to-reach locations.

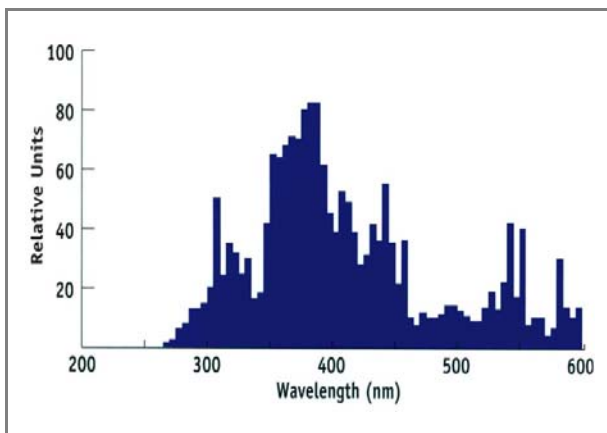


Description	Part Number
3 mm/60°	39029
3 mm/90°	39030
5 mm/60°	38042
5 mm/90°	38049
8 mm/60°	39334
8 mm/90°	39333

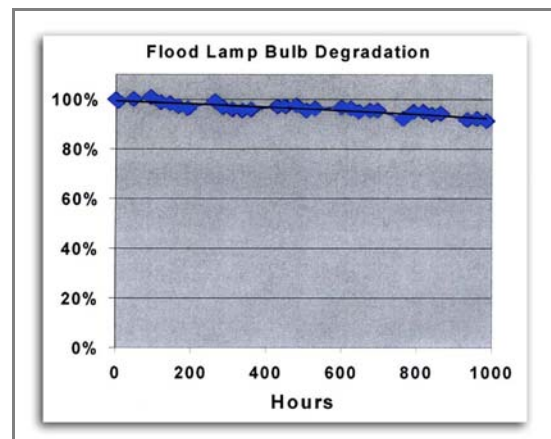
UV LIGHT-CURING FLOOD-LAMP SYSTEMS

DYMAX UV light-curing flood-lamp systems are ideal for light curing large parts or curing many small parts simultaneously. With intensities ranging from 75-225 mW/cm², DYMAX flood lamps are capable of curing most UV light-curable adhesives, sealants, and coatings, tack free in 30 seconds or less. These flood lamps can be incorporated into automated assembly systems or mounted onto conveyors. DYMAX flood units can also be used as turnkey benchtop units (with optional shutters). Please refer to DYMAX literature #Lit206 for more information on UV light-curing flood-lamp systems.

8" x 8" (203.2 mm x 203.2 mm) Curing Area	5" x 5" (127mm x 127 mm) Curing Area
 <p data-bbox="418 842 667 890">2000-EC Modular – 75 mW/cm² PN 38105</p>	 <p data-bbox="959 842 1219 890">5000-EC Modular – 225 mW/cm² PN 38100</p>
 <p data-bbox="370 1236 711 1308">2000-EC Modular – 75 mW/cm² Shown with optional shutter and light shield PN 39721</p>	 <p data-bbox="922 1236 1263 1308">5000-EC Modular – 225 mW/cm² Shown with optional shutter and light shield PN 39821</p>



2000-EC and 5000-EC UV light-curing flood lamps spectral distribution using a standard metal halide bulb (PN 38560)



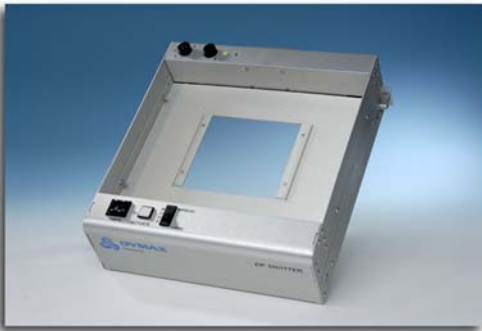
The intensity generated by DYMAX flood systems is very consistent. Bulb degradation of less than 10% over the first 1,000 hours is typical (on/off every eight hours). More frequent on/off cycles will accelerate bulb degradation.

