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If you have comments, this will be discussed at the 2022 ILDA Conference (General Business Meeting), and we also accept comments via email or phone (mail@ilda.com).

Version 3.0, July 13, 2022 Submitted to ILDA Board

Version 4.0, July 15, 2022. Changed name from "Baseline Laser Show" to "Basic Safe Laser Show". Edits for clarity or additional information. Defined "General Public" and "Laser Personnel". Split first section into two: Introduction and Requirements. Added "Training and Instruction" section.

1. ILDA Basic Safe Laser Show: Introduction

This document defines a "Basic Safe" laser light show or display as used in the entertainment, advertising, and artistic composition fields. Such laser shows are accepted popular media in entertainment and the arts.

# Background

Since laser light shows began in the mid-1970s, there have been hundreds or thousands of laser shows performed worldwide each day using Class 3B and Class 4 lasers[[1]](#footnote-1). Many of these shows, especially outside the United States, include audience scanning at levels that appear to be well above the ocular Maximum Permissible Exposure (MPE)[[2]](#footnote-2).

Yet during more than four decades of laser shows, there have been essentially no documented or proven injuries to audience members or performers from the millions of shows using continuous wave lasers. This experience base includes shows with audience scanning well over the ocular MPE. This record has effectively and conclusively shown that Class 3B and Class 4 laser shows using continuous wave lasers represent negligible concern, even where there is audience exposure.

The Basic Safe Laser Show expands upon this record. It provides proven requirements which provide basic laser safety for a light show, and which are easy for an inspector to confirm. It does not allow audience scanning, it requires continuous monitoring of the lasers, and it incorporates standard conditions of U.S. FDA variances.

ILDA considers a Basic Safe Laser Show as "safe," meaning that the chance of injury (hazardous effect or adverse biological changes) to any person is considered to be vanishingly small as long as the requirements of this document are met.

# Purpose

The International Laser Display Association will not object to Basic Safe Laser Shows that meet the requirements in this document. These requirements are based on generally accepted government regulations, safety standards, and/or safety principles.

A laser show that deviates from these requirements is, by definition, not a Basic Safe Laser Show and shall follow requirements of other standards such as ANSI Z136 and IEC 50825 plus any requirements set by government and/or an Authority Having Jurisdiction.

*Regulatory Note: The Basic Safe Laser Show in general follows the standard conditions listed in a U.S. FDA laser light show variance. However, to be legal in the U.S. at the federal level, any laser light show, display or device using Class 3B or Class 4 lasers must apply for a variance and receive FDA approval before introducing the show into commerce (e.g., before rehearsing and performing the show). Currently this FDA requirement applies even to a Basic Safe Laser Show. Note that ILDA will not object to a show that meets or exceeds the Basic Safe Laser Show requirements, regardless of its regulatory status.*

# Requirements vs. recommendations

In this document, "shall"refers to a requirement which must be met. "Should" refers to a suggested recommendation which is not an absolute requirement.

All parts of this document are included in the "shall" and "should" requirements, including those listed in the Roles section and the Training and Instruction section.

1. Primary Requirements and Recommendations

# Use visible, continuous wave lasers only

Only continuous wave lasers emitting in the range of 400 nm to 700 nm shall be used.

Specifically, lasers emitting light in pulses such as pulsed Nd:YAG and metal vapor lasers shall not be used. This applies even to lasers with very high pulse repetition rates such as 80,000 Hz.

# Applies to lasers 30 watts or less

The maximum possible power that can be emitted by a single laser beam from an aperture of the laser or laser show projector shall not exceed 30 watts. The power is determined by valid measurement or reputable manufacturer information. If any single beam emitted during the show is or could be over 30 watts, then the entire show does not qualify as a Basic Safe Laser Show.

It is not permitted to use lasers in excess of 30 watts and turn down the power to be less than 30 watts.

*Note: Use of Class 3B and Class 4 power levels are necessary to achieve the required effects of laser light shows and displays. Basic Safe Laser Shows impose a reasonable limit of 30 watts based on decades of experience with safe indoor and outdoor shows. For many or most of these shows, 30 watts allows sufficient visibility for the desired effects.*

# Lasers have been certified/approved

For a Basic Safe Laser Show performed in the United States, all laser products, systems, and projectors used in the show shall have been certified to comply with 21 CFR 1040.10.

