ABO Advanced Exam Review
Domain III

Use of Ophthalmic Instrumentation Part I

NFOS

Domain 3 Tasks

- Explain the use of ophthalmic instrumentation
- Analyze the utilization of dispensing information
- Determine method of fabrication and ordering
- Distinguish the uses of visual assessment instrumentation
- Apply knowledge of legal and professional requirements for equipment maintenance

The Art and Science of Eyewear Fabrication

The Art and Science of Eyewear Fabrication

- Apply formulae used in the manufacture of eyewear.
- Describe the capabilities and limitations of conventional and digital surfacing.
- Explain the lens blank selection process.
- Describe factors that affect lens curves and thickness.
- List the steps from surface layout to finished lens edging.
- Apply verification standards in compliance with ANSI and federal regulations.

Lens Fabrication

- Base Curves
- Boxing System
- Minimum Blank Size
- Optical Cross
- Transposition
  -

Lens Designs

Single Vision

- Spherical
- Aspheric
- Atoric

Bifocals

Progressive Addition Lenses

Prescription to Lens Blank

- Material
- Minimum Blank Size
- Vertex Power Compensation
- Resultant Prism
- Nominal Power
- Sagittal Depth Formula
- Thick Lens Back Vertex Power

History of Spherical Lens Design

- Biconvex
- Biconcave
- Plano Convex
- Plano Concave
- **Meniscus**

Aberrations

Chromatic VS monochromatic

Aberrations

Chromatic

Chromatic Abberation

Dispersion of white light into individual colors

Through prism

Aberrations

More dispersion for some materials than others

Inverse of the amount of Dispersion = abbe

Therefore, for Abbe, HIGH number is less dispersion

Low number is MORE dispersion

Aberrations

Glass Abbe = 58

CR -39 = 58

Poly = 43-45

Poly = 30

High Index 1.70 = 36

Aberrations

Chromatic aberration is a function of MATERIAL

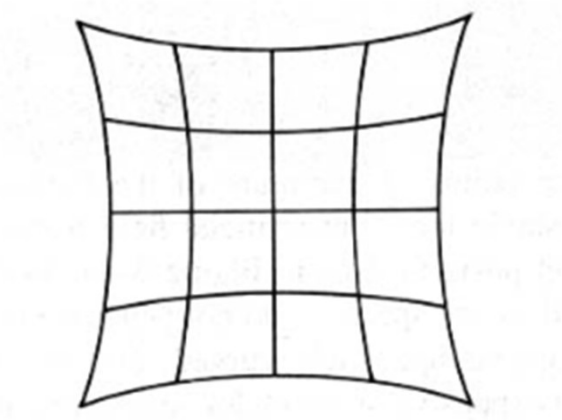
I

Achromatic Abberations

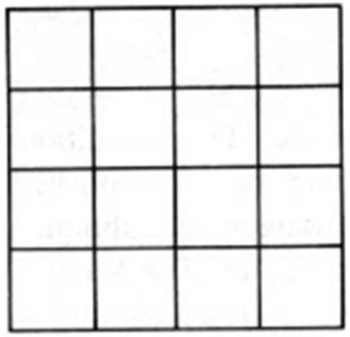
- 5 seidel abberations
  - Spherical Abberation
  - Coma
  - Marginal/Oblique Astigmatism
  - Curvature of Field
  - Distortion

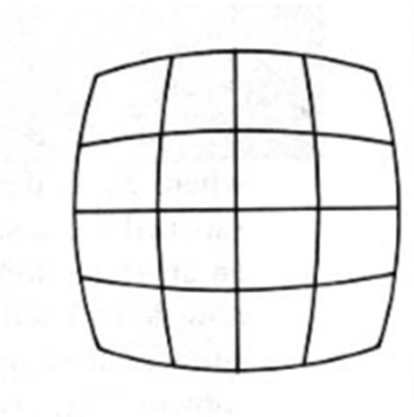
Achromatic Abberations

- 5 seidel abberations
  - Spherical Abberation
    - Not generally a big deal due to pupil size
  - Distortion



