Compensated Powers
(and other ophthalmic conundrums)

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Vice President Professional Services
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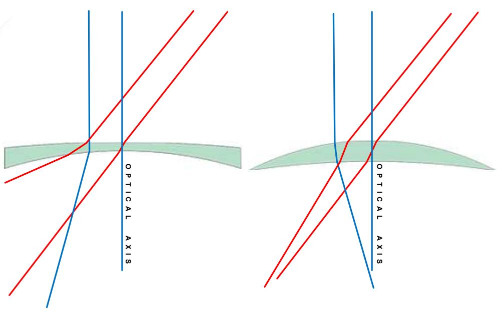
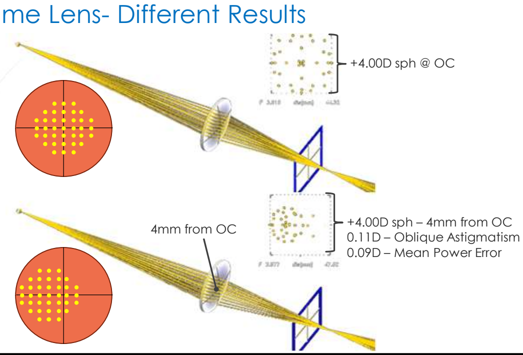
VISION EXPO

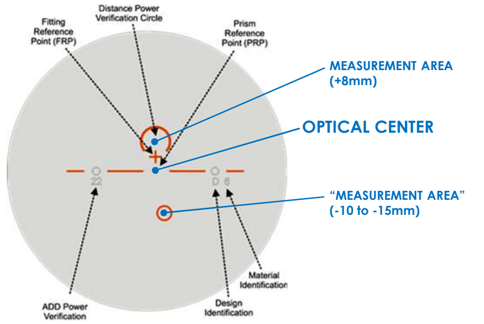
What are Compensated Powers?



Same Lens- Different Results

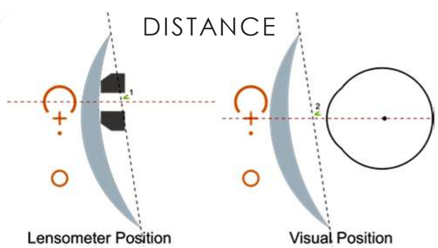


PALs are not measured @ OC



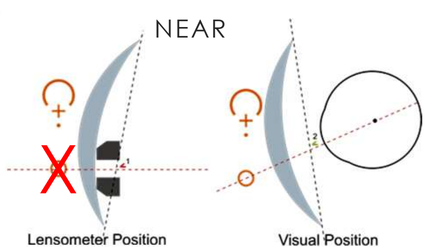
PALs are not measured “in position”

DISTANCE

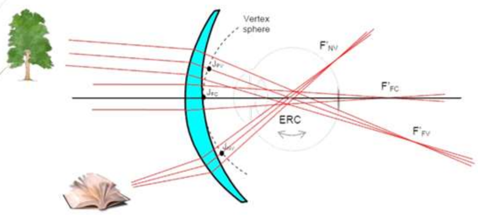


PALs are not measured “in position”

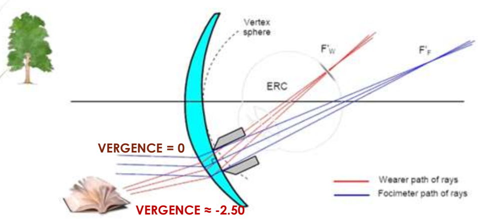
NEAR



PAL as seen by the eye…

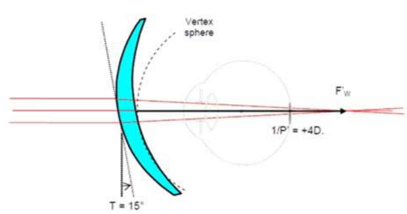


PAL as measured by a lensometer…



Measured vs. Worn Conditions

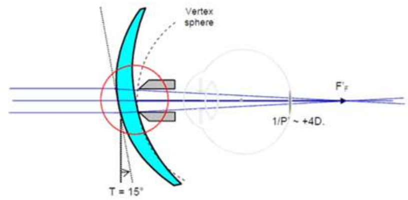
+4.00 sph SV lens in worn position w/ 15° pantoscopic tilt