For a Basic Safe Laser Show in a jurisdiction outside the U.S., all laser products, systems, and projectors used in the show should be certified, inspected or otherwise approved for use under the laws and regulations of the jurisdiction. See the International Electrotechnical Commission standard for laser products, IEC 60825-1 (current edition).

# Use of Class 1, 2 and 3R lasers

Class 1, 2 and 3R lasers shall be used in accordance with any applicable governmental regulations.

**IMPORTANT: The remainder of this document about Basic Safe Laser Shows applies only to light and beams from Class 3B and Class 4 lasers, except where otherwise noted.**

# Beam locations for the General Public

The following applies to beam locations for the General Public:

## Keep beams away from human-accessible areas

Beams from Class 3B and 4 lasers, and any other light in excess of Class 3R limits such as diffuse reflections, shall be at least 3.0 meters (9' 10") above any surface upon which the General Public may be reasonably expected to stand, and shall be at least 2.5 meters (8' 2") below or in lateral separation from any place where the General Public is permitted to be.

*Note: "Reasonably expected" may depend on the venue and event type. In a concert hall with classical music, persons are not reasonably expected to stand. At a music festival, persons may be standing on structures or hanging on trusses. So the actual laser minimum height above the floor or ground would need to be higher at a music festival than in a concert hall.*

## Beam terminations on a balcony

Beams on a balcony or similar demarcated surface may be terminated less than 2.5 meters below or in lateral separation, if the beam is separated from human access such that if a member of the General Public were to lean over or otherwise try to reach the laser beam, the difficulty of their reaching the beam and the risk of falling or other injury is more of a hazard than accessing the beam.

##  Diffuse laser light on General Public

The only laser light from Class 3B and Class 4 lasers allowed on the General Public or in accessible uncontrolled areas is diffuse reflections produced by 1) the atmosphere, 2) added atmospheric scattering media such as haze or fog, and 3) reflections off target screens.

"Audience scanning", where beams are deliberately aimed close to or on the General Public, is specifically prohibited for a Basic Safe Laser Show.

# Beams on or near Laser Personnel

This section refers to persons who have been made aware of the laser's hazards AND who can reasonably be expected to follow instructions to avoid such hazards. These persons include Laser Operators, employees of the Employer, and performers who have been briefed and who will follow safety instructions.

*Note: For purposes of this document, a person is either classified as being in the General Public or is Laser Personnel. If unsure, classify them as General Public.*

## No laser light on or near to any Laser Personnel face or eyes

Laser light shall not be on any Laser Personnel's face or in their eyes. Laser light shall not be close enough to any Laser Personnel's face or eyes so that in the course of their reasonably expected movements their face or eyes may accidentally be exposed to the laser light; for example, if a performer turns around to face the rear of the stage.

## No Class 4 laser light on or near any Laser Personnel

Laser light from a Class 4 laser shall not be permitted on any Laser Personnel's skin or clothing. Laser light from a Class 4 laser shall not be close enough to any Laser Personnel's skin or clothing so that in the course of their reasonably expected movements their skin or clothing may be accidentally exposed to Class 4 laser light.

*Note: It is possible to diffuse, scan or otherwise reduce the irradiance of Class 4 laser light to levels that are safe for skin or clothing exposure. However, a Basic Safe Laser Show does NOT allow this. Any skin or clothing exposure must come from a laser or projector properly classified as Class 3B, 3R, 2 or 1. This way, safety does not rely on any diffusion, scanning etc. being performed properly.*

## Use Class 3B laser light carefully if illuminating skin or clothing

Any exposure of light from a Class 3B laser on Laser Personnel shall be tested in advance to determine that there is no possibility of skin heating or injury, or damage to clothing or costume, under reasonably foreseeable conditions.

