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**Course Highlight**

### LASER SAFETY AWARENESS TRAINING: 2020 REVISION

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**Executive Director's Message**

We hope that you, your families and your communities are healthy and safe as we go through this challenging period created by the COVID-19 (coronavirus) pandemic. We thank all who are providing support on critical LIA projects during this difficult period. Your support has been invaluable.

In response to the COVID-19 pandemic the entire LIA staff has been operating remotely for over three weeks. The transition from our office to a remote virtual workplace has been nearly seamless. I am appreciative and thankful for the resiliency and leadership of the entire staff in innovatively completing critical tasks.

LIA online safety courses show high activity during this challenging period. Many professionals are updating their laser safety knowledge base. The Laser Safety Awareness (LSA) course has been completely revised. The medical laser safety officer (MLSO) and medical laser safety awareness (MLSA) courses have been refreshed and will be available mid-May.

We are updating our blog with improved content that better informs our community about laser and photonics developments. We are completing a new conferences website which will make it easier to navigate to both ICALEO 2020 and ILSC 2021 information. Our membership website is also being improved. Website improvements will be launched early May.

We are exploring contingency plans, particularly for ICALEO 2020 and LIA governance meetings, to provide remote access. We are tracking approaches by other technical societies.

A question asked by engineers and scientists is how can our skills contribute solutions to end the pandemic. Companies involved in additive manufacturing are already fabricating parts for personal protective equipment and ventilators. Specific ultraviolet light wavelengths are being evaluated for destroying the coronavirus particularly on surfaces. Laser technology and other aspects of photonics offer solutions yet to be identified. We have a responsibility to explore new paths that accelerate not only our recovery from the current pandemic but also implementation of new innovations that support the medical/health industry in rapid diagnosis and destruction of existing and new pathogens.

Stay safe and keep others safe.

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**President's Message**

In these challenging times as we all deal with the coronavirus pandemic, I hope you and your family are well and safe. The LIA staff is continuing to work safely through this by working remotely. With your thankful continued support, the state of the organization is doing well. The LIA staff is also investing this time on several new projects which, in the end, will benefit and grow the organization.

To help us through these times, many members are being professionally active by taking time to review educational safety requirements they may need. Please keep in mind that the LIA offers many on-line courses that you can take from your home. LIA on-line proceedings can also be researched for projects or any papers you may need to compose.

Since we are all in this together, emotionally encourage yourself and others to shift from what is fearful to seeing the situation and possibilities from a different perspective. Shine a light on the heroes, good deeds and humility that’s emerging during this pandemic. Defocus on misinformation and projections and choose to focus on details that are factual. Misdirection of thinking erodes energy and hope for the future. Fear is contagious, but so is hope.

We all look forward to the days where it will be business as usual.

Be well and safe.
EFFICIENT PRODUCTION OF DESIGN TEXTURES ON LARGE-FORMAT 3D MOLD TOOLS

By: Andreas Brenner, Markus Zecherle, Sven Verpoort, Kersten Schuster, Claus Schnitzler, Markus Kogel-Höllacher, Martin Reisacher, and Benedikt Nohn

Abstract: Laser surface structuring is becoming increasingly important in the industry for tool and mold making. While structured surfaces contribute to minimizing friction in combustion engines or to increasing efficiency of light-emitting diode-based lighting systems, surface texturing is evolving a quality feature of products with regard to optical and haptic properties. Currently used manufacturing processes for tool texturing like photochemical etching are limited in precision and in flexibility. To establish a digital process chain and to increase the design flexibility, laser ablation with (ultra) short pulse laser radiation is becoming an increasingly important technology. In the research project "eVerest," all necessary parts of a laser texture processing are integrated into the machine and operating concept, e.g., the virtual design of the product including unrolling and visualization of the textures. Finally, new process strategies and advanced machine and system technologies are developed.

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TRENDING IN THE NEWS:
LIA’S TOP 4 ARTICLE PICKS

1. LASERS TURN METAL SURFACES INTO BACTERIA KILLERS
Purdue University researchers have discovered a laser treatment to texture metals that can potentially transform almost any metal surface into one that quickly eliminates any bacteria that come into contact with it.

Read more

2. BLASTING AIRPLANES WITH LASERS MAKES IT MUCH HARDER FOR ICE TO STICK TO WINGS
Researchers in Germany have developed a better way to keep planes free of ice and snow using a technology called Direct Laser Interference Patterning (DLIP).