Measured vs. Worn Conditions

+4.00 sph SV lens in worn position w/ 15° pantoscopic tilt

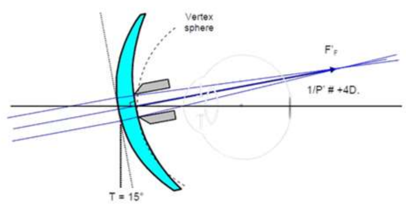
Lens is not measured in worn position…



Measured vs. Worn Conditions

+4.00 sph SV lens in worn position w/ 15° pantoscopic tilt

Lens is tilted 15° away from worn position…



Measured vs. Worn Conditions

ANGLE (°)	SPHERE (D.)	CYLINDER (D.)	AXIS (°)
0	4.00	0.00	-
3	3.99	0.01	90
6	3.94	0.04	90
9	3.87	0.10	90
12	3.77	0.17	90
15	3.64	0.27	90

Measured focimeter powers of an as-worn +4D. SV calculated lens taking into account a tilt of ANGLE.

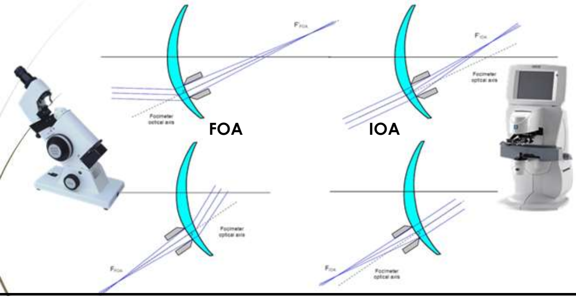
Has the power really been "compensated" (changed)?

No. The lens is still a +4.00 sph.

"Compensated" power indicates how the lensometer will see the lens.

Methods of Measurement

All lensometers are not created equal…



Methods of Measurement

+5.00 -4.00 x 090 FOA vs IOA (CV)

	Min. sphere (D.)	Max. sphere (D.)
FOA	1.03	5.06
IOA	0.99	4.98
Discrepancies (FOA – IOA)	+0.04	+0.08

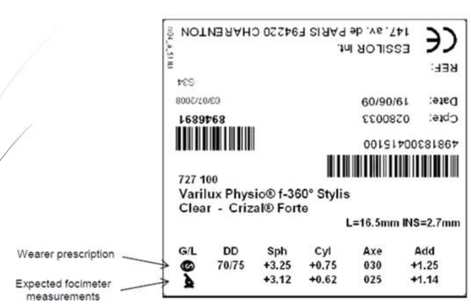
ADD measurement discrepancy FOA (CV v CX)

		Convex	Concave
Mean sphere (D.)	Far vision	3.05	2.92
	Near vision	5.72	5.40
Addition		2.48	2.67
Discrepancies (Concave – Convex)		+0.19	

ADD measurement discrepancy IOA (CX v Wearer)

		Convex	Wearer
Mean sphere (D.)	Far vision	2.95	3.05
	Near vision	5.46	5.90
Addition		2.51	2.84
Discrepancies (Wearer – Convex)		+0.33	

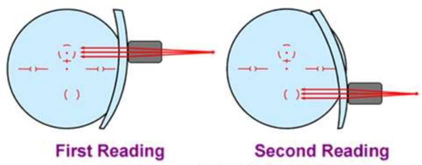
Measured power ≠ ordered power



If you simply *must* verify near power…

- Use FRONT vertex power for Traditional & Dual-Sided PALs
  - mount lenses "backwards" on lensometer
  - measure distance power through distance verification circle
  - measure power through near verification circle
  - calculate the difference and compare to *compensated* value

(For FBS PALs, measure BACK vertex power)



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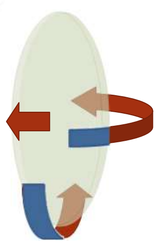
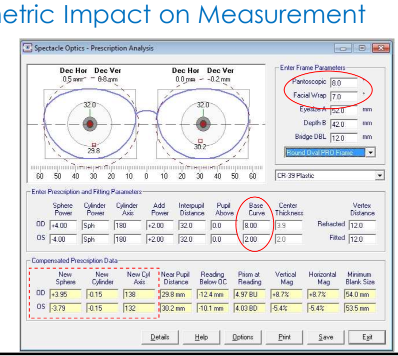
Lens Geometry Also Has an Impact