*Note: It is possible for light from a Class 3B laser to harm skin or clothing, primarily at close ranges (within a few feet or yards), when the beam is stationary relative to the eye or skin (e.g., heat building up), and when the beam is in the hundreds of milliwatts.*

*In most laser light show situations, the Laser Personnel (performer) can be far enough away from the beam source, and can move relative to the beam, so that light from a Class 3B laser cannot cause skin injury or material damage. Any such exposure must be tested in advance so as to prevent injury or damage.*

# Trained, competent operators

A Basic Safe Laser Show shall be under the direct and personal control of a trained, competent Laser Operator. All of the following conditions shall be met:

## Under control of the Employer

The Laser Operator shall be under control of the Employer, who shall be responsible for the training and conduct of the Laser Operator. While the Laser Operator does not have to be an employee, there must be a financial or other relationship such that the Laser Operator will do as instructed by the Employer.

*Regulatory note: FDA requires the Laser Operator to be "an employee of the variance holder....". FDA does not define what constitutes an employee relationship. The Basic Safe Laser Show does not require an employee relationship, but does require the Laser Operator to do as instructed.*

## All beams can be seen

The Laser Operator shall be located where all beam paths can be directly observed at all times during laser emission, or be in continuous contact via headset or similar means with one or more Laser Safety Observers such that the entire group of operator plus observer(s) shall directly observe all beam paths during laser emission.

## Terminate unsafe beams

The Laser Operator shall immediately terminate the emission of laser light which is causing, or may imminently cause, any unsafe condition.

*Note: Other laser light may continue if it is not related to the unsafe conditions. This allows use of multiple e-stops or similar. If an unsafe condition arises, one laser or set of lasers can be terminated while other, safe, lasers continue emitting.*

## Terminate in emergency conditions

The Laser Operator shall immediately terminate the emission of laser light in case of an emergency at the venue such as, but not limited to, crowd disruption, panic, fire, or a shooting.

## Terminate upon request of an authority

The Laser Operator shall immediately terminate the emission of laser light upon the request of an Authority Having Jurisdiction[[3]](#footnote-3) over the laser operation, such as a city or state radiation control officer or (in some jurisdictions) a fire department.

For shows with unterminated beams outdoors, the Laser Operator shall immediately terminate the emission of laser light upon request by any air traffic control officials.

*Note: This document does not allow for reducing the laser power. It only permits termination of the laser emission. This is because fewer decisions need to be made: Either keep the beam on, or turn it off. Also, it is easier for inspectors and others to determine compliance by observing the laser beam turning completely off.*

# Do not change the show during performance

No new laser effects, or deviations from the planned laser operation, shall be introduced during the active show or display. Only those laser effects and operations agreed upon prior to the show shall be performed during the show.

If there are changes to be made, they shall be accomplished either prior to, or after the show.

Any new effects, or deviations from the planned laser operation, shall comply with the requirements for a Basic Safe Laser Show.

# Secure mounting of lasers and associated devices

The laser and all other components whose positioning changes or affects the beam location, power or divergence shall be securely mounted or fixed in place to prevent unintended movement or misalignment.

The laser and other components may be on a moving structure and/or may be aimed at a moving structure or target. If so, all movements shall be known and rehearsed in advance. The laser light shall be terminated if there is movement or misalignment which is causing, or may imminently cause, an unsafe condition.

# Beam masking to keep beams to known locations

Beam masking shall be used as needed to prevent overfilling of targets such as screens, mirrors, beam stops, etc. Such masking can be done by physical means using opaque, laser-safe material, or by software control of the beam intensity based on its location (a "beam attenuation map").

If done by physical means, the laser projector and the physical masking of the laser output aperture shall be sufficiently rigid with respect to each other and sufficiently far from the aperture to block the intended safe areas.

If done by software contol, the mask shall be tested prior to each show to ensure beams cannot go beyond the software-set limits. One or more specific test patterns should be used for this purpose.

# Prevent uncontrolled damage to materials

No laser beam shall cause materials damage which is potentially hazardous to humans, including starting a fire or creating smoke. No laser beam should cause damage to materials even if there is no human hazard created.

