Laser-Illuminated Cinema Projection
Regulatory Update

ICTA at CineEurope - 2015

Bill Beck

• LIPA Co-founder and Membership Chair
• The Laser Guy – Barco
Outline

1. What is LIPA and what does it do?
2. What is a Laser Illuminated Projector - “LIP”?
3. Why are LIPs regulated?
4. Who regulates LIPs?
5. What must Exhibitors do to deploy LIPs?
6. Summary
Introduction to LIPA

Mission and Objectives
Membership
LIPA= Laser-Illuminated Projector Association

Mission: To simplify the adoption of laser illuminated projectors through cooperative industry activity
  » Safety
  » Regulatory Simplification
  » Education, metrology and best practices

Membership: Performance projection industry
  » Projector manufacturers (Cinema and non-cinema)
  » Component manufacturers (lasers, chips, screens, lenses)
  » End-Users (exhibitors, integrators, studios, theme parks)

LIPA GOAL: Make it easier and safe to install and operate Laser illuminated projectors = “LIPs”
LIPA Members - 23

Please Join LIPA...!
Laser Illuminated Projector Systems

How LIPs are different from Lamp Projectors
Laser ILLUMINATED Projectors

RED GREEN and BLUE laser beams are EXPANDED to Illuminate the 3 imaging chips in the projector. Each primary image is then recombined and projected onto the screen.

Further expanding the beam:

But no high power laser beams come out of the projector.
Laser Illumination Architectures

- **All-Laser**
  - 2D array of red, green, and blue lasers
  - Micro-spatial light modulators (LCOS, DMD, or LCD)
  - Optical diffuser
  - Light combiner

- **Bulb-based**
  - Projector bulb

- **Phosphor**
  - 2D array of blue laser diodes
  - Phosphor element and light combiner

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Past regulation logic
LIPA Proposes new risk definition
Why are Laser Projectors Regulated?

- In the 1970s, Laser Light Shows (LLS) came on the scene.
- These Laser Light Shows used dangerous, high power, “collimated” laser beams that rapidly scanned the venue.
- Direct exposure to high RADIANCE laser beams could cause eye damage.
- First US FDA, then other agencies, regulated Laser Light Shows.
- 40 years later, Laser ILLUMINATED Projectors (LIPs) arrived.

BUT THEY ARE MORE LIKE LAMP PROJECTORS THAN LASER SHOWS.
LIP Regulatory Terminology

- Brightness [lumens] (photometric)
- Throw Ratio
- Angular subtense $\alpha$ [Rad]
- Radiance $L$ [W/m²sr] (radiometric) ≈ effect on the human eye

- **IEC 60825-1:2014** laser safety standard
- **IEC 62471:2006** lamp (broadband) safety standard
- **IEC 62471-5:2015** (Final Draft stage) image projector safety standard
Laser Brightness – RADIANCE

From Sliney DH and Trokel, S, 1993
Comparison of RADIANCE Values

<table>
<thead>
<tr>
<th>Light Source</th>
<th>Radiance Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 mW laser pointer</td>
<td>70</td>
<td>MW/m²-sr</td>
</tr>
<tr>
<td>The SUN (visible λ)</td>
<td>7</td>
<td>MW/m²-sr</td>
</tr>
<tr>
<td>30,000 lumen Laser cinema projector</td>
<td>2</td>
<td>MW/m²-sr</td>
</tr>
</tbody>
</table>

If one looks directly into the lens – then you blink!
How are LIPs Regulated?

Per definition: any and all LIP emissions = laser radiation

Regulatory bodies base safety regulations on the LASER classification scheme

So Classification of LIP’s = Class 4 laser product

BUT…

By the end of 2014, the classification scheme in the laser safety standard for Projectors updated => LIP emission = lamp-based emission
How did LIPA Change the LOGIC?

- LIPA Commissioned Study: Tested optical characteristics of
  - 35mm film projector
  - Current Xenon short-arc digital cinema projectors
  - Prototype laser projectors (DLP Cinema® and LCoS)
- Lead Researcher: Dr. David Sliney
  - Casey Stack, Laser Compliance
  - Jay Parkinson, Phoenix Laser Safety
  - David Schnuelle, Dolby Laboratories
- 8 LIPs and Xenon projectors tested over 7 months

Study Conclusion: IF LIP Radiance = Lamp Radiance, THEN... HAZARDS ARE EQUIVALENT
LIPA Peer-Reviewed Cover Story

- Published in *Health Physics*, March 2014
  - Radiation Safety Journal
  - Official Journal of the Health Physics Society
- Peer review complete
- Cover story!