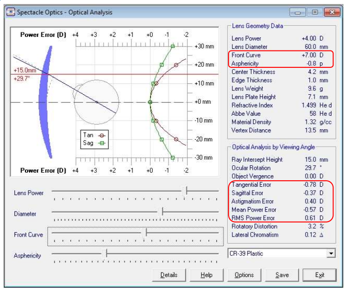
- **Surface Geometry**
  - Curvature
  - P-value (asphericity)
  - Thickness
- **Positional Geometry**
  - Pantoscopic Angle (vertical tilt)
  - Wrap Angle (horizontal tilt)
  - Vertex Distance
  - Optical Center Position

Geometric Impact on Measurement



Geometric Impact on Measurement

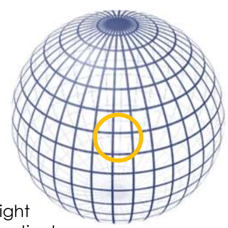
P-values (asphericity) also effect measurements…



P 1.0 = SPHERE, P 0.0 = PARABOLOID, P -0.5 = HYPERBOLOID, P 0.5 = PROLATE ELLIPSOID

Communicating Compensation

The "Beach Ball" example…



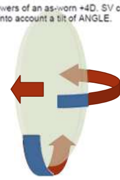
…of course, the ball is still spherical- but its effect on light changes depending on direction!

Communicating Compensation

Simple demonstration…

ANGLE (°)	SPHERE (D.)	CYLINDER (D.)	AXIS (°)
0	4.00	0.00	-
3	3.99	0.01	90
6	3.94	0.04	90
9	3.87	0.10	90
12	3.77	0.17	90
15	3.64	0.27	90

Measured focimeter powers of an as-worn +4D. SV calculated lens taking into account a tilt of ANGLE.



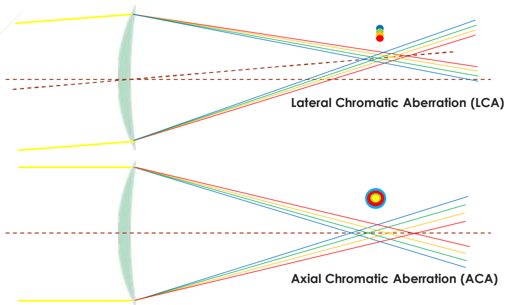
Take a +4.00 spherical lens, and measure with different amounts of tilt.

Compensated Powers

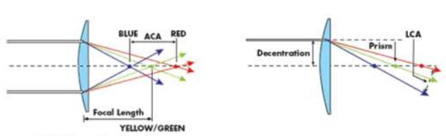
"Compensation" does NOT change the ordered power…

…compensation indicates how the ordered power will be seen by the lensometer!

What is Chromatic Aberration?



What is Chromatic Aberration?

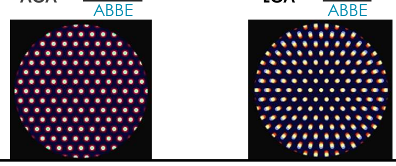


Axial Chromatic Aberration

$ACA = \frac{POWER}{ABBE}$

Lateral Chromatic Aberration

$LCA = \frac{PRISM}{ABBE}$



Abbe Value and Chromatic Aberration

Abbe Facts (Fabbies ☺)

- Plano lenses produce ZERO chromatic aberration
- No LCA at the optical center- regardless of power
  (if blur occurs looking straight ahead, its not LCA)
- Human eye has >1.00 diopter of ACA
- Studies show >0.12D CA <u>may</u> be noticeable to some
  (>3.75D of power/prism is required for 0.12D CA)
- If patient non-adapts to poly, but accepts 1.67… the problem was NOT chromatic aberration
- AR does NOTHING to reduce chromatic aberration

Abbe Value and Chromatic Aberration

Abbe Facts (Fabbies ☺)

- Plano lenses produce ZERO chromatic aberration

0 0

ACA = POWER / ABBE

(ANY VALUE)

0 0

LCA = PRISM / ABBE

(ANY VALUE)

Abbe Value and Chromatic Aberration

Abbe Facts (Fabbies ☺)

- No LCA at the optical center- regardless of power

If the patient has blur in the center of the lens, the problem <u>is not chroma</u> (unless the lenses are exceptionally high power).