*Note: Higher power Class 3B beams, and Class 4 beams, can heat materials. Depending on the material color and susceptibility to damage, this can cause materials to smolder, melt, burn or otherwise be damaged.*

*Note: Video camera sensors and projector imaging elements are susceptible to being damaged by laser light. Due to the lens concentrating incoming laser light, this damage can happen at irradiance levels below that which would cause harm to other materials or the human eye. The laser show producer should take reasonable precautions to avoid damage to cameras and projectors, especially expensive professional ones. However, if such damage does occur, it is not considered to violate the requirements of a Basic Safe Laser Show, which is focused on human safety.*

# Anticipate problems, and plan for mitigation

Most reported laser show incidents and accidents have been due to events which could have been foreseen and planned for.[[4]](#footnote-4)

Because of this, the show shall be reviewed for factors which may adversely affect safe laser operation. Especially consider situations where lasers may be moved unexpectedly (persons running into them) or elements may move unexpectedly relative to the laser (stage or trusses out of position).

Contingency plans shall be drawn up to address potential adverse events including those considered unlikely to occur. For example, if a movable stage is out of position, the contingency plan may be to safely adjust the stage laser beam locations, or to kill the stage lasers and activate alternate lasers thus avoiding a total shutdown of beams.

# Signage and/or access restriction

Areas which may contain light from Class 3B or Class 4 lasers shall be clearly identified by the posting of warning signs and/or by restricting access through physical means such as pressure switches, photo cells, barriers, guards, etc.These requirements apply to temporary areas such as during set-up and alignment procedures, as well as to final or permanent areas.

# Notice to authorities

The show should be done in compliance with all applicable notification, registration and certification requirements of the jurisdiction where the show takes place.

*Note: This document covers the safe use of lasers in entertainment and display. If the Basic Safe Laser Show requirements are followed, ILDA considers the show to be safe.*

 *It is not the intent of this document to require, as a safety measure, that the show shall comply with any and all relevant laws. Such laws have their own requirements and penalties. They do not need further assistance from this document in order to apply legal requirements to laser show producers.*

 *The one exception for Basic Safe Laser Shows is the requirement below that outdoor unterminated shows in the U.S. be submitted to FAA. This is because FAA has safety knowledge of airspace that the laser show producer does not have. It is necessary for FAA to review and give their assessment of the show's safety, based on their expert knowledge.*

*Regulatory Note: As previously described, to be legal in the U.S. at the federal level, any laser light show, display or device using Class 3B or Class 4 lasers must apply for a variance and receive FDA approval before introducing the show into commerce. FDA requires notice of laser shows through the Form 3147 variance procedure, as well as related submissions such as the Form 3640 laser light show report and the Form 3636 annual report requirement. In addition, some state and local authorities may require notice of laser shows, registration of the laser equipment, and/or certification of the laser operator.*

# Beams outdoors

The following conditions apply to any light shows or displays that have laser beams projected outdoors into open airspace at any time, including set-up, alignment, rehearsals, and performances.

## Terminated beams

If all beams are terminated on surfaces such that crewed aircraft (including helicopters) could not intercept or pass through the beams, then no reporting is required to aviation authorities.

*Note: There may be unclear cases, such as whether it is possible for a medical helicopter to land in a courtyard or other small restricted area. Consult with the relevant aviation authorities to see if they would request a laser safety submission in such a case.*

## Unterminated beams

If a crewed aircraft could intercept or pass through the beams, then the outdoor portion of the laser operation shall be reported to aviation authorities.

### Report to FAA in the United States

For shows taking place in the United States or with beams that enter the navigable airspace of the United States, reporting of the outdoor laser operation shall be made to the U.S. Federal Aviation Administration, using their current forms and instruction guidelines. (At time of this writing, Form 7140-1 and Advisory Circular AC 70-1B.) Such reporting should be submitted at least 30 days in advance.

FAA will review the submission. If FAA objects to any laser effects, the objections shall be resolved and any conditions requested by FAA shall be adhered to. If these conditions cannot be met, the objectionable effects shall be deleted from the show.

The FAA letter of determination, or copy thereof, shall be available onsite (in paper or electronic format) during all operation of outdoor beams, and shall be made available upon request to FDA, FAA or other relevant authority with jurisdiction over the laser operation and/or the airspace.