SHIELDING & SHUTTERS for UV LIGHT-CURING FLOOD-LAMP SYSTEMS

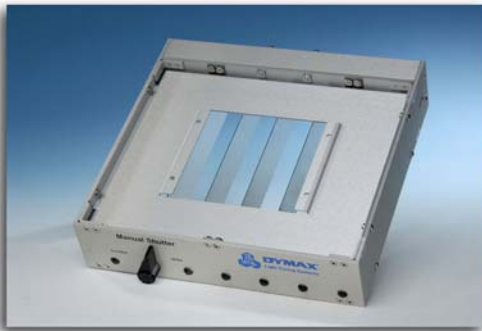
DYMAX 2000-EC and 5000-EC UV light-curing flood lamps can be outfitted with the shutters and shielding shown below. Additional shutters, enclosures, and accessories may be available.

SHUTTERS

Turning a bulb off and on between cycles is not practical since each off/on cycle shortens bulb life and requires a 5-minute warm-up period. A shutter, however, can be used to shield a flood system between cycles. Shutters control exposure time, reduce heat on the work surface, and shield operators from exposure to UV light. There are two types of shutters pictured below. Both ZIP™ and manual shutters are compatible with 2000-EC and 5000-EC flood lamps.



ZIP™ Shutter – Timed and manual modes. Foot pedal or PLC controlled. **PN 37863**



Manual Shutter – Most cost-effective shutter system. **PN 35572**

SHIELDING

DYMAX offers two standard shielding options for 2000-EC and 5000-EC flood lamps; the Light Shield, and the mounting stand kit shown below. Both shields are 100% UVA blocking and visibly tinted.



Light Shield – 360° shielding with lifting door and sliding curing shelf. Compatible with DYMAX shutters. **PN 38125**



Mounting Stand Kits – Cost-effective, 3-sided shielding. Not compatible with DYMAX shutters.
PN 38290 – 2000-EC Mounting Stand Kit
PN 38289 – 5000-EC Mounting Stand Kit

DYMAX UV LIGHT-CURING CONVEYOR SYSTEMS

The standard DYMAX conveyor platform, the UVCS series, has a belt width of 12" (304.8 mm) and can be outfitted with a number of different UV light-curing systems (as shown below). Belt speed is accurately measured using an optical encoder and displayed on a digital LCD. The UVCS series conveyors are completely shielded. The DYMAX 5000-EC and Fusion® F300S curing systems listed below are described in more detail on pages 12 and 14, respectively. Please refer to DYMAX literature #Lit051A for more information on UV light-curing conveyor systems.



Two DYMAX 5000-ECs mounted on a DYMAX UVCS 12" conveyor platform

ADVANTAGES OF DYMAX UV LIGHT-CURING CONVEYORS

- Multiple flood or focused-beam configurations available
- 12" belt width (wider conveyors are also available)
- Up to 10" clearance available (with optional risers)
- Accurate belt speed (using an optical encoder)
- 1-27 fpm (faster conveyors are available)

Overall Dimensions for All UVCS Conveyors

- 51" (129.54 cm) long
- 39.5" (100.33 cm) tall
- 35" (88.9 cm) wide
(from control panel to rear of blower)



Custom Conveyors

Looking for a wider conveyor, shorter conveyor, or one with more clearance? DYMAX can custom design a conveyor to your specifications. Contact DYMAX for more information on customized conveyors.

UVCS LAMP CONFIGURATIONS

	5000-EC LAMPS				FUSION F300S LAMPS	
	One 5000-EC ¹	Two 5000-ECs (Series) ¹	Two 5000-ECs (Parallel)	Four 5000-ECs (Parallel)	One Fusion F300S ¹	Two Fusion F300Ss (Parallel)
Part Number	39060 ²	39070 ²	39080 ²	39100 ²	39150	39160
Belt Width	12"				12"	
Width of Illuminated Area	6"		12"		6"	12"
Maximum UVA Intensity (320-390 nm)	225 mW/cm ²				2,500 mW/cm ²	
Maximum UVA Energy (320-390 nm @ 5 fpm (J/cm ²))	1.5	3	1.5	3	5	
Shipping Weight with Crates (lbs.)	390	410		450	475	580
Belt Speeds (feet per minute)	1-27 fpm				1-27 fpm	

¹These conveyors have center-mounted lamps and are supplied with removable guides to channel parts into the middle 6" of conveyor.

²These conveyors require 120 volts. 230 volt conveyors are also available.