Pincushion
Plus lenses





Barrel
minus lenses

Base Curves

Flatter Base Curves

Less Magnification

Thinner lenses

Steeper Base Curves

More Magnification

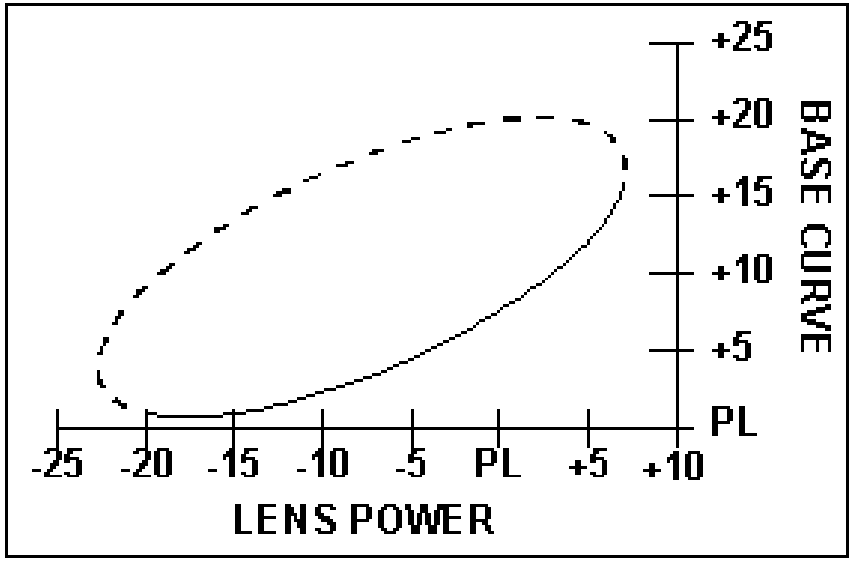
Thicker lenses

Corrective Curve or "Best Form" Lens Theory

- Tscherning Ellipse
  - Best Base Curve to eliminate **Marginal** or **Oblique Astigmatism**