The FAA letter of determination shall be retained for at least one year after the end of the laser operation to which the letter applies.

### Reporting outside the United States

For shows taking place outside the U.S. and where beams do not enter the navigable airspace of the United States, reporting of the outdoor laser operation should be made to the appropriate national or regional authority.

If there is no specific agency or requirement for centralized reporting of lasers in airspace, local air traffic control should be notified prior to the show. This notice should include information on how to contact the Laser Operator during the show, if re-aiming or termination should be necessary.

# Record-keeping log

A log shall be kept of the date and location of all laser emissions associated with the Basic Safe Laser Show, including set-up, alignment, rehearsals, and performances. A record of the time, or approximate time ("late morning", "early evening"), of laser emission should also be kept. Additional information on projectors, aiming locations, etc. should also be kept in sufficient detail to confirm compliance with the requirements of this Basic Safe Laser Show.

## Recording incidents and accidents

Any incidents or accidents shall be recorded in the log.

* An **incident** is an event which potentially could have caused personal injury or property damage, but did not.
* An **accident** is an event which caused personal injury or property damage.

This logging requirement applies no matter who reports the incident or accident -- audience, crew, performer, etc. -- or even a person not at the show such as a medical professional. The log serves to record that there was a reported occurrence; it does not prove or disprove the validity or causality of the incident or accident.

## Log-keeping method

The log shall be kept in paper form and/or in electronic form. Either format is acceptable as long as the information is readable and is readily accessible upon the request of an authority with jurisdiction over the laser operation.

## Length of record-keeping

Each record in the log shall be kept for at least one year from the date of laser emission stated in the record.

*Regulatory Note: A standard FDA variance requires information "in sufficient detail to confirm compliance with the regulations and this variance." Thus, FDA requires more information than the above requirement.*

1. Roles of Various Entities at Laser Shows

At a laser show, there are entities with many different roles. These can include the venue management, the band or performers hiring lasers, the general show production company, the production staff including stagecraft unions, the persons or companies providing the lasers, those operating the lasers, and those interacting with the lasers such as performers who are in or near beams.

The multiplicity of roles may diffuse laser safety responsibility. Therefore, for purposes of this document, ILDA has defined the following terms.

## The General Public

The term "General Public" as used herein includes audiences, workers not employed by the Employer [see definition below], and any other persons in the laser show area who cannot be expected to know about laser hazards and/or who cannot be expected to reliably follow instructions to avoid such hazards.

## Laser Personnel

"Laser Personnel" encompasses persons who have been made aware of the laser's hazards and who can reasonably be expected to follow instructions to avoid such hazards. These persons may include Laser Operators, employees of the Employer, and performers who have been briefed and who will follow safety instructions.

*Note: For purposes of this document, a person is either classified as being in the General Public or as Laser Personnel. If unsure, classify them as General Public.*

## Role of the Employer

The employer of the Laser Operator (the “Employer”) has the fundamental responsibility for the assurance of safe use of lasers. The Employer shall establish and maintain an adequate program for the control of laser hazards.

## Role of the Laser Safety Officer

The Laser Safety Officer (LSO) is an individual designated by the Employer with the authority and responsibility to effect the knowledgeable evaluation and control of laser hazards, and to monitor and enforce the control of such hazards. The LSO either performs the stated task or ensures that the task is performed.

The LSO shall have authority to suspend, restrict, or terminate the operation of a laser system if they deem that laser hazard controls are inadequate. For laser safety to be effective, the LSO must have sufficient authority to accompany the responsibility.

## Role of the Laser Operator

The Laser Operator is the person in control of the laser system during normal operation of the laser system. This does not include maintenance or service.

### Continuous monitoring

During laser emission, the Laser Operator's duties depend on the hazard potential of the laser usage.

If the laser beams are kept well away from human exposure, and all persons including the audience, performers and crew can reasonably be expected not to accidentally or deliberately try to intercept the laser beams, then the Laser Operator can do other tasks such as operate lighting or sound boards as long as he or she monitors the laser beams at a reasonable interval such as every 30 seconds.