Read more

3. NEW TECHNOLOGY FOR PATHOGEN DETECTION DRIVEN BY LASERS
Researchers at Purdue University use lasers to detect toxins and pathogenic E. coli in food, water, and industrial materials hoping to help stop the spread of foodborne illnesses.

Read more

4. RECORD-BREAKING TERAHERTZ LASER BEAM TURNS AIR INTO GLOWING PLASMA
Scientists at TU Wien (Vienna) have used a laser to turn air into plasma, producing terahertz radiation that can be used for many different applications.

Read more
The advent of the COVID-19 pandemic has led to an increase in interest in the use of ultraviolet light for sterilization purposes. Lamp system suppliers are currently bringing to market a host of UV lamps for potential use in sterilization of the SARS-CoV-2 virus and the world is wide awake to the prospect. Given that there could soon be widespread increase in the use of UV lamps for sterilization then it is appropriate to review how international safety standards can help researchers, workers and users evaluate the potential hazard to the eye and to the skin.

UV Photobiological Safety

Clearly, any light source that can sterilize and kill a living pathogen such as a virus will also be quite capable of causing harm to human eye and skin. The hazard potential is exacerbated by the invisible nature of ultraviolet light implying that there is usually no awareness that a sterilizing UV light beam is present. Furthermore, with many ultraviolet light related injuries there may be no immediate awareness that damage to the skin or eye has occurred until a few hours later. There also the potential for ultraviolet light to cause a longer-term chronic injury such as cataract to the eye, and skin cancer, decades later.

UV Lamp Technology

The interest in the use of UV light for health related purposes and treatments is around 100 years old and evolved from the use of natural sunlight to treat certain ailments. Intriguingly the lamp technology that is predominant in use for photobiological applications in the UV region still tends to be centered around the mercury vapor gas discharge lamp, a lighting technology that dates back to this period - Figure 1 shows an original patent for a mercury lamp from 1901. It is reasonable to expect that workers in the UV field.

Figure 1 Mercury Lamp Patent – P C Hewitt (1901)

However due to the pending widespread use of high power UV light sources associated with all manner of lamp and laser sources it is necessary to revisit how the potential for ultraviolet light related injuries there may be no immediate awareness that a sterilizing UV light beam is present. Furthermore, with many ultraviolet light related injuries there may be no immediate awareness that damage to the skin or eye has occurred until a few hours later. There also the potential for ultraviolet light to cause a longer-term chronic injury such as cataract to the eye, and skin cancer, decades later.

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The corresponding maximum exposure time $t_{\text{max}}$ can be determined from equation (2) to be:

$$t_{\text{max}} = \frac{10000}{104} = 96 \text{ seconds}. \quad (5)$$

A similar analysis for an exposure using a limiting aperture of $d_{\text{lim}} = 1.0 \text{ mm}$ for the human eye indicates that the corresponding maximum exposure time $t_{\text{max}}$ is reduced by a factor of $10^3$ compared to that of the limiting aperture. 

**IEC 62471 Lamp Safety Standard Approach**

In contrast to the laser standard that assumes a laser to be a narrowband source, the lamp standard assumes the source spectrum of a lamp or LED to be broadband in nature e.g. of the order of 100 to 1000 nm wide. In this case, rather than consult a lookup table for an individual wavelength based MPE limit value, the lamp standard requires a spectral overlap integral methodology to be adapted. In this method, the source spectrum is compared mathematically to a corresponding hazard spectrum referred to as the hazard ‘action’ spectrum. The action spectrum is weighted in accordance with the wavelength dependent nature of the specific photobiological effect or skin hazard of concern. The various action spectra corresponding to differing photobiological hazard mechanisms are listed in the IEC 62471 lamp safety standard. The approach of the 62471 safety standard can be considered to be flexible in that additional hazard action spectra can be incorporated in line with new lamp and LED related safety studies. This situation is almost certain to occur as experience and expertise increases in the UV LED field and new applications proliferate for UV LED technology.

