ANSI Z80.1 – 2005
New Standard, New Specs

ANSI Z80.1 = The Lens Standard

ANSI Z80.1 is officially known as:
ANSI Z80.1-2005 – American National Standard for Ophthalmics –
Recommendations for Prescription Ophthalmic Lenses

Optical labs know it as ANSI Z80.1 – the lens standard. The newest revision of Z80.1 was approved by ANSI with an effective date of December 19, 2005, and copies of the standard are now ready for distribution.

- ANSI Z80.1-2005 replaces ANSI Z80.1-1999
- Copies are free to OLA Members (see story on this page)
- Changes in the tolerance on cylinder axis
- Changes in the tolerance on refractive power for progressive lenses

• Results for labs
  - significant decrease in rejects for cylinder axis error
  - significant decrease in PAL rejects for refractive power error

This newsletter contains an analysis of Z80.1-2005 by OLA Technical Director Dan Torgersen. Dan’s report describes the new specifications of Z80.1-2005. He presents the research results that were used to develop the 2005 revision, and he documents the resulting reductions in cylinder axis error and in refractive power error in progressive lenses. OLA is preparing a Quick-Reference Summary chart of the technical specifications from Z80.1-2005, that OLA Members can use in their labs and with their accounts.

FREE for OLA Members!!

OLA Members – get a free copy of the new ANSI Z80.1-2005 standard!

OLA Members – get a free copy of the new ANSI Z80.1-2005 standard! As a benefit of your OLA membership, you may obtain a copy of the new ANSI Z80.1-2005 standard at absolutely no cost. Non-members will have to buy the standard for $75 at the ANSI store.

The standard is available in electronic format (Adobe PDF document format). OLA grants the right to OLA members to copy and distribute ANSI Z80.1-2005 only for use within their own company. Revenues from the sale of ANSI Z80.1 support OLA’s participation on the ANSI Z80 Standards Development Committee.

How to get your FREE copy of ANSI Z80.1-2005 –
1. Go to the OLA website – www.ola-labs.org
2. Click on “Get Z80.1-2005” near the top of the homepage
3. Enter your Members Only username and password (call OLA 800-477-5652 for help)
4. Follow the instructions on the ANSI Z80.1 screen to download the standard. Call OLA (800-477-5652) for assistance.

The Members Only login screen protects the value of your OLA membership benefits. Forgot your username and password? Call OLA – 800-477-5652, or email ola@ola-labs.org.

Not online? OLA will provide a copy of Z80.1-2005 – on a CD, or 3.5 disk, or printed hard copy – for the cost of production, shipping, and handling. CD or 3.5 disk - $15; printed, GBC bound copy - $25.
ANSI Z80.1 - 2005

By Dan Torgersen, OLA Technical Director

ANSI Z80.1-2005, American National Standard for Ophthalmics – Recommendations for Prescription Ophthalmic Lenses, has been given final approval by ANSI with an effective date of December 19, 2005. This revision replaces ANSI Z80.1-1999 and contains two significant changes: the tolerance on cylinder axis and the tolerance on progressive lens refractive power.

Tolerance on Cylinder Axis

A comparison of ANSI Z80.1-1999 and ANSI Z80.1-2005 shows the following tolerances on cylinder axis.

Tolerance on Direction of Cylinder Axis

<table>
<thead>
<tr>
<th>Nominal Value of Cylinder (D)</th>
<th>≤ 0.25</th>
<th>.375</th>
<th>.50</th>
<th>&gt; 0.50 to ≤ 0.75</th>
<th>&gt; 0.75</th>
<th>≤ 1.50</th>
<th>&gt; 1.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis Tolerance ANSI Z80.1-1999</td>
<td>± 7°</td>
<td>± 7°</td>
<td>± 5°</td>
<td>± 5°</td>
<td>± 3°</td>
<td>± 2°</td>
<td></td>
</tr>
<tr>
<td>Axis Tolerance ANSI Z80.1-2005</td>
<td>± 14°</td>
<td>± 7°</td>
<td>± 7°</td>
<td>± 5°</td>
<td>± 3°</td>
<td>± 2°</td>
<td></td>
</tr>
</tbody>
</table>

Basis for the Change

It is apparent that the tolerance on the cylinder axis for cylinders below 0.75 D has been increased. The Z80 Committee approached the tolerance on cylinder axis by asking how far the axis must be shifted in order to introduce an error in the cylinder power equivalent to a cylinder power tolerance of 0.12 D. This can be calculated by the following equation.

\[ \alpha = \sin^{-1} \left( \frac{C}{2F_1} \right) \]

Where:
\[ \alpha \] = the angle
\[ C \] = resultant cylinder power error (0.12 D)
\[ F_1 \] = prescribed cylinder power

The graph below illustrates the result of this calculation. This result was used to establish the tolerance for the low cylinders (0.50 D and less).