RADIOMETERS for UV LIGHT-CURING SYSTEMS

A radiometer is a device that measures the intensity and/or energy associated with light of specified wavelengths. UV light is, by definition, not visible and so a radiometer is required to determine UV intensity. DYMAX offers the ACCU-CAL™ 50 for spots, floods, and conveyors. The ability to measure light intensity is useful for three reasons:

1. **Maintaining a light-curing process** – A radiometer can measure whether a light-curing system is providing intensity above the “bulb change” intensity. A radiometer is to a light-curing process what a thermometer is to a heat-curing process.
2. **Providing a worker-friendly light-curing process** – A radiometer is required to determine if any UV light is reaching operators or bystanders.
3. **Measuring transmission rates through substrates** – A radiometer can be used to measure the transmission rates of various wavelengths through substrates that absorb UV and/or visible light. To assure an effective curing process it is critical to measure the light intensity reaching the light-curable material below the intervening substrate.

ACCU-CAL™ 50 RADIOMETER

DYMAX's ACCU-CAL 50 is capable of measuring both the UV intensity (mW/cm²) and dose (J/cm²) emitted from spot lamps*, flood lamps, and conveyors. This easy-to-use radiometer is compatible with 3-mm, 5-mm and 8-mm lightguides and only requires re-calibration once per year. Please refer to DYMAX literature #Lit159 for more information.

ACCU-CAL™ 50 RADIOMETER	
Part Number	39561 – UVA; compatible with all lamps except spot lamps* 39560 – UVA; compatible with all lamps; includes lightguide simulator and attachments*
Measures	Intensity (mW/cm ²); 320-395 nm (UVA)
Intensity	0-35 W/cm ²
Resolution	0.001 W/cm ² or 3 significant figures
Battery Life	100 Hours

*Part #39560 includes lightguide attachments, part #39561 does not.



ACCU-CAL™ 50 Radiometer

ACCU-CAL™ 50-LED RADIOMETER

DYMAX's ACCU-CAL 50-LED can measure energy levels emitted from 3-mm, 5-mm, and 8-mm lightguides and LED flood lamps. This radiometer has a spectral sensitivity range of 350-450 nm and an intensity measurement from 1 mW/cm² to 40 W/cm², making it ideal for measuring LED curing-source energy levels. A specially designed photo-sensor assembly provides repeatable measurements and protection from high temperatures associated with some LED systems on the market. Please refer to DYMAX literature #Lit276 for more information.

ACCU-CAL™ 50-LED RADIOMETER	
Part Number	40505 – compatible with LED spot and flood units 40519 – compatible with LED flood and conveyor units
Measures	Intensity (mW/cm ²); 350-450 nm (UVA)
Intensity	1-40 W/cm ²
Resolution	0.001 W/cm ² or 3 significant figures
Battery Life	250 Hours



ACCU-CAL™ 50-LED Radiometer

UV LIGHT-CURING SAFETY

DYMAX ultraviolet light-curing technology has been used successfully for over 30 years. The fast cure, one-component nature of our UV light-curing technology has made it the process of choice for many manufacturers requiring a “Cure on Demand” assembly process. There are three common questions/concerns related to UV light-curing systems: UV exposure, ozone, and bright visible light.

UV EXPOSURE

Standard DYMAX UV light-curing systems and bulbs have been designed to primarily emit UVA light¹. UVA light is generally considered the safest of the three UV ranges: UVA, UVB, and UVC. Although OSHA does not currently regulate ultraviolet light exposure in the workplace, the American Conference of Governmental Industrial Hygienists (ACGIH) does recommend Threshold Limit Values (TLV’s) for ultraviolet light. The strictest interpretation of the TLV (over the UVA range) for workers’ eyes and skin is 1 mW/cm² (intensity), continuous exposure. Unless workers are placing bare hands into the curing area, it is unusual to exceed these limits. To put 1 mW/cm² limit into perspective, cloudless summer days in Connecticut regularly exceed 3 mW/cm² of UVA light and also include the more dangerous UVB light (primarily responsible for sun burns) as well.

The human eye can not detect “pure” UV light, only visible light. A radiometer should be used to measure stray UV light to confirm the safety of a UV light-curing process. A workstation that exposes an operator to more than 1 mW/cm² of UVA continuously should be redesigned. UV adhesive light curing can be a regulatory-compliant, “worker-friendly” manufacturing process when the proper safety equipment and operator training is utilized. There are two ways to protect operators from UV exposure: Shield the operator and/or shield the source.

SHIELDING THE OPERATOR

- **UV-Blocking Eye Protection** – UV-blocking eye protection is recommended when operating UV light-curing systems. Both clear and tinted UV-blocking eye protection is available from DYMAX.
- **UV-Blocking Skin Protection** – Where the potential exists for UV exposure upon skin, opaque, UV-blocking clothing, gloves, and full face shields are recommended.