0 0

LCA = PRISM / ABBE

(ANY VALUE)

Abbe Value and Chromatic Aberration

Abbe Facts (Fabbies ☺)

- If patient non-adapts to poly, but accepts 1.67… the problem was NOT chromatic aberration

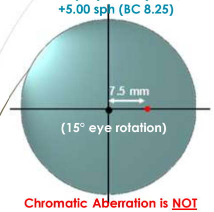
0.161 **LCA** = 5.00 PRISM / ABBE 31 (Poly)

0.156 **LCA** = 5.00 PRISM / ABBE 32 (1.67)

Abbe Value and Chromatic Aberration

Abbe Facts (Fabbies ☺)

- Studies show >0.12D CA may be noticeable to some



LCA = 3.75 PRISM / ABBE

Abbe Value and Chromatic Aberration

Abbe Facts (Fabbies ☺)

- Studies show >0.12D CA may be noticeable to some

CR-39 (58) = 0.06∆ LCA = 20/21
Trivex (44) = 0.09∆ LCA = 20/22
Polycarb (30)= 0.13∆ LCA = 20/23
1.60 MR-8 (41)= 0.09∆ LCA = 20/22
1.67 MR-7 (32)= 0.12∆ LCA = 20/23

LCA = 3.75 PRISM / ABBE

Chromatic Aberration is NOT an issue in ANY material (for 93.7% of wearers at least)!

LATERAL CA	VISUAL ACUITY
0.05 ∆	20/21
0.10 ∆	20/22
0.15 ∆	20/24
0.20 ∆	20/26
0.25 ∆	20/28
0.30 ∆	20/31
0.35 ∆	20/34
0.40 ∆	20/39
0.45 ∆	20/44
0.50 ∆	20/51
0.55 ∆	20/60
0.60 ∆	20/75

Effect of Chromatic Dispersion of a Lens on Visual Acuity,
Meslin, D. & Obrecht, G.
Am. J. of Optom. & Physiol. Optics. 65:25-28, 1988.)

How No-Glare Works

Eliminating Reflections with Reflections

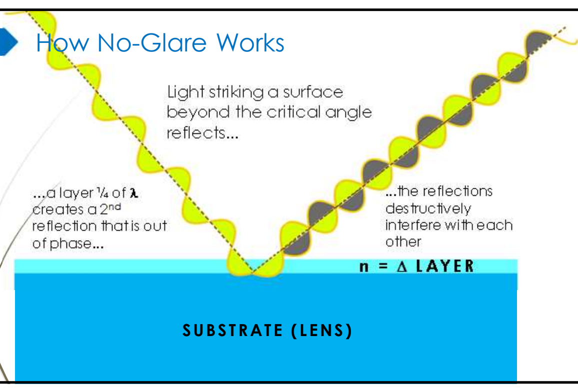
Light waves can be "cancelled" through a process called "destructive interference…"

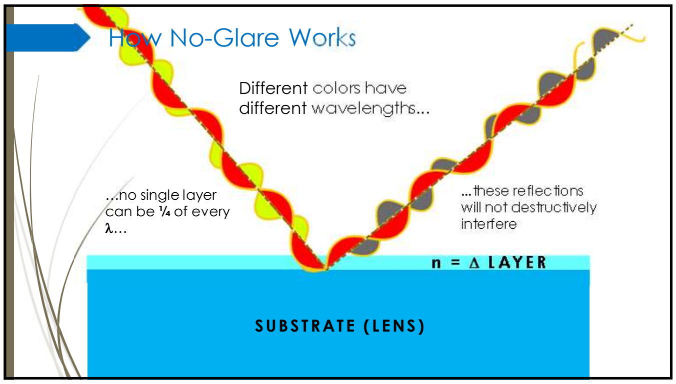
…light waves in opposition cancel each other out