There is precedence in using this approach. Dr. Glen Fry used a similar methodology to arrive at the same conclusions in 1977 and was published in Optometric Weekly in an article entitled “Tolerances for Cylinder Axis”. That analysis expanded the tolerances in the 1972 standard to those of the 1979 standard. ANSI Z80.1-1999 used the same tolerances as the 1979 standard. Despite the fact that Dr. Fry’s analysis indicated that the cylinder axis tolerance for low cylinder powers should be expanded to those indicated in the above graph, the ANSI Z80 Committee at that time thought the expansion would be too extreme to be accepted.

Why Change Now?

In 2004 the majority of presbyopes used progressive lenses. It is common that progressive lenses have small amounts of unwanted cylinder at the distance reference point. This is recognized in ISO standards for semi-finished blanks which allow more cylinder for progressive lenses than standard multifocal and single vision semi-finished blanks. The presence of even a small amount of cylinder can significantly change the prescribed cylinder axis. Consider an Rx which has prescribed cylinder of -0.25 D @ 180°. This Rx is ground into a semi-finished blank having unwanted cylinder of -0.09 D @ 45° (which is equal to the ISO tolerance). The result, as shown below in Figure 1, is a crossed cylinder with a resultant cylinder of -0.26 D @ 10°.

Effect on the Wearer

How might the increased tolerance on cylinder axis affect the wearer?

As noted above, a 14° axis error for a 0.25 cylinder produces a cylinder power error of 0.12 D. The 1999 standard allowed a 7° axis error which produces a cylinder power error of 0.06 D. Consequently, the difference in cylinder power error between the two standards is 0.06 D.

How does the cylinder power error affect the wearer? Simply stated, it moves the circle of least confusion by one-half the amount of the error as shown in Figure 2.

The 1999 standard allowed a 7° axis error for a -0.25 D cylinder which produces a cylinder power error of 0.06 D. Consequently, the wearer will experience a change in the circle of least confusion of 0.03 D. The 2005 standard allows a 14° axis error for a -0.25 D cylinder which produces a cylinder power error of 0.12 D. Consequently, the wearer will experience a change in the circle of least confusion of 0.06 D. Obviously, the difference in the circle of least confusion between the 1999 and 2005 standards is 0.03 D, a difference most wearers will not notice.
Effect on the Labs

How might the increased tolerance on cylinder axis affect the laboratory?

In 1999 a study was done in which 800 lenses were taken from the shipping room and measured by an independent company to assess compliance with the applicable tolerances of ANSI Z80.1-1999. The highest number of rejects in the study was for cylinder axis error and amounted to 9.3%.

Applying the new cylinder axis tolerance to the lenses tested in 1999 would decrease rejects to 7.0% (see Figure 3). This is a very significant decrease in rejects!

Refractive Power Tolerance

The US has no tolerances on front curves for semi-finished blanks. Manufacturers therefore follow the International Standard Organization (ISO) tolerances for front surface accuracy of semi-finished blanks. The ISO standard tolerances (ISO 10322-1 for semi-finished single vision and multifocal lens blanks and ISO 10322-2 for semi-finished progressive lens blanks) are different in recognition of the fact that progressive lenses are more difficult to manufacture than single vision and standard multifocal lens blanks. The ISO standards are:

### ISO 10322-1, Semi-finished Single Vision and Multifocal Lens Blanks

<table>
<thead>
<tr>
<th>Surface power of the meridian with the highest absolute surface power</th>
<th>Tolerance on surface power ( \frac{F_1 + F_2}{2} )</th>
<th>Tolerance on astigmatism for spherical surfaces ( IF_1 - F_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \geq 0.00 ) and ( \leq 2.00 )</td>
<td>( \pm 0.09 )</td>
<td>0.04</td>
</tr>
<tr>
<td>( &gt;2.00 ) and ( \leq 10.00 )</td>
<td>( \pm 0.06 )</td>
<td>0.04</td>
</tr>
<tr>
<td>( &gt;10.00 ) and ( \leq 15.00 )</td>
<td>( \pm 0.09 )</td>
<td>0.04</td>
</tr>
<tr>
<td>15.00 and ( \leq 20.00 )</td>
<td>( \pm 0.12 )</td>
<td>0.06</td>
</tr>
<tr>
<td>&gt;20.00</td>
<td>( \pm 0.25 )</td>
<td>0.06</td>
</tr>
</tbody>
</table>

**NOTE -** \( F_1 \) and \( F_2 \) are the surface powers of the principal meridians

### ISO 10322-2, Semi-finished Progressive Lens Blanks

<table>
<thead>
<tr>
<th>Distance surface power of the meridian with the highest absolute surface power</th>
<th>Tolerance on the distance surface power ( \frac{F_1 + F_2}{2} )</th>
<th>Tolerance on astigmatism specified by the manufacturer ( IF_1 - F_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \geq 0.00 ) and ( \leq 10.00 )</td>
<td>( \pm 0.09 )</td>
<td>0.09</td>
</tr>
<tr>
<td>( &gt;10.00 ) and ( \leq 15.00 )</td>
<td>( \pm 0.12 )</td>
<td>0.12</td>
</tr>
</tbody>
</table>