The action spectra in the lamp safety standard are dimensionless functions that are usually normalized to a peak hazard efficacy value of 1.0, where the peak of the function identifies the wavelength of peak hazard corresponding to a specific photobiological damage mechanism. In contrast to this, in the laser safety standard, the MPE values and their related safety coefficients tend to increase numerically with a decreasing laser beam size. In other words, the safety coefficients in the laser standard might be thought of as being ‘upside down’ compared to their equivalent parameter in the lamp safety standard. In regard therefore the action spectra in the lamp safety standard tend to provide a more intuitive grasp of the wavelength dependent nature of a UV lamp hazard, in that the peak of the action spectrum corresponds to the peak of the hazard.

An example of a lamp safety hazard action spectrum is given in Figure 5.

**UV-C Lamp Exposure Example**

Consider the case of a semiconductor UV-C LED emitting at a wavelength of $\lambda = 265 \text{ nm}$, characterized by a full width half maximum (FWHM) linewidth of $15 \text{ nm}$, the spectral output of the LED source might be as shown in Figure 6. In order to assess the corresponding actinic eye hazard, the spectral irradiance produced by the usually highly divergent LED (or an array of such sources) will need to be determined as a function of distance, either by measurement or estimation from LED emission properties.

The solid curve in Figure 5 shows the normalized actinic action spectrum from the 62471 standard plotted on a linear scale. When plotted on a logarithmic scale, it has the appearance of a ‘shark-fin’ that usefully warns of a hazard which peaks occur at the tip of the ‘fin’ at $270 \text{ nm}$. This concept would not be of the area, $P_{\text{LED}} = 8 \text{ W.m}^{-2}$.

$$t_{\text{max}} = 300 \text{ J.m}^{-2} / 8 \text{ W.m}^{-2} = 37.5 \text{ seconds}. \quad (6)$$

The corresponding maximum exposure time for the LED hazard from the UV standard can be calculated in accordance with equation (2) as follows

$$t_{\text{max}} = \frac{ELV_{\text{actinic}}}{E_{\lambda,\text{peak}}} \times \frac{300}{8} = 37.5 \text{ seconds}. \quad (8)$$

Figure 8 presents the example of how the actinic UV hazard posed by the LED would be reported using commercially available photobiological safety software [9].
'continuous disinfection' process that can be manifested in the UV A and violet light region of the spectrum. In these continuous disinfection processes, the background/surfacialization exposure durations are likely to be of the orders of several hours (rather than a few seconds) as is required in the UV-C sanitation process.

In a similar manner to the actinic region described above, the UV-A photobiological hazard assessment can be undertaken using an appropriate near-UV hazard action spectrum defined in the EN 62471 standard. As an example, a comparison can be made with the laser safety approach applied to the Helium-Cadmium laser earlier in this article. In this case, consider several UV-A lasers emitting at 325 nm each with a PWHM linewidth of 15 nm, and a combined total spectral irradiance at a target site of E325nm = 10 W.m\(^{-2}\).

The output of the UV LEDs and the corresponding EN 62471 near-UV hazard action spectrum are shown schematically in Figure 9.

Figure 9: UVA LED Spectrum & 62471 Near-UlV Hazard Action Spectrum

The analysis of the near UV photobiological hazard is similar to that described above for the actinic region, with the main difference being that the near-UV hazard action spectrum is represented by a 'top-hat' function spanning from 315 nm to 400 nm. It can be seen in Figure 9 that the LED source spectrum under assessment is truncated only at the lower end of the window, i.e. below 315 nm, with approximately 95% of the LED emission lying within the near-UV hazard band. This equates to an effective near-UV source irradiance for the LED of the order of EUVA = 9.5 W.m². This may be compared to the total emission of only given as E325nm = 10 W.m². Because of the top-hat nature of the near-UV hazard action spectrum, many workers will simply treat the total emission of any LED source in this region as being 'effective' for the near-UV hazard.

The corresponding exposure limit value in the near-UV region is EUV\(_{\text{max}}\) = 10000 J.m\(^{-2}\). This is equivalent to the corresponding laser safety MPE. It can be determined that the corresponding maximum permissible exposure time is:

\[ t_{\text{max}} = \frac{\text{EUV}_{\text{max}}}{\text{EUV}_{\text{LED}}} = \frac{10000}{9.5} = 1052 \text{ seconds} \]

Given that the LED irradiance is a factor of 10x less than that produced by the low divergence He-CD laser beam in the earlier example, it turns out the maximum permissible exposure time for the near-UV hazard will be around 10x longer i.e. approximately 10000 s for the LED, versus 100 s for the laser exposure.