Additional analysis presented at Society of Motion Picture & Television Engineers Conference – October 22, 2013.
What the SCIENCE tells us…

Hazard Risk is based on **RADIANCE**

For ~same brightness, **LIP** emission RADIENCE ~=

**lamp projector** emission RADIENCE

Therefore -

**LIP regulations should conform to Lamp projector regulations**
Who Regulates LIPs

International/Europe
USA
Major Regulatory Agencies
LIPA Strategy to change IEC, FDA Regs

LIPA’s strategy to simplify and update regulations:

- Use scientifically validated “Equivalent Hazard” doctrine to harmonize LIP regulations with Lamp Projector regulations
- First with the IEC (Global Scope)
- Then recommend FDA conform with IEC Edition 3
“Old” IEC Laser Projector Regulation

All laser product requirements are defined in 60825

- Medical
- Industrial
- Laboratory
- Laser Welding
- Laser Illuminated Projectors

IEC 60825-1 Ed 2 (2007)
Safety of Laser Products
Part 1: Equipment classification & Requirements
IEC 60825-1 was updated in 2014

IEC 60825-1 Ed 3 (2014)
Safety of Laser Products
Part 1: Equipment classification & Requirements

IEC 62471 Ed 1 (2006)
Photobiological safety of lamps and lamp systems

Carve-out for devices with RADIANCE < (1 MW m⁻² sr⁻¹)/α
LIP Regulation under IEC

IEC 60825-1 Ed 3 (2014)
Safety of Laser Products
Part 1: Equipment classification & Requirements

IEC 62471-5 Ed 1 (2015)
Photobiological safety of Lamp Systems for Image Projectors
IEC “DASH 5” SUCCESS!!!

IEC 62471-5:2015 Photo-biological safety of lamps and lamp systems
Part 5: Image projectors

Abstract

IEC 62471-5:2015(E) provides a risk group classification system for image projectors, and measurement conditions for optical radiation emitted by image projectors. It includes manufacturing requirements that may be required as a result of an image projector system being assigned to a particular risk group. Therefore, this part of IEC 62471 provides safety requirements for lamp systems that are intended to produce projected visible optical radiation, such as theatre projectors, data projectors and home-use projectors. The assigned risk group of a projector product also may be used by projector manufacturers to assist with any risk assessments, e.g. for occupational exposure in workplaces. National requirements may exist for the assessment of products or occupational exposure.
IEC’S New Approach: Risk Groups

• Laser safety standards IEC EN 60825-1 → Classification based on Accessible Emission Limits (AEL): Class 1 and 2 are defined as safe

<table>
<thead>
<tr>
<th>60825-1:</th>
<th>62471-1:</th>
<th>Risk:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1 (8h)</td>
<td>Risk Group 0</td>
<td>Inherent safe</td>
</tr>
<tr>
<td>Class 1</td>
<td>Risk Group 1</td>
<td>Safe reasonably foreseeable conditions of operation</td>
</tr>
<tr>
<td>Class 1M</td>
<td>Risk Group 2</td>
<td>Safe, based on aversion responses (&lt;0.25 s exposure)</td>
</tr>
<tr>
<td>Class 2</td>
<td>Risk Group 3</td>
<td>Potentially hazardous for eye and skin. Safety measures are required</td>
</tr>
<tr>
<td>Class 2M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 3R</td>
<td></td>
<td></td>
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<tr>
<td>Class 3B</td>
<td></td>
<td></td>
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<tr>
<td>Class 4</td>
<td></td>
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</tbody>
</table>

• Broadband safety standards IEC EN 62471 Classification → based on Accessible emission limits: Risk group 0, 1 and 2 are defined as safe

• ICNIRP guidelines define exposure limits, which in turn are basis for ELVs in the AORD and AELs in IEC standards
Risk Group Classification according IEC 62471-5:2015 FDIS (Final Draft International Standard)

**RG3:** Potentially hazardous, require controlled user and/or installation requirements
Cinema and staged applications

**RG2:** safe based on aversion response (blink reflex)
Home/office use projectors

**RG1:** safe for prolonged staring
Pico projectors

**RG0:** inherently safe

For throw ratio 2.0

Hazard Distance

- > 1m
- < 15,000 lm
- < 500 lm
- 0 lm
Regulatory Compliance for Cinema Manufacturers and Exhibitors