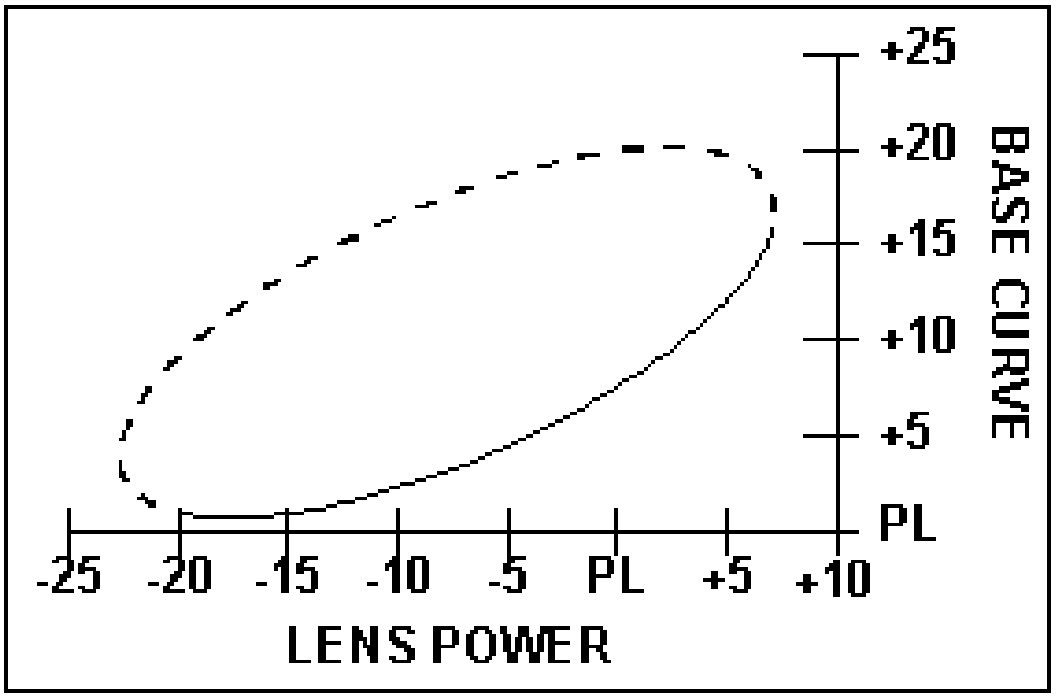
Tscherning Ellipse

- A graphical representation of the front surface power as a function of the total lens power in best-form lenses.
- There are two possible solutions, those that are least curved and those that are most curved.



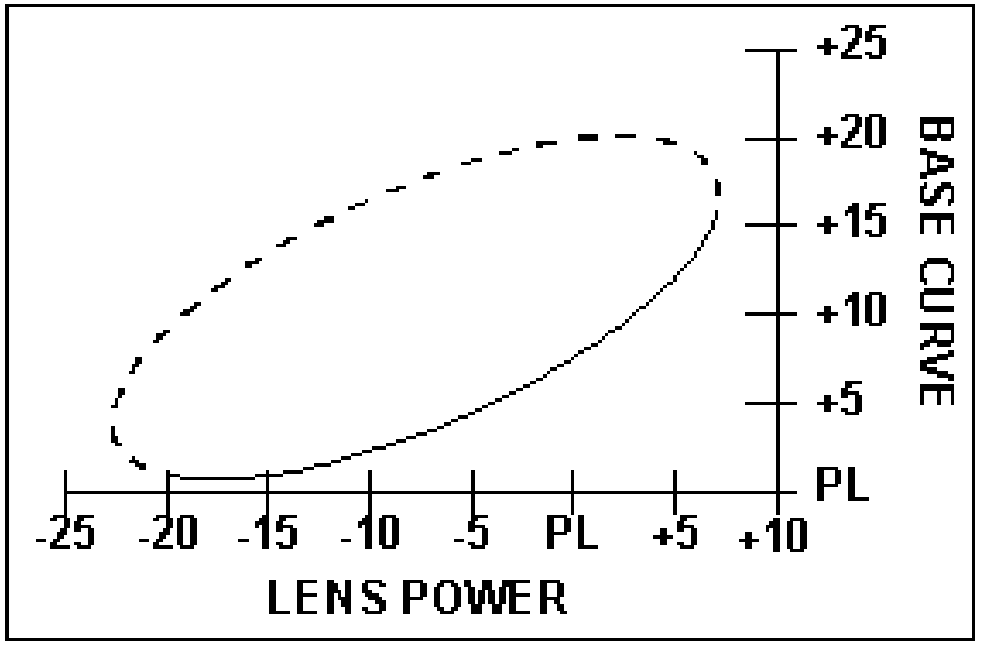
Tscherning Ellipse: Oswalt Branch

- The least curved portion is called the Oswalt Branch.