SHIELDING THE SOURCE OF UV

Any substrate that blocks UV light can be used as a shield to protect workers from stray UV light. The following materials can be used to create simple shielding structures or blind corners:

- **Sheet Metal** – Aluminum, steel, stainless steel, etc. Sheet metal should be coated black or black anodized to minimize reflection of UV and visible light.
- **Rigid Plastic Film** – Transparent, UV-blocking plastics (typically polycarbonate or acrylic) are commonly used to create shielding where transparency is also desired. These rigid plastic films are available either water-clear or tinted, (to reduce visible light glare).
- **Flexible Film** – UV-blocking, flexible urethane films can be used to quickly create workstation shielding. This UV-blocking, flexible urethane film is available from DYMAX.

OZONE

Standard DYMAX bulbs (UVA type) generate an insignificant amount of UVC and therefore essentially no ozone¹. Some UV light-curing systems, like those used to cure UV inks, emit primarily “shortwave” (UVB and UVC) energy. Upon exposure to UVC light (specifically <240 nm), oxygen molecules (O₂) split into oxygen atoms (O) and recombine with O₂ to create Ozone (O₃). The current, long-term ozone concentration limit recommended by ACGIH, NIOSH, and OSHA is 0.1 ppm (0.2mg/m³).

BRIGHT, VISIBLE LIGHT

The bright, visible light emitted by some UV light-curing systems may be objectionable to some workers and may cause eyestrain. Tinted eye protection and/or opaque/tinted shielding can be utilized to address this concern.

SUMMARY

UV light sources can be more “worker friendly” than many commonly accepted industrial processes, provided the potential concerns are addressed. Contact your DYMAX representative for information regarding the proper use of DYMAX UV light-curing systems.



Tinted “Over the Eyeglasses” Eye Protection 99.9% UV Blocking
PN 35285



Clear “Over the Eyeglasses” Eye Protection 99.9% UV Blocking
PN 35284

¹DYMAX also provides special order “shortwave” bulbs that emit primarily UVB and UVC light. Contact DYMAX directly for information regarding the use of “shortwave” bulbs.

SETTING UP and MONITORING a UV LIGHT-CURING PROCESS

There are two parameters that must be considered to ensure a successful light-curing process, 1) intensity at the curing location and 2) cure time. DYMAX recommends setting up and monitoring a UV light-curing process as follows:

1. **Choose a Light-Curing Material (LCM)** – Select an LCM that satisfies the performance requirements of the application.
2. **Determine available light-cure time** – Determine the cure time available so that the UV curing process is not a “bottleneck” in the manufacturing process. For example, if dispensing and assembly requires 12 seconds per part in a one piece flow process, the maximum available cure time is 12 seconds. For a UV light-curing conveyor, determine the minimum line speed required.
3. **Choose a light-curing system** – Choose the appropriate light-curing system that will fully cure the LCM within the cure time available. DYMAX Applications Engineering can help you identify the best light-curing system for a specific application.
4. **Determine the lowest acceptable intensity** – The lowest acceptable intensity is that which fully cures the LCM in the available cure time (determined above). The lowest acceptable intensity can be determined through quantitative testing of parts cured at various intensities as shown in the diagram to the right. In the case of a focused-beam lamp on a conveyor, determine the lowest acceptable dose[‡], not intensity.

The following techniques may be used to artificially modify intensity to facilitate determining the lowest acceptable intensity.

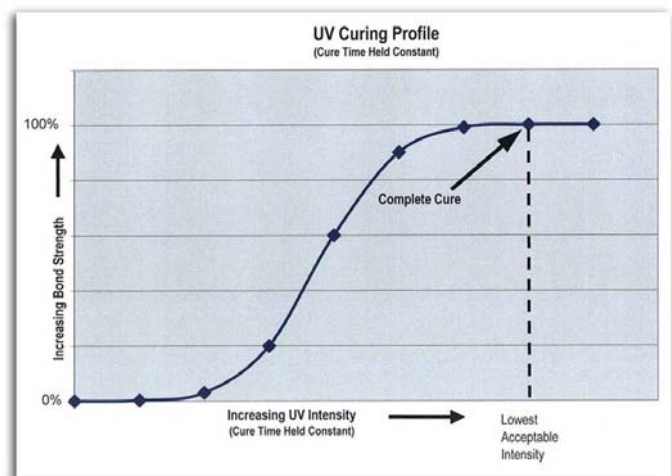
- **Increase distance** – Since light emitting from light-curing lamps diverges, the intensity decreases as the distance from the lamp increases. This is especially useful for flood lamps.