Manufacturers
Exhibitors
It is Legal to install LIP Systems in Theaters

- e.g., DP4KL-60L = **Class 4** laser power *inside*
- Complies with strict engineering requirements
- Risk-based Hazard Distance (**HD**)
- Barco has received a **Variance** from US FDA
- Installation and information requirements
Manufacturer’s Responsibilities

- Provide the end-user (theater operator):
  - All **required** information on how to **install** a LIP resulting in a safe installation
  - **Provide** installation and operator **training** and support
  - Provide all required **emission data** in order to make a risk assessment (RA) possible

- Release products to the market that **comply with strict safety standards**

- **Regulators** will give more attention to high brightness emission

- Manufactures have the **obligation** to provide their customers **training** and **guidance**
Exhibitor Regulatory Requirements

- Implement **local** government **safety regulation**
  - Laser light show **variance**
  - **Event safety** regulation

- Requirements based on **exposure limits** (**not laser class**)
  - **LIP operator**
    - Laser system Operator Training requirements
    - Projection booth requirements (restricted area, protective barriers)
    - Risk-based implementation
  - **Cinema visitor** (general public)
    - No exposure above safety limits is allowed in any case!
    - Physical barrier or sufficient separation height (**SH**) >3 meters within Hazard Distance (**HD**)
U.S. Regulatory Environment

FDA = Food and Drug Administration
CDRH = Center for Devices and Radiological Health
FDA Guidance Document

- Intended to address Laser Illuminated Projectors
- Immediately in effect (as of February 18, 2015)
- “Document describes FDA’s intent…”
- “…does not establish legally enforceable responsibilities”
- “… non-binding recommendations”

Immediately in Effect Guidance Document: Classification and Requirements for Laser Illuminated Projectors (LIPs)

Guidance for Industry and Food and Drug Administration Staff

Document issued on February 18, 2015.

For questions about this document, contact Patrick Harris at Patrick.Harris@fda.hhs.gov or (301) 796-5927.

U.S. Department of Health and Human Services
Food and Drug Administration
Center for Devices and Radiological Health
Office of In Vitro Diagnostics and Radiological Health (OID) Division of Radiological Health
Problems with New Guidance Document

- It incorrectly **compares Risk Groups** with laser **Classes** in terms of risk
  - Some Laser Regulations still apply (e.g. LSO, State regulations)
- **References outdated IEC standards** for characterizing LIPs
- **Mismatch in evaluation conditions, distance for determination of Risk Groups**
  - Overstates risk of many projectors
- **Overly restricts access** --
  - Entire light beam, not just within Hazard Distance
- Even **more projectors require a Variance application** than previously
Managing Hazard Distance (HD)

FDA Guidance Document requires:
“…a restricted access area that extends beyond the beam hazard distance.”

Requested revision:
“No direct exposure to beam shall be permitted within the Hazard Distance”
LIPA Urgent FDA Recommendations

- **Revise** the Guidance Document

- Harmonize **classification measurement** methods with International (IEC) standards

- Adopt **reasonable safety precautions** for Risk Group 3 projectors
  - Harmonize with latest IEC standards
    - IEC 60825-1 Ed 3 (2014)
    - IEC 62471-5 Ed 1 (2015)

- Then **NO PRODUCT VARIANCES** will be required
Bottom Line for Digital Cinema

• You can legally purchase, import, operate and enjoy LIPS today!
  • Manufacture requires a product variance for each model / family
  • But the operator (theater) typically does not need variance

• Regulatory compliance is required (defined in each variance)
  • Reporting, record-keeping on installation
  • permanent immobile installation
  • Separation Height = HD >3 meter IEC (2.5 meter for FDA variances)
  • Signage for Access controlled booth
  • Emergency shut-down capability
  • State, local and municipal regulations
  • ANSI Z-136 requirements (e.g. Laser Safety Officer)*
  • Variance will need to be renewed (typically 5 year term)

  *Subject to interpretation; Consult Local Legal Counsel
Summary

LIPs are safe
Regulatory Compliance has been Simplified
Summary

• Laser Illuminated Projectors (LIPs) will be the foundation of Next-Generation Cinema

• With LIPA’s guidance, global standards have evolved and the regulatory environment is becoming more favorable

• LIPs are safe and regulatory compliance has been simplified thanks to LIPA’s good work

• Commercialization has begun and early adopters are quickly learning how to safely deploy, operate and profit from Laser Illuminated Projection

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Thank You for Your Interest

Questions?