Long Term Near-UV Photobiological Hazard Limit

The analysis for the UV-A hazard above used the same exposure limit value of EUVA = 10000 J.m\(^{-2}\) that can be found in both the laser (60825) and lamp (62471) standards. However, it can sometimes be overlooked that depending upon which standard is consulted, a discrepancy can exist in the near-UV photobiological hazard region. Specifically, certain safety standards report a 'long-term' near-UV exposure limit in spectral irradiance terms rather than a 'dose' related radiant exposure limit. In this case the spectral irradiance limit commonly applied is EUVA = 10 W.m\(^{-2}\) and this is typically applied for exposure durations longer than 1000 s.

Thus if a limit value of EUVA = 10 W.m\(^{-2}\) is applied to the analysis of the UV-A LED above, then it could be determined that a UV-A source whose effective irradiance is ELV\(_{\text{UVA}}\) = 9.5 W.m² would not be deemed hazardous per se. This finding can also be inferred from the analysis where tmax was determined to be longer than the t = 1000 s that is actually used as a boundary between an effective radiance exposure limit of 10000 J.m² and an effective spectral irradiance limit of 10 W.m\(^{-2}\) for t > 1000s. This discrepancy should be borne in mind when analysing optical radiation hazards in the near-UV region, pending harmonisation of all the relevant safety standards in the near future.

Next Steps

The increased prominence and widespread use of UV LED sources will likely bring with it a need to refine and review the various limits and approaches adopted in the safety standards, especially for the UV lamp safety Risk Group designations in the 62471 standard. Interestingly, there is also growing interest in the far-UV-C region of the spectrum, around a wavelength of 222 nm [10], where the UV light stimulation process might be achieved along a drastically reduced hazard potential to the human eye and skin. Developments in the far-UV-C area will be interesting to follow. It is also likely that light tissue interactions associated with skin therapy research in the near region of the UV spectrum will lead to a better understanding of a host of potential injury mechanisms occurring in this region with further action spectra developed related to e.g. light induced vitamin D synthesis and erythema (skin reddening).

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4 E 62471: 2008 Photobiological Safety of Lamps and Lamp Systems
7 American Conference of Governmental Industrial Hygienists (ACGIH). www.acgih.org
9 NPL, eyeLightTM Analytical Platform for Optical Radiation Hazard Assessment

Meet the Author

Neil Haigh has a PhD in Applied Optics (Imperial College, London), allied with a string technical background gained in industry in fibre optics, optical communications, and laser safety. He is presently involved in the development of both LED light sources, analytical software, and associated technical training.

WASHINGTON, DC – The U.S. Department of Labor’s Occupational Safety and Health Administration (OSHA) issued interim guidance for enforcing OSHA’s recordkeeping requirements (29 CFR Part 1904) as it relates to recording cases of COVID-19.

OSHA’s enforcement policy will provide certainty to the regulated community and help employers focus their response efforts on implementing good hygiene practices in their workplaces and otherwise mitigating COVID-19’s effects. For further information and resources about the coronavirus disease, please visit OSHA’s COVID-19 webpage.
As mentioned in the introductory article in the January/February issue of LIA Today, the biggest use of lasers in the veterinary field is for photobiomodulation or laser therapy. However, that is a more recent development growing rapidly just in the last 6-8 years. Over 20 years ago, CO2 surgical lasers were first introduced to veterinarians and became very popular for a wide variety of conditions. In many practices, the surgical laser completely replaced the scalpel for surgery. Surgery and PBM are the two biggest areas of laser use by veterinarians. However, there are other areas where lasers have become an integral part of the veterinary armamentarium.

Veterinarians, as a rule, tend to be resourceful practitioners. They readily adapt and are willing (and sometimes compelled!) to explore alternative methods to improve the health of their patients. In addition, with many owners considering their pets more and more a part of the family, the level of care demanded has driven the incorporation of many technologically advanced modalities for routine diagnostic and therapeutic procedures. These include ultrasound, endoscopy, MRI, CT, chemotherapy, radiation therapy, orthotics, organ transplants, open-heart surgery, and, of course, lasers.