- **Adjust Intensity** – Some UV light-curing systems (like the BlueWave® 200 with intensity adjustment feature) allow users to adjust intensity.

As with any manufacturing process, it is advisable to operate with a safety factor. DYMAX recommends a “bulb change” intensity that is 50-100% higher than the “lowest acceptable intensity”.

5. **Monitor and maintain intensity** – Using a radiometer, monitor the UV light intensity at the bond line. If the intensity reaches the “bulb change” intensity, install a new bulb or conduct appropriate maintenance (see page 19 [Maximizing Lamp Performance](#)). In the case of a conveyor, dose (not intensity) should be monitored.

If the resulting cure process is causing heat damage, a cooling fan or shorter cure time is recommended. If the resulting bulb life is too short, a longer cure time or higher intensity lamp is recommended.



[‡]Both residence time and intensity varies with lamp height on conveyors with focused-beam lamps. For this reason, it is better to monitor dose (J/cm^2) on these systems rather than intensity. The most practical way to artificially lower the dose on these systems is to adjust the line speed.

MAXIMIZING UV LIGHT-CURING LAMP PERFORMANCE

There are three ways to maximize lamp performance:

- 1. Proper Set-Up** – The first key to maximizing lamp performance is proper set-up. Reference the operation manual provided with each DYMAX lamp for instructions on proper set-up. After ignition, wait five (5) minutes before use to allow the lamp to reach full intensity. Then, use the following techniques to maximize intensity at the curing location.
 - **Spot-Cure Systems** – Maximize curing intensity by minimizing distance from the end of the lightguide to the light-curable material, while still covering the curing area. Positive airflow can prevent those vapors commonly emitted during cure from condensing on the end of a lightguide. Be aware that excessive bending, clamping, or set-screw tightening can damage lightguides. The minimum bend radii for standard lightguide diameters are as follows:
 - 3-mm lightguides – 40-mm bend radius
 - 5-mm lightguides – 60-mm bend radius
 - 8-mm lightguides – 100-mm bend radius
 - **Flood Lamps** – Minimize distance from the bottom of the flood housing to the light-curable material. Note that distances 3" (76.2 mm) or more from the lamp housing provide the most uniform intensity across the curing area.
 - **Focused-Beam Lamps** – Place light-curable material at the focal point of the focused-beam lamp for maximum intensity. The focal distance for the Fusion® F300S is 2.1" (53.34 mm) below the lamp housing.
- 2. Optimizing Bulb Life** – The intensity of light being emitted from UV bulbs gradually decreases with usage (except in the Fusion F300S). This degradation cannot be avoided, but it can be minimized through proper operation.

The longest bulb life is obtained by simply using the lamp continuously (not turning it off). The more often the lamp is cycled on and off, the more quickly the bulb degrades. The general rule of thumb is to leave the lamp on if it will be used again within an hour.

Once ignited, do not turn the lamp off for at least five minutes. Turning the lamp off before it has reached its operating temperature can damage the bulb. In addition, do not attempt to re-start a UV light-curing system until it has been allowed to cool for five (5) minutes.
- 3. Proper Maintenance** – As with all production equipment, routine maintenance will optimize performance. In the case of a spot lamp, keep the end of the lightguide clean and replace it if it no longer transmits enough light (a lightguide simulator is available from DYMAX to help determine lightguide transmission). See [Lit#069 Lightguide Simulator](#) for more information on lightguide and bulb maintenance. In the case of a flood lamp, the reflector and lamp base (sockets that the bulb fit into) should be cleaned and/or replaced as necessary. Please refer to the Operation Manual for each light curing system for further guidance on proper maintenance.

FREE DYMAX EQUIPMENT EVALUATION

Contact your DYMAX representative to initiate rental of DYMAX UV light-curing equipment. The highlights of the DYMAX Trial Rental/Lease program are:

- *Two (2) weeks free evaluation and 3% per week thereafter*
- *Eight (8) weeks of rental fees are deducted from the price at purchase*
- *50% of additional rental fees are deducted*
- *Customer pays shipping both ways*

For further assistance with adhesive and equipment selection, contact DYMAX Applications Engineering.



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