ANSI Z136
Current Status of Laser Safety Standards

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Laser Safety Standards

- Accredited Standard Committee (ASC) Z136
- Formed in 1969 by request of DoL
- First standard published in 1973
Standard Setting Process: Simplified Overview

**SSC** – Standards Subcommittee
**SCD** – Subcommittee draft
**SCDV** – Subcommittee draft for vote
**TSC** – Technical Subcommittees
**EWG** – Editorial Working Group
**CDV** – Committee draft for vote

*Begin* SSC → SCD → SCDV → Balloting Group → EWG → Secretariat → CDV

**TSC**

**Publish Standard!**

**End**

**ASI** → Public Review

**Re-ballot (?)** → Balloting Group

*Begin* SSC

**Re-ballot (?)**
Current & Draft Standards

- Z136.1-2007 – for Safe Use of Lasers
- Z136.2-2013 – for Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources
- Z136.3-2011 – for Safe Use of Lasers in Health Care
- Z136.4-2010 – RP for Laser Safety Measurements for Hazard Evaluation
- Z136.5-2009 – for Safe Use of Lasers In Educational Institutions
- Z136.6-2005 – for Safe Use of Lasers Outdoors
- Z136.8-2012 – for Safe Use of Lasers in Research, Development, or Testing
- Z136.9-20XX – for Safe Use of Lasers in Manufacturing Environments
- Z136.10-20XX – for Safe Use of Lasers in Entertainment, Displays and Exhibitions

Purple – under revision; Red – draft standard; Green – on furlough; Brown – just reconvened
## Status of Standards in Revision or Draft Format

<table>
<thead>
<tr>
<th>Standard</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z136.1</td>
<td>CDV approved but in recirculation (consensus); late 2013 or early 2014</td>
</tr>
<tr>
<td>Z136.2</td>
<td>Approved; announced by LIA yesterday!</td>
</tr>
<tr>
<td>Z136.5</td>
<td>On furlough; may or may not reconvene</td>
</tr>
<tr>
<td>Z136.6</td>
<td>SCDV approved; in queue for 1st EWG review; need to establish balloting group; ~ 18 months out</td>
</tr>
<tr>
<td>Z136.7</td>
<td>Just reconvened; Jim Sheehy chair again</td>
</tr>
<tr>
<td>Z136.9</td>
<td>CDV approved but in recirculation (consensus); through EWG; will publish just before Z136.1</td>
</tr>
<tr>
<td>Z136.10</td>
<td>SCD; hope to have SCDV following ILSC in March</td>
</tr>
</tbody>
</table>
Some Information from A Few Standards

- Z136.1
- Z136.2
- Z136.8
- Z136.9
- Z136.6 & .10

Information from draft standards is subject to change!!
Z136.1 – for Safe Use of Lasers

- Will remain the “horizontal” standard for one more edition
- Revision of the control measures section
- Changes to the non-beam hazards section
- Significant change for correction factor $C_C$
- Major revision to maximum permissible exposure (MPEs)
Laser Eye Protection

- Currently not required for Class 3B lasers or laser systems
  - Section 4.3.10.1 (9)
- Proposed change to require LEP for Class 3B & 4 unless LSO can demonstrate it is not necessary
- Information added on saturable absorption & visual light transmission
Warning Signs

- Four signal words:
  - Danger – death or serious injury, e.g., multi-kW lasers
  - Warning – Classes 3R & 3B & more conventional Class 4 lasers

- New sign format:
  - ANSI Z535.2-2011

- Existing signs are grandfathered in...
Changes to Non-beam Hazards

- More detailed information on irradiance-dependent non-beam hazards
- Includes section on lasers and generation of nanoparticles
- Bibliography removed from the standard and placed online
  - Z136.org web page in the “references” section
Overview of MPE Changes

- MPEs won’t change for many commonly used point-source, CW lasers including:
  - Yb:YAG - 1030 nm
  - Nd:YAG - 1064 nm
  - Yb fiber - 1070 nm
  - CO₂ - 10,600 nm

- Most skin MPEs did not change

- No changes in the magnitudes of $C_A$, $C_B$, $T_1$ & $T_2$

- MPEs won’t change for
  - UV-emitting lasers
  - Far IR lasers from 1800 nm to 1 mm
Some of the Changes to MPEs