Tscherning Ellipse: Wollaston Branch

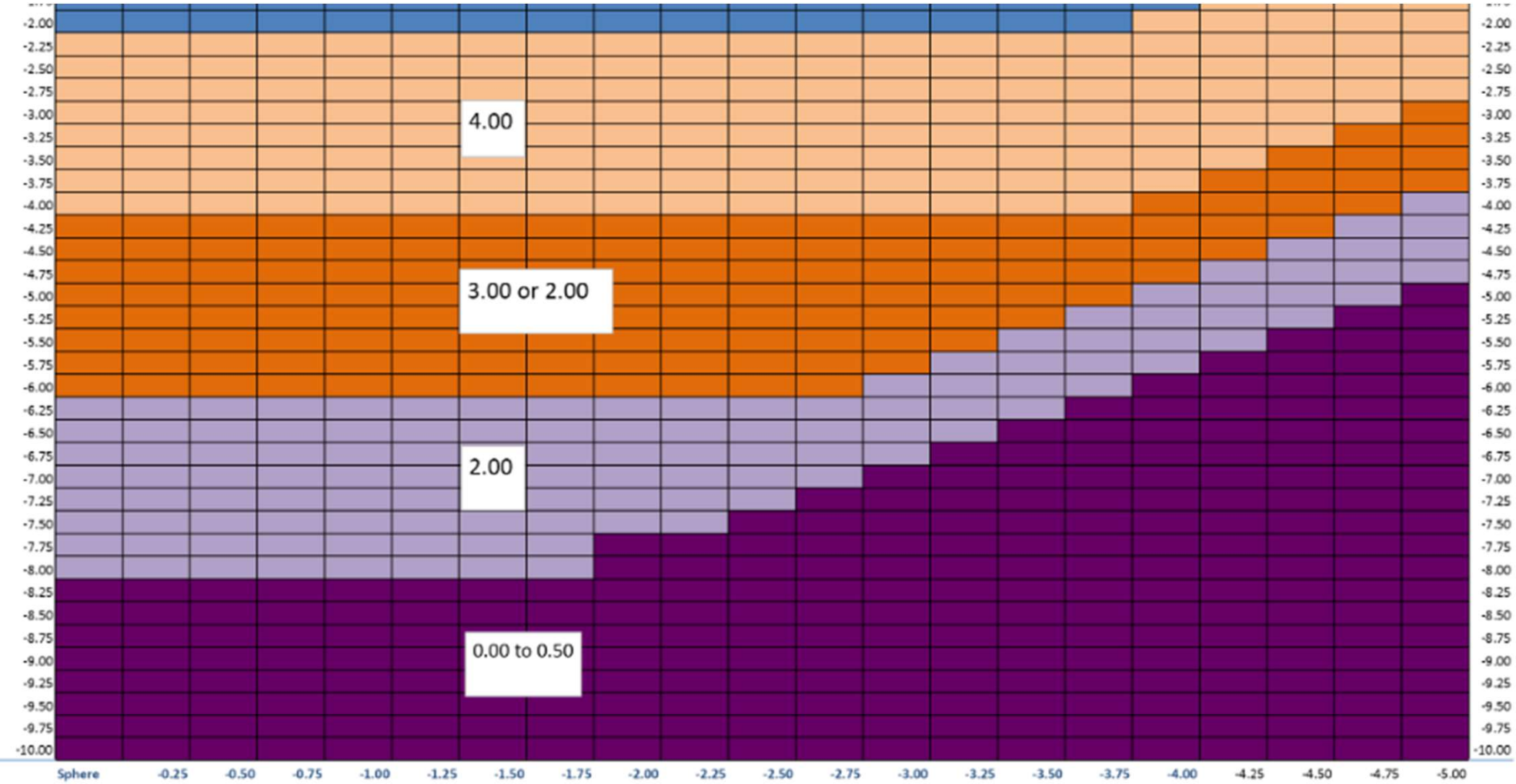
- The most curved portion of the ellipse is called the Wollaston Branch.



Corrected Curve Theory

- Different curves were needed to suit different families of Rx's.

- Proper matching would result in "Best Form" lenses with minimal aberrations.


4.00
3.00 or 2.00
2.00
0.00 to 0.50
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-3.75
-4.00
-4.25
-4.50
-4.75
-5.00

Choosing an Appropriate Base Curve

Higher Plus = STEEPER Base/Front Curves

Higher Minus = FLATTER Base/Front Curves

Vogel's Formula

Choosing an Appropriate Base Curve

For Plus Lenses :

BC = SE +6.00

For Minus Lenses :

BC = (SE +6.00) / 2

Vogel's Formula

Example: Rx +3.75 -1.50 x 90 = +3.00

BC = SE +6.00

SE = +3.00

Base Curve = +3.00 +6.00 = +9.00

- Example 2 : Rx -3.00 - 1.00 x 90

$$BC = (SE + 6.00) / 2$$

Spherical Equivalent = -3.50

BC = (-3.50/2)+6.00 =

+4.25

Aspheric Curves

Instead of a single radius of curvature (same curve throughout surface of the lens), changes towards periphery of lens

