# Laser Light Show Safety Overview

**Laser light shows MUST be safe for everyone: audience, performers, stage workers and laser techs. This document gives a quick summary and overview. If you are creating, producing, or otherwise in charge of a laser show, it is highly recommended to take a Laser Safety Officer course specifically focused on laser shows.**

**Laser light shows SHOULD also be legal; see the other side for U.S. legal requirements.**

## Safe Setup and Performance

- **Inspect and test projectors** before use including shutters, interlocks, and emergency stops.
- * For each show, **fill out and follow a checklist** which covers written procedures for setup, alignment, testing, and performance. You must have both the procedures and the corresponding checklist items for each show.
- **Plan where the beam will be going:** projector locations, beam paths, audience areas, performers, and reflective surfaces.
- **Plan for things that can go wrong** (people breaching barriers, performers out of position, equipment slipping, etc.). Prepare backup plans in advance to ensure safety and to not artistically impact the performance.
- * **Secure the projectors and any targets** (mirrors, termination points) so they cannot slip or move. Small movements can become large ones at distance.
- Use secondary **safety cables** for any overhead mounted equipment.
- Do laser positioning and set-up with the lowest power needed so that beam termination points can reliably be seen.
- Make a plan to validate zones before the show. During the show, make sure beams stay within their specified zone.
- **Prevent static beams** into audience and public accessible areas. Eliminate reflective hazards.
- **Brief crew and performers** on beam locations and restrict access to projector areas.
- * Do the show or effects **only at the highest power needed** for the effect. Do not use excessive power (such as 50 watt beams in an arena).
- **Avoid charring or burning materials;** prevent any beam from causing fire or flame.
  - Dark materials relatively close to a thin (low divergence) beam are more susceptible to damage.
- **Avoid hitting cameras and video projectors;** the sensor or imaging element may become damaged.
  - It is not illegal to damage equipment, but it may be expensive. Laser safety laws exist to prevent *human* injuries.
- * **Keep beams well above audience head height.**
  - In the U.S., normally beams must be 3 meters (9' 10") above the surface where the audience is reasonably expected to stand, and they must be 2.5 meters (8' 2.5") to the side or below where the audience can be.
  - Beams must NOT be on anyone unless special safety measures and procedures are used. In the U.S., the FDA must approve an "audience scanning" variance. Without an audience scanning variance, any audience exposure is likely to be VERY HAZARDOUS and will definitely be ILLEGAL.
- * All laser light shows must be under the direct and personal control of a **trained, competent operator**.
- * The operator must be able to **see all beam paths at all times** (or be assisted by a spotter, so all beams can be seen and known to be safe).
- * Have one or more **emergency stops accessible** to the operator at all times.
- * In the event of an imminent or actual unsafe condition, **IMMEDIATELY e-stop the laser(s)** causing the unsafe condition.
  - Pre-plan either so there are no unsafe conditions, or so the show quality is not adversely affected if one or more lasers have to be e-stopped. **There is no excuse for not e-stopping to prevent human exposure to laser light.**
  - You may want to have multiple e-stops, one for each major group of lasers. If there is a problem with lasers in one group, that group can be e-stopped while the other group continues.
- For laser beams aimed outdoors into airspace, design the show, and e-stop when necessary, to **prevent any beam from being near or on any aircraft.** Use spotters if needed to assist.
  - * In the U.S., the Federal Aviation Administration must review and not object to light show laser beams in navigable airspace. The review should be submitted to FAA at least 90 days in advance of the show,
- **Document any issues** during the show in the checklist, so they can be prevented at future shows.

** Items in blue are specifically required by U.S. Food and Drug Administration (FDA) variances. See back of this sheet for FDA forms and additional requirements.*

# Forms and Requirements for U.S. Laser Light Shows

## FDA Form 3632 – Laser Product Report (manufacturers/importers only)

**Submitted by manufacturers or importers** of lasers, laser systems, and laser show projectors.

- Laser light show users in the U.S. should only purchase and use projectors that were certified by the manufacturer or importer using Form 3632. These will have a legitimate Accession Number from FDA. **Buy from well-known, reliable, U.S. legal laser manufacturers** – not from eBay, Alibaba or similar.

## FDA Form 3147 – Application for a Variance for a Laser Light Show, Display, or Device

**Required for laser show projectors** (e.g., equipment/devices), **and for laser light shows** (e.g., how the equipment will be used)

- Submitted by the projector manufacturer (equipment) or show producer (laser shows).
- Describes projectors, safety features, beam effects, audience exposure controls, and procedures.
- See other side of this sheet for items required by FDA in a standard variance (shown in blue).
- FDA will review the application and will (hopefully) send a variance approval letter.

**No U.S. laser shows or displays can be done without an approved FDA variance.**

## FDA Form 3640 – Laser Light Show Report

**Required to submit with the variance application**, plus when you do new types of shows or installations

- The laser light show producer must describe the specific projectors being used, the nature of the shows performed, and the engineering and administrative safety controls.

## FDA Form 3636 – Guide for Preparing Annual Reports on Laser Light Show Products

To maintain the variance, **an annual report must be filed by September 1 each year.**

- Variances are good for one year, from July 1 to the following June 30. Then you must file an annual report. Otherwise, the variance expires on December 31
- List shows done during the year, confirm continued compliance.

## For outdoor laser operations: FAA Form 7140-1 and FAA Advisory Circular AC 70-1B

Required by FDA's variance, **for any outdoor show where beams may enter navigable airspace.**

- Submit information to FAA using Form 7140-1. Instructions are in a separate document, AC 70-1B.
- FAA will review the request; this may take 30-90 days. FAA will reply with a "Letter of Determination."
    - The letter will either state that FAA has no objections to the usage, or the letter will state that FAA objects to the usage and will give the reason. If there are objections, FDA's variance requires either that the objectionable laser effects not be used, or that the usage should be changed to fix FAA's objections.

## Documents to have onsite

**FDA requires the following documents to be available at the laser show:** your variance application, FDA's variance approval letter, your most recent annual report, FDA's annual report acknowledgement letter, your procedures, and your checklist. For outdoor shows in airspace, you also must have your FAA submission forms and FAA's Letter of Determination not objecting to the show.

In addition, **you optionally may want to have other documents** such as any submissions, registrations, etc. to state or local authorities; certificates and printed manuals from any laser safety courses you have taken; standards such as ANSI Z136.1 or NFPA 115 Laser Fire Protection; etc. This helps show your safety knowledge.

## State, local and venue requirements

**FDA requires notification of state and local laser safety agencies**, and that you follow any special requirements they may have.

- Several U.S. states have requirements ranging from licensing operators (NY) or having third-party inspectors onsite (IL), to notification and/or laser equipment registration (AZ, FL, MA, TX).
- Some cities (including Cleveland, Orlando, Palm Springs and Portland) require registration with, and inspection by, the local fire department.
- Venues may have their own requirements.

Check in advance with persons experienced with doing laser shows in these states, localities, and venues to find out requirements.

- A partial listing of these requirements is at lasershowsafety.info/state-laws.html

This document covers Class 3B and 4 lasers (above 5 milliwatts) used in public laser light shows. FDA requirements are less stringent for Class 2 and 3R lasers that are too dim for most laser light shows, and for laser light shows done exclusively in a home for family and friends ("not introduced into commerce").