However, if there are greater potential hazards, then the Laser Operator should have no other duties during laser emission other than continuously monitoring the laser emission. Such potential hazards include if the laser beams are on or close to humans, if the audience is unruly, or if there are changes to the laser mounting (moving trusses) or targets (moving stage sets).

In no case shall the Laser Operator, during any laser emission, be more than an arm's length away from laser beam termination controls such as an e-stop or software screen "off" or "stop" button.

### Mitigate or terminate hazards

If laser emission presents a hazard at any time, including during setup, rehearsal, and show presentation, the Laser Operator shall immediately mitigate the hazard or terminate laser emission.

### Authority and responsibility of the Laser Operator

The Laser Operator may be subject to pressures from other parties to operate or change the show to make it less safe; for example, not to stop the laser effects if a hazard arises during a show.

The Employer shall give the Laser Operator the authority and responsibility to maintain laser safety despite outside pressures. The Employer is responsible if the Laser Operator does not maintain laser safety.

### Laser Operator Training

The Employer or LSO shall provide training or instructions to the Laser Operator adequate to maintain laser safety throughout the scope of the Laser Operator’s tasks. The Laser Operator shall be able to identify all reasonably foreseeable laser hazards, and shall know how to mitigate those hazards.

## Role of the Laser Safety Observer

Other persons may assist the Laser Operator in monitoring for hazards (“spotting”) during laser emission. They may be watching areas the Laser Operator cannot see, looking for stray beams, misaligned targets, performers out of position, unruly audience members, etc. Outdoors, they may be looking for aircraft flying near beam locations (“spotters”).

During laser emission the primary duty of the Laser Safety Observers is to observe beam paths and to help prevent hazardous exposures. The Laser Safety Observers shall be in instant or near-instant (within a few seconds) communication with the Laser Operator. The Laser Safety Observers shall communicate any potential or actual hazards to the Laser Operator.

If a Laser Safety Observer sees a potential or actual hazard, one of the two scenarios below shall occur:

### Scenario 1: Laser Operator terminates

After the Laser Safety Observer communicates any potential or actual hazards to the Laser Operator, they (the Laser Operator) shall then decide whether the hazard requires them to terminate laser emission or otherwise take steps to migitate the hazard (for example, by removing an audience member from a hazard area).

### Scenario 2: Laser Safety Observer terminates

The Laser Safety Observer has the control and authority to terminate laser emission or otherwise mitigate the hazard, without prior consultation with the Laser Operator. Note that the Laser Operator will have been informed of the potential or actual hazard, and that the Laser Operator also retains their control and authority over mitigation/termination.

Throughout this document, the term “Laser Operator” refers both to the actual operator of the laser and to any and all Laser Safety Observers assisting the Laser Operator, unless otherwise noted.

## Persons with more than one role

In cases where a single person produces and presents a laser show or display, the person would be the Employer, the LSO and the Laser Operator. They shall be responsible for all Employer, LSO and Laser Operator responsibilities listed in this document.

## Role of other parties

Other parties such as the venue, the show organizer or producer, bands or other performers, and workers/unions may have laser safety oversight and inputs.

If these parties have concerns, they should present these to the Laser Operator, the LSO (if there is one), and/or the Employer for resolution.

If these parties have authority over the Employer, they may override the Employer if their change increases laser safety. However, they shall not override the Employer if their change may make the laser usage less safe in the judgement of the Employer or the person delegated by the Employer (such as an LSO or Laser Operator) to maintain laser safety.

## Employer as a sub-contractor

If the Employer is a sub-contractor or is otherwise employed by another party having authority over them, the Employer should inform the party of the following: "I [the Employer] have the fundamental responsibility for safe use of lasers. This responsibility may require actions impacting the laser portion of the show, including not operating lasers if an actual or potential hazard is present or develops during the laser emission. Termination of the lasers in the event of a hazard is a legal responsibiity according to government regulations. It is also a legal and moral responsibility to not cause harm to any person."