Lasers are used by many general practitioners but also by veterinary specialists. Diode lasers are used for many dental procedures. They are routinely used in ophthalmology to treat glaucoma and intra-ocular tumors as well as retinal disease. They are also used for endoscopic procedures especially in the equine world for many common upper respiratory conditions. The holmium laser is used for laser lithotripsy and arthroscopically for joint-related issues. As mentioned above, the CO2 laser can completely replace a scalpel for all general soft tissue surgery. It is particularly useful for oral and perianal surgery. It has nearly revolutionized pharyngeal surgery, particularly for the brachycephalic breeds.

The benefits of laser to the doctor and patient are the same for both human and veterinary. For the doctor, the laser adds versatility and precision. There is often less bleeding so visualization is improved. A laser can allow for less invasive procedures and, therefore, often shorter procedure time. It can expand the types of procedures that can be performed. For the patient, this all means less tissue trauma, shorter hospitalization, and quicker recovery. It will reduce pain and swelling and can reduce the risk of infection. This will lead to fewer rechecks and fewer bandage changes. These advantages save both time and money for all parties involved.

Again, the most widespread use of lasers in the veterinary field is for laser therapy; to reduce pain and inflammation and to enhance tissue healing. And it is the healing effect that is most beneficial. Laser therapy directly stimulates tissue repair, regeneration, and remodeling. It allows practitioners to resolve conditions that were traditionally less responsive. In addition, it helps many common conditions heal much faster and much better.

Laser light in the red and near-infrared range is absorbed by specific chromophores in the body (cytochrome C oxidase/hemoglobin/water) and this has a positive effect on specific biological reactions. This photochemical reaction increases blood flow to the tissue, stimulates the release of O2 from the hemoglobin delivered, and enhances the conversion of O2 to useful energy by cytochrome C oxidase in the production of ATP. This leads to improved cellular function and/or an increase in cell growth, replication, repair, or production of beneficial biochemical compounds – enzymes, proteins, cytokines, immunoglobulins, DNARNA. There is a cascade of secondary and tertiary effects that enhance/accelerate/improve the following physiologic reactions.

- Vasodilation
- Angiogenesis
- Lymphatic drainage
- Accelerate tissue repair and growth
- Faster wound healing
- Decreased fibrosis
- Improved osteogenesis
- Analgesia
- Decreased inflammation
- Improved nerve function, axonal regeneration, neurologic repair
- Immunoregulation/Immunomodulation
- Acupuncture stimulation
- Trigger Point modulation
The two most important features that determine the optimum response of a laser are wavelength and power. Laser light in the red and near-infrared range has bio-stimulatory properties. Roughly, this corresponds to wavelengths between 600nm and 1100nm. The shorter wavelengths are absorbed more superficially and therefore do not have the ability to penetrate as readily as the longer wavelengths. Wavelengths in the visible red range (650nm-660 nm) are highly absorbed by melanin and near the peak of the Hb absorption curve. However, the 905 nm wavelength is even closer to the peak of the hemoglobin absorption curve. Recent studies have indicated that this wavelength creates an even as much as a 30-50% increase in O2 release to the tissue over the 970-980 nm wavelengths. The most important discovery was related to wavelengths near the 800nm range (750-830). These are at the peak of absorption for the cytochrome-C oxidase enzyme. This is the rate-limiting step in the conversion of O2 to ATP within the electron transport cycle. These wavelengths will accelerate the production of ATP within the mitochondria. Utilizing all 4 wavelengths can give you a synergistic effect and a wider range of treatment options across a broader spectrum of clinical conditions and patients which will result in better clinical outcomes.

Laser power is the rate at which the laser energy is delivered. Although seemingly straightforward, the power question seems to raise the most discussion regarding appropriate parameters. The physics associated with laser penetration within non-pigmented tissue is well established and quantified by the rate of decay of an incident beam as it moves through tissue. Classification of all lasers is dictated by the FDA, based on the maximum power the laser can deliver. It is used for guidance when discussing safety and the potential to cause harm/damage, especially to the eye. Most therapeutic lasers are class II, III, or IV. Class IIb lasers produce ≥ 500 mW of power (112 watt). Class IV Lasers are anything over 500mW of power. Class IV therapy lasers are extremely rare. The main benefit of higher power is the ability to deliver enough photons at the surface (a larger total dose) to compensate for the power loss (decreased number of photons) reaching deeper tissues. This allows for a more direct photochemical response on these tissues. Lower dosages are used when treating superficial wounds and for acupuncture point or trigger point stimulation. Adjustable power output can make a Class IV laser effective for superficial dermatologic lesions, deep musculoskeletal conditions, and anywhere in between.