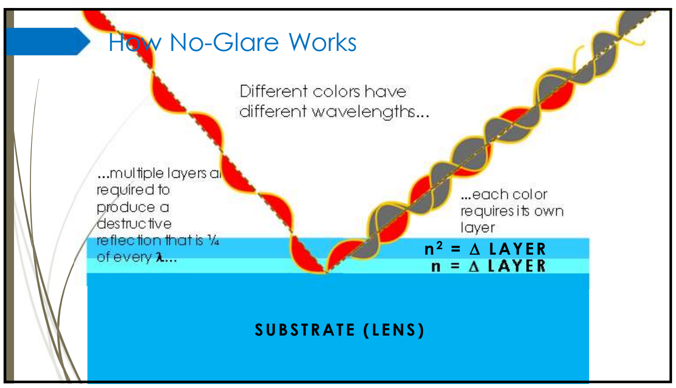
How No-Glare Works

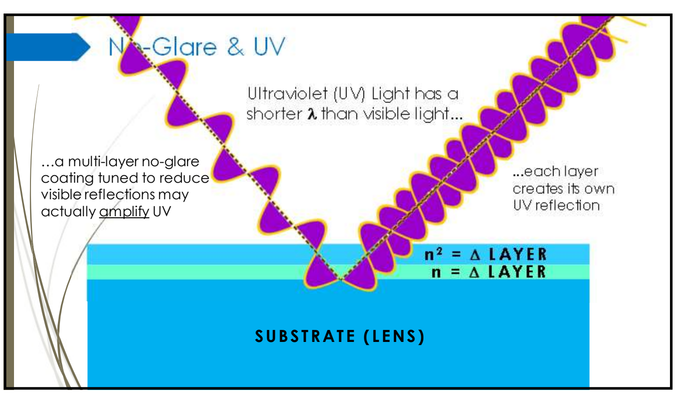
Noise cancellation headphones use the same principle...

How No-Glare Works




How No-Glare Works
Different colors have different wavelengths…
…no single layer can be ¼ of every λ…
…these reflections will not destructively interfere
n = Δ LAYER
SUBSTRATE (LENS)

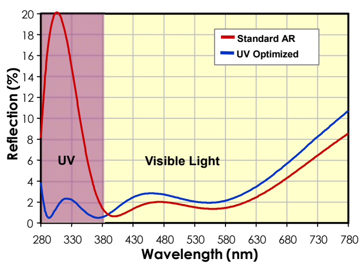

How No-Glare Works
Different colors have different wavelengths…
…multiple layers a required to produce a destructive reflection that is ¼ of every λ…
…each color requires its own layer
n² = Δ LAYER
n = Δ LAYER
SUBSTRATE (LENS)


No-Glare & UV
Ultraviolet (UV) Light has a shorter λ than visible light…
…a multi-layer no-glare coating tuned to reduce visible reflections may actually amplify UV
…each layer creates its own UV reflection
n² = Δ LAYER
n = Δ LAYER
SUBSTRATE (LENS)

No-Glare & UV

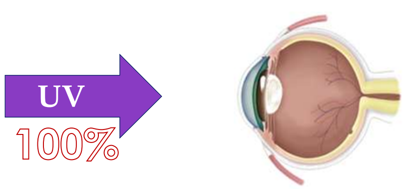
Imagine the result if the cancellation sound in the headphone was the SAME (in phase) as the external noise ...