*Note: In their contract with a party having authority over them, the Employer may wish to include language such as the following: "We are not responsible for damages or consequences if we terminate laser operation, as required by the Basic Safe Laser Show requirements and any applicable governmental regulations and venue requirements, due to an actual or potential hazard that occurs outside our control."*

*This helps ensure that the Laser Operator can maintain laser safety without being unduly concerned over the aesthetic and financial consequences of laser termination during an entertainment, display or exhibition.*

1. Training and Instruction

In this document, “Training” refers to providing information so a person may gain useful knowledge and understanding of topics such as laser safety and procedures in order to 1) safely operate a laser or laser system or 2) safely perform their duties in an environment where laser light is being used.

In contrast, “Instruction” refers to telling a person what to do. There may be a basic reason given (“So your eyes don’t get injured”), or the reason may simply be that it is required by their job (“Because we told you so”).

A trained person is considered more likely to take appropriate actions and to make sophisticated decisions in complex situations.

# General

All training and instruction are the responsibility of the Employer. They may delegate this responsibility to an LSO, Laser Operator or other person qualified to understand and transmit knowledge of the safety procedures and laser operation instructions required by the Laser Personnel.

Training or instruction shall be provided to each LSO, Laser Operator, Laser Safety Observer, and Laser Personnel routinely working with or potentially exposed to Class 1M, Class 2M, Class 3B or Class 4 laser light.

*Note: The type of information -- training or instruction -- and the level of detail required depends on factors including the person's role, their ability to follow instructions, their potential for exposure, and the level of exposure. To give examples: A LSO or Laser Operator may be trained in depth on laser hazards and control measures, and can be expected to implement safety measures. A performer may be given just a brief training background on laser hazards and then instructions on where to stand during laser emission, and can be expected to follow the blocking instructions.*

# LSO Training

The Employer shall provide the LSO with training on the potential hazards (including bioeffects), control measures, applicable standards, and any other pertinent information pertaining to laser safety and applicable standards for the show or display, or the Employer shall provide to the LSO adequate consultative services instead.

LSO training shall cover all laser Classes, including Class 3B and Class 4 lasers.

LSO training shall include all topics covered or discussed in this standard which are relevant to the particular show or display. In addition, LSO training shall include all topics in the section “Class 3B and 4 training topics” below.

The depth of training shall be commensurate with the nature and degree of potential laser hazards with which the LSO will be working.

The training shall include consideration for the evaluation and control of any non-beam hazards associated with the lasers and the laser systems under the jurisdiction of the LSO.

*Regulatory Note: FDA does not require use of LSOs, nor any specific training of LSOs. They do require in Form 3147 (variance) that “All laser light shows shall be under the direct and personal control of trained, competent operators.” There appears to be no additional definition or requirement relating to what “trained” means.*

# Laser Operator training

The Laser Operator shall be trained on the operation of the laser, laser system, and associated laser safety devices and features. The training shall cover both normal operation, and what to do in case of abnormal operation, misalignment, audience unruliness, and other reasonably foreseeable potential hazards.

In addition, the Laser Operator training shall include all topics in the section “Class 3B and 4 training topics” below that are relevant for the show or display.

The duties of the Laser Operator, as detailed elsewhere in this document (“Role of the Laser Operator” section) shall be described to the Laser Operator, including the need to continuously monitor the laser during operation, and to maintain laser safety despite outside pressures.

The Laser Operator shall also be given the training described in the Laser Personnel section below.

*Regulatory Note: See above Note regarding FDA’s requirement for trained, competent operators.*

# Laser Personnel training

Training shall ensure that Laser Personnel are knowledgeable of the potential hazards and the control measures for the part of the show or display that they are operating and/or over which they have safety authority. They may be given additional general-purpose laser safety training.

Laser Personnel shall be trained to understand control measures, to recognize control measure failures, and how to assess how hazardous a situation may be, so that they can make decisions based on this. For example, a Laser Safety Observer shall be trained to know when and how to notify the Laser Operator and/or to take action on their own if appropriate.

All training shall be commensurate with the greatest potential for hazards associated with each laser operation at the show or display. The training shall include how to recognize and avoid both beam hazards and non-beam hazards that are specific to the operation or presence of the laser equipment.

Laser Personnel shall be given authority and responsibility, if appropriate, to direct others (“keep away from there”) in order to maintain laser safety. Laser Personnel shall take direction from the Employer, LSO and Laser Operator in laser safety-related matters.

A clear line of authority shall be established so that Laser Personnel know their own responsibilities, and know who to report to for any potential safety issues that go beyond their own responsibilities.

# General Public

The General Public cannot be expected to be trained nor instructed. They have little or no incentive to follow any training or instruction. For example, they are not employees of the Employer who can be reassigned or disciplined.

For this reason, laser show safety measures shall not rely on the ability of the General Public to understand or follow instructions.

*Note: For example, it should be assumed that the General Public may ignore signs such as "Do Not Enter." Instead, positive steps should be taken so they cannot easily enter a restricted area. These steps may depend on the crowd size and composition. In the "Do Not Enter" example, stanchions can be sufficient for a reserved crowd such as a classical concert audience, while metal barricades would be more appropriate at a music festival.*

# Laser Safety Training Program Topics

Laser safety training shall cover the laser-related hazards (beam and non-beam) specific to the show or display laser use, and to the responsibilities of the person or role being trained.

## Class 3B and 4 training topics

Topics when Class 3B and Class 4 lasers are in use may include, but are not necessarily limited to the following:

1. Where laser radiation and laser light falls on the electromagnetic spectrum
2. Why laser radiation is more hazardous than conventional light or energy sources of the same wavelength
3. Bioeffects of laser light on the eye and skin
4. History (number of occurrences) and examples of laser injuries to technicians and audience members at laser light shows
5. Significance of specular and diffuse reflections
6. How lasers are classified, and what the Classes are, especially concentrating on those Classes which are in use
7. Control measures, especially concentrating on those in use
8. How to recognize failure or breach of the control measures
9. How to anticipate and plan for possible problems (moving stages/trusses, audience unruliness, equipment being moved, changes to performer positions, etc.)
10. Laser safety responsibilities, authority and expectations of the various parties involved, including the Employer; Laser Safety Officer; Laser Operator or Demonstrator; Laser Safety Observer; Laser Personnel; and General Public. Includes chain of command, and reporting requirements when potential hazards develop.
11. Governmental regulations and requirements specific to the person or role being trained
1. Class 3B continuous wave lasers emitting visible light are between 5 mW and 499.9 mW. Class 4 lasers are those 500 mW and above. [↑](#footnote-ref-1)
2. The MPE is a concept in the laser safety field, defined as "the level of laser light to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin." This concept has many facets such as a "reduction factor". The end result is that exposure to laser light levels somewhat above the MPE does not necessarily mean there will be a hazardous effect or adverse changes. It should also be noted that a laser beam's light does spread out. At a close distance a beam may be well above the MPE and thus be hazardous. But at a farther distance the beam's energy has spread out so the exposure (irradiance) on the eye or skin is relatively safer and may even be below the MPE. [↑](#footnote-ref-2)
3. "Authority Having Jurisdiction" means a federal, state, provincial, local, or other regional department; or an individual such as a fire marshal, building official, electrical inspector, utility provider or other individual having statutory authority over the venue, event, gathering, etc. [↑](#footnote-ref-3)
4. Examples include: A movable stage set in the wrong position so audience members were exposed to laser light; audience members being unruly or deliberately trying to access the beam; mylar confetti being unexpectedly shot off in the path of a beam (this involved a pulsed Nd:YAG where a single reflected pulse exceeded the MPE at the audience position); a heavy outdoor laser tilting after rain softened the ground underneath, causing a 70-watt beam to come close to audience members; performers or stagehands accidentally bumping into laser equipment; a motorized truss being moved through the beam path, damaging over $1,000,000 worth of video projectors; a performer who tripped over a stage laser and received a serious eye injury, and a curtain being lowered into a Class 4 beam which started a fire that destroyed the theater. It should be noted in a number of these cases that the laser emission did not cease when the mis-aiming was first noticed. This is unsafe and goes against the ILDA Basic Safe Laser Show requirements. It should also be noted that in all cases but one, there was no reported eye injury from these incidents and accidents. [↑](#footnote-ref-4)