Notwithstanding years of research on the bio-stimulatory effects of laser light, we are just starting to realize all the clinical applications for veterinary patients (and humans). Exciting new possibilities include help with OCD (osteochondritis dessicans), chronic rhinitis/bronchitis, joint/soft tissue injuries, allergic reactions, chronic intestinal or urinary tract inflammation, bacterial/viral infections, and adjunct therapy to improve stem cell results. Laser therapy, by becoming a standard of care for the elderly, provides promise for many of these conditions. Laser therapy does not just accelerate healing; it actually improves repair, regeneration, and remodeling of tissue. Post-op complications are reduced. Muscle atrophy can be reversed. Type I collagen production yields better tendon and ligament strength and elasticity. There is a positive effect on neurologic function and axonal sprouting. The joint capsule, synovial lining, and cartilage all benefit. Therefore ROM, function, flexibility, and mobility are all enhanced. The potential for re-injury is greatly reduced. Performance animals not only recover quicker but they can regain their competitive edge. Pets can get back to their daily routines and become an active member of the family again.

These are exciting times. Like all technology, lasers have become smaller, safer, more efficient, and easier to use. Their broad range of applications makes them not just affordable but profitable. It’s no wonder that lasers are rapidly becoming an indispensable tool in thousands of veterinary hospitals.

About the Author - David S Bradley has practiced for over 30 years in Mixed, SA, Equine, and Exotics with a special interest in surgery. He began using lasers in private practice in 1999, but shortly thereafter began training and education in laser physics and tissue interaction. He has authored numerous articles and a chapter in two recently published texts related to Laser Therapy and Laser Surgery and has lectured nationally and internationally on veterinary laser use.

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As much of our staff is working remotely, and shipping may be delayed, we encourage you to consider the electronic version of the ANSI Z136 Standard. We are currently offering a 25% discount on the electronic versions - just use code ANSI20 at checkout! Find them here!
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Changes Coming Soon!

We are excited to announce that BLS is working toward ANSI (ANAB) accreditation, which means that we will be making changes to our procedures to ensure we are in compliance with the ISO IEC 17024. This may result in changes to our certification management system, in particular record keeping. We will keep CLSO’s and CMLSO’s informed of the changes to come that may affect documentation requirements for recertification in the coming year.

Paper-and-Pencil Exam Administration

The next pencil-and-paper exam will be offered prior to the 2020 DOE LSO Workshop on August 17-20, 2020 in Austin Texas. Computer-based testing will resume once our third party test administrator’s testing facilities open up. After that, Computer-based testing will be available year-round. For exam information, visit www.lasersafety.org, or contact us at bls@lasersafety.org.

CLSO Exam Reference Guide Now Available

Thanks to the considerable efforts of the CLSO Technical Review Board, an updated CLSO Exam Reference Guide is now available and includes sample questions. This guide is available to download for free on the BLS website.

DOE LSO Workshop

The DOE LSO Workshop is a great opportunity for CLSOs to earn CM credit toward renewal. The Workshop was rescheduled due to the COVID-19 pandemic. The new date of the workshop is August 18-20, 2020. You can find a link to the Workshop on the BLS home page www.lasersafety.org

ASC Z136 Annual Meeting

The ASC Z136 Annual Meeting was postponed due to the COVID-19 virus. It will be rescheduled to a later date. Check the Z136.org website for updates or for more information please email z136@lia.org

Write for BLS!

Looking for a way to earn BLS CM points for free? BLS has restarted it's newsletter and is inviting CLSOs and CMLSOs to share laser safety knowledge with the laser community! Published article submissions are worth 0.5 BLS Certification Maintenance (CM) points in Category 3. For more information on guidelines and regulations, email us at bls@lasersafety.org. Check out one of our submissions on the next page!