- **400-1400 nm**
  - MPEs increase & decrease for $1 \times 10^{-13} \leq t < 5 \times 10^{-6}$ s
  - $t^{3/4}$ dependence extended from 18-50 µs to 5 or 13 µs, but removed for shorter duration pulses
  - $\alpha_{\text{max}}$ is now time dependent and not constant at 100 mrad
    - This alters $C_E$ which is a function of $\alpha_{\text{max}}$ for sources with large angular subtense

- **1200-1400 nm**
  - MPEs increase because of increase in correction factor $C_C$
  - MPEs expressed as dual limits for retina and cornea/iris/lens

- **1400-1500 nm**
  - MPEs increase for $1 \times 10^{-9} \leq t < 4$ s
Correction Factor $C_C$

- Newest correction factor (2000 Std)
- Thermal effects correction factor where water in the vitreous attenuates far-IR wavelengths between 1150 and 1400 nm
- Currently, MPE's can increase as much as 8X (1200-1400 nm)
- Change: beyond $\sim$1250 nm $C_C$ increases exponentially resulting in $C_C = 1,000,008$ at 1400 nm
Rule 3: Multiple Pulse Correction Factor

- Rule 3 will apply only if:
  - $400 \text{ nm} \leq \lambda \leq 1400 \text{ nm}$
  - $t > t_{\text{min}}$ where $t_{\text{min}} = 5 \mu\text{s}$ for $400-1050 \text{ nm}$ & $13 \mu\text{s}$ for $1050-1400 \text{ nm}$
  - $\alpha > 5 \text{ mrad}$

- Hence, only Rules 1 & 2 are necessary for UV and far-IR lasers
- And, of course, Rule 3 has never applied to skin MPEs
Something Anticipated That Didn’t Occur...

- Extend ultra-short pulse duration from $1 \times 10^{-13}$ to $1 \times 10^{-14}$ s
  - Still don’t have the necessary animal test data
  - Hence, MPE determination still must be based on peak irradiance at 100 fs for $t < 100$ fs
Changes of MPE & Associated Tables

<table>
<thead>
<tr>
<th>Item</th>
<th>2007 Standard</th>
<th>Draft Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocular MPEs</td>
<td>Tables 5a &amp; 5b</td>
<td>Tables 5a, 5b, 5c, 5d, 5e &amp; 5f</td>
</tr>
<tr>
<td>Skin MPEs</td>
<td>Table 7</td>
<td>Tables 7a, 7b &amp; 7c</td>
</tr>
<tr>
<td>Correction factors</td>
<td>Table 6</td>
<td>Tables 6a, 6b &amp; 6c</td>
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So, the MPEs will have a different appearance and will take a little more page turning to determine the magnitude...but laser safety software sales should benefit!
Z136.2 for Safe Use of OFCS Utilizing Laser Diode and LED Sources

- Adds free-space optical communication systems (FSOCS)
- Hazard evaluation now based on
  - OFCS - Hazard level of complete system
  - FSOCS - Access level of complete system
- Hazard & access levels are based upon reasonably foreseeable accessible optical radiation & location of the system
Z136.8 for Safe Use of Lasers in Research, Development, or Testing

- Does not include MPEs, so dot 1 is necessary as well
- Non-beam hazards not included in the standard
- Opinion: concern about the guidance dealing with uncertified laser products, e.g., OEM devices
  - Standard does include a copy of the Federal Laser Product Performance Standard (FLPPS) in an appendix.
- Includes information from EN207 on the LEP classification
  - D, I, R, M for emission duration and L number for scale (similar to OD)
- Includes audit forms & administrative forms in an appendix
- Includes information on export controls
Other Standards

- for Safe Use of Lasers in Manufacturing (Z136.9-201X)
  - Very similar to existing dot 1
  - Recirculation ballot due to debate about MPEs in document

- for Safe Use of Lasers Outdoors & for Safe Use of Lasers in Entertainment...
  - Worked out scope issue with outdoor applications, which will remain with outdoor std.

- for Safe Use of Lasers in Entertainment... (Z136.10-201X)
  - Very diverse target audience (part-time DJs to laser entertainment professionals)
  - Will use personnel categories for controls at trade shows
Never underestimate the importance of safety training!

THE END!