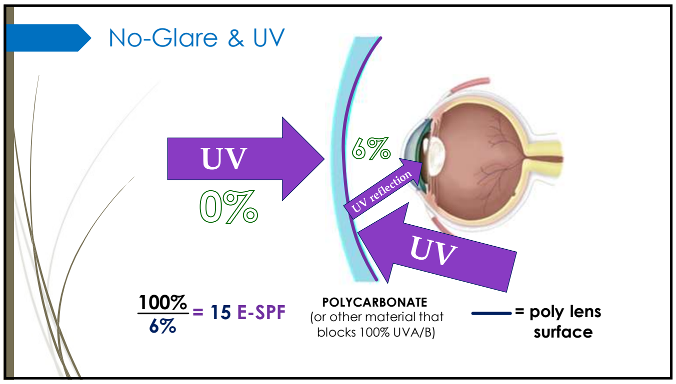
No-Glare & UV

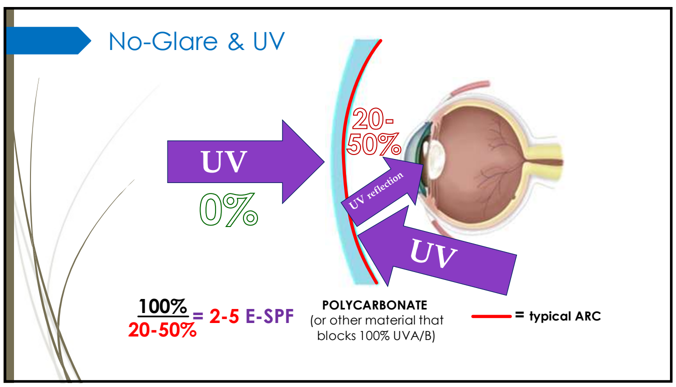


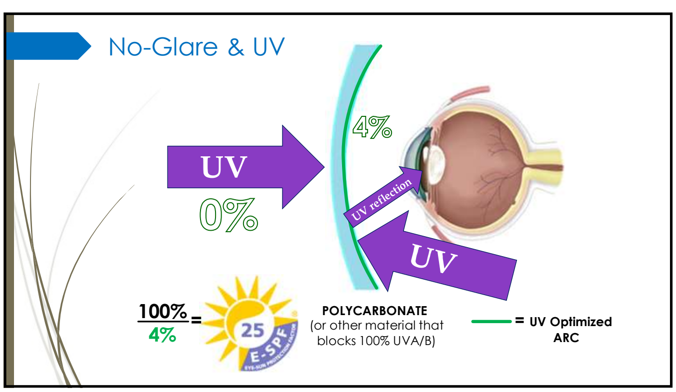
Imagine the result if a no-glare coating created UV reflections IN PHASE with each other…

No-Glare & UV




No-Glare & UV
UV
0%
6%
UV reflection
UV
100% / 6% = 15 E-SPF
POLYCARBONATE
(or other material that blocks 100% UVA/B)
= poly lens surface


No-Glare & UV
UV
0%
20-50%
UV reflection
UV
100% / 20-50% = 2-5 E-SPF
POLYCARBONATE
(or other material that blocks 100% UVA/B)
= typical ARC


No-Glare & UV
UV
0%
4%
UV reflection
UV
100% / 4% =
25 E-SPF
POLYCARBONATE
(or other material that blocks 100% UVA/B)
= UV Optimized ARC

What is ANSI?

AMERICAN NATIONAL STANDARD — ANSI Z80.1-2010

1.2 Purpose

This standard reflects the shift in utilization from mass-produced lenses to a basic dependence upon custom-processed lenses at the laboratory level. It does not represent tolerances that describe the state-of-the-art of the ophthalmic laboratory, but provides quality goals for new pristine lenses prepared to individual prescription. The individual performance parameters listed in this standard can be achieved reliably. However, it is difficult to meet all of the requirements simultaneously in any given lens or mounted pair. The fact that, under rigorous application of this standard, a significant number of spectacles (approximately 25%, based upon industry data) will not achieve all parameters simultaneously, must be accepted as a reflection of the state-of-the-art. As such, this standard expresses desirable technical concepts that provide a frame of reference for safety and effectiveness and is not designed as a regulatory instrument.

…and what ISN'T it?

5.1 General

Both uncut and edged finished lenses shall meet the following requirements. For lenses produced with compensations to account for as worn correction, the tolerances in the tables in clause 5 apply to those values specified by the manufacturer and not to the prescribed RX.

5.1.1 Distance Refractive Power (Back Vertex Power)

5.1.1.1 Single Vision and Multifocal Lenses

Table 1 – Tolerance on Distance Refractive Power (Single-Vision and Multifocal Lenses)

Sphere Meridian Power	Tolerance on Sphere Meridian Power	Cylinder ≥ 0.00 D ≤ - 2.00 D	Cylinder > - 2.00 D ≤ - 4.50 D	Cylinder > - 4.50 D
From - 6.50 D to + 6.50 D	± 0.13 D	± 0.13 D	± 0.15 D	± 4%
Stronger than ± 6.50 D	± 2%	± 0.13 D	± 0.15 D	± 4%

5.1.1.2 Progressive Addition Lenses

Table 2 – Tolerance on Distance Refractive Power (Progressive Addition Lenses)

Sphere Meridian Power	Tolerance on Sphere Meridian Power	Cylinder ≥ 0.00 D ≤ - 2.00 D	Cylinder > - 2.00 D ≤ - 3.50 D	Cylinder > - 3.50 D
From -8.00 D to + 8.00 D	± 0.16 D	± 0.16 D	± 0.18 D	± 5%
Stronger than ± 8.00 D	± 2%	± 0.16 D	± 0.18 D	± 5%