Specific Laser Information

<table>
<thead>
<tr>
<th>Manufacturer:</th>
<th>Address:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model #:</td>
<td>Serial #:</td>
</tr>
<tr>
<td>Wavelength (nm)</td>
<td>Laser Type: CO2, CO2, etc.</td>
</tr>
<tr>
<td>Laser Class for system</td>
<td>Laser Class for embedded laser:</td>
</tr>
<tr>
<td>Beam Diameter (mm)</td>
<td>Beam Diameter (mm)</td>
</tr>
<tr>
<td>Operating Mode (continuous, pulse, etc)</td>
<td>Power (Watts)</td>
</tr>
<tr>
<td>Energy (Joules)</td>
<td>Pulse width (s)</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>Pulse repetition rate (Hz)</td>
</tr>
</tbody>
</table>

LSO Exam Reference Guide

Creating a simple yet robust inventory system will provide any new LSO with a proper foundation upon which their laser safety program can be built on. Based upon my personal experience as a laser technician over the past decade I understood the importance of why an inventory was not only critical but in my opinion serves as the very foundation of which any program should be developed based upon one simple rule: “How can any LSO ensure the safety of their campus if they do not understand the hazards present with each laser and where to find them?”

The Table below shows only a small portion of what would later make up my site’s laser inventory template. Understanding your laser’s capabilities is incredibly important as it allows you the LSO to determine what hazards may be present at based upon things such as Wavelength, Class, Power, etc.

Performing Audits both Internal and External

Performing Audits for each laser system at your site whether Internal or External can help establish if there are any findings that violate ANSI Z136.1 Standards or OSHA safety regulations. And while understanding all standards and regulations can be a difficult task at times, it ultimately should be looked at as an opportunity to develop your own ability in spotting compliance issues. Such as warn out or incorrect labels and most importantly safety violations that present a direct risk of allowing both exposure and access to the hazard in question.

As I stated before having a full understanding of all ANSI and OSHA regulations can take decades of training and practice to correctly implement, which is exactly why I personally reached out to Thomas Lieb, President and Founder of L*A* - International, an independent company offering both education and consulting services.
to companies dealing with laser technology. After performing your audit if any findings come forth such as compliance or safety hazards it will be important to follow up with your site EH&S and create a risk assessment of which findings to tackle first, with safety of course taking priority above all else.

Example of an OSHA Violation found during an Audit

OSHA Violation
While taking a closer look at the station it was found that there was a safety issue present that was previously unknown, the station has a very large opening along the direct beam path in which the beam can escape. The wavelength used by this laser is one that can be transmitted directly to the retina causing permanent blindness. It was later revealed that a cover for this section of the station did exist at one point but was scrapped due to an increased need to perform maintenance in a timely manner to get production running again.

NOTE: The final point to make for this section of why performing audits are critical, is because they can also uncover the history of the machine in question. As such can be seen with the example provided, where lack of knowledge and respect for laser safety resulted in the removal of physical guarding that was designed and intended to protect against both exposure and access of the known hazard present.

Affected vs. Authorized and Knowing the Difference

The last topic I will touch on is one related to training your Affected vs. Authorized users and ultimately knowing the difference between the two. (Note: The definitions provided are unique to the author’s site and are not defined in ANSI Z136.1)

Affected
Laser associates whom are trained on how to operate and run production in a Class 1 environment but who are NOT trained in performing maintenance on the system and Shall never operate the laser with guards or interlocks bypassed. *No PPE required*

Authorized
Laser associates whom are trained to perform routine preventive maintenance and or troubleshooting that may result in taking the laser from a class 1 environment to a class 3B or higher. Authorized associates Shall be trained in proper PPE use/handling prior to any work performed on said system. *PPE REQUIRED*

CONCLUSION

The industry of laser technology will continue to grow exponentially for years to come and will require more individuals that understand and can apply the standards correctly. And if my own journey of becoming an LSO/CLSO has taught me anything it would be that 1. Misinterpretation of standards is more common than not, and 2. That associate compliance with any program developed depends solely on the culture that is established by your organization through leading by example.

And finally, I will leave you with a quote that has always stuck with me through the years and at its core represents the very essence of why we all have become LSOs.

“an ounce of prevention is worth a pound of cure”

The mission of the Board of Laser Safety (BLS) is to provide a means for the recognition of laser safety professionals through certification and to promote competency in the field of laser safety. BLS certification will enhance the credibility of a designated Laser Safety Officer, and demonstrate that individuals serving in the field have agreed to adhere to high standards of safety and professional practice. For the employer, having a CLSO or CMLSO on staff demonstrates due-diligence and helps to ensure legitimacy and adequacy of the laser safety program, validating the company’s dedication to a safe working environment for all employees.