**NOTE -** \( F_1 \) and \( F_2 \) are the surface powers of the principal meridians

The ISO tolerances are for surface power while the US typically uses surface curve. Converting the above table from surface power to surface curve (in 1.530 D) for CR-39 (refractive index of 1.498) yields the following:

<table>
<thead>
<tr>
<th>Surface curve (1.530 D) in the meridian of highest absolute surface curve</th>
<th>Tolerance on surface curve ( \frac{F_1 + F_2}{2} )</th>
<th>Tolerance on astigmatism for spherical curves ( IF_1 - F_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \geq 0.00 ) and ( \leq 10.64 )</td>
<td>( \pm 0.096 )</td>
<td>0.043</td>
</tr>
<tr>
<td>( &gt;10.64 ) and ( \leq 15.96 )</td>
<td>( \pm 0.096 )</td>
<td>0.043</td>
</tr>
</tbody>
</table>

**NOTE -** \( F_1 \) and \( F_2 \) are the surface curves in the principal meridians

The most common step tooling used by laboratories is 0.125 D. This means that at the extreme of the tooling, the error due to tooling can be 0.0625 D. In the case where the errors are additive and each is at the extreme of the tolerance, the error on a CR-39 progressive lens can be 0.1585 D (0.096 due to the semi-finished blank tolerance and 0.0625 D from the step tooling). It was for this reason that the tolerance was set at 0.16 D, due to manufacturing capability at the extremes of the tolerances, and cognizant of the fact that ANSI standards are meant to be minimum standards.

The refractive power tolerance for single vision and standard multifocal lenses did not change from that of ANSI Z80.1-1999. The refractive power tolerance for progressives in ANSI Z80.1-2005 is:
Another paper by Judith Perrigin, et al, “A Comparison of Clinical Refractive Data Obtained by Three Examiners” reported the repeatability of refraction on 32 subjects was 98% within ± 0.50 D (*American Journal of Optometry & Physiological Optics*, Vol 59, No 6). This again indicates that an increase in the tolerance from 0.12 D to 0.16 D should, for the average patient, be non-problematic.

Consequently, the conclusion to be drawn from the above clinical studies indicates that the typical wearer should experience no problems from the expanded tolerances of refractive power.

**Conclusion**

The two significant changes in ANSI Z80.1-2005 are justified from a manufacturing capability point of view and also from a consistency viewpoint.

The effect on the lab should be a significant decrease in rejects thereby improving delivery time and cost containment of prescription prices.

The decrease in visual acuity on the wearer should be negligible.

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**Effect on the Labs**

Is the increase in the refractive power tolerance in ANSI Z80.1-2005 validated in lab rejects? The following data are from the COLTS ANSI Conformance Study done in 1999 and using the 1999 standard.

![Figure 4 - ANSI Conformance Study – Total % Rejects by Style](image)

It is clear that progressives have more rejects by almost a factor of 2. Figure 5 shows the rejects for failures in the Meridian of Highest Absolute Power, the ANSI Conformance Study.

When the above reject data was analyzed using the progressive lens refractive power tolerance of ANSI Z80.1-2005, the percentage rejects decreased from 11.17% to 6.31%!

![Figure 5 - % Failure for Rejects in the Meridian of Highest Absolute Power](image)

Another paper by Judith Perrigin, et al, “A Comparison of Clinical Refractive Data Obtained by Three Examiners” reported the repeatability of refraction on 32 subjects was 98% within ± 0.50 D (*American Journal of Optometry & Physiological Optics*, Vol 59, No 6). This again indicates that an increase in the tolerance from 0.12 D to 0.16 D should, for the average patient, be non-problematic.

Consequently, the conclusion to be drawn from the above clinical studies indicates that the typical wearer should experience no problems from the expanded tolerances of refractive power.

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**Effect on the Wearer**

What is the effect on the wearer when the refractive power tolerance is increased by 0.03 D?

A paper that was published in the May 2005 edition of *Optometry and Vision Science* by Jim Sheedy, et al, “Evaluation of an Automated Subjective Refractor” reported that the repeatability of refraction on 60 patients at the 95% LoA was -0.49 to +0.46 D. This indicates that an increase in the tolerance from 0.12 D to 0.16 D should, for the average patient, be non-problematic.

Another paper by Mark Bullimore, et al, “The Repeatability of Automated and Clinical Refraction” reported the repeatability of refraction on 86 patients at the 95% limits of agreement was -0.36 to + 0.40 D (*Optometry and Vision Science*, Vol 75, No. 8, August 1998). This indicates that an increase in the tolerance from 0.12 D to 0.16 D should, for the average patient, be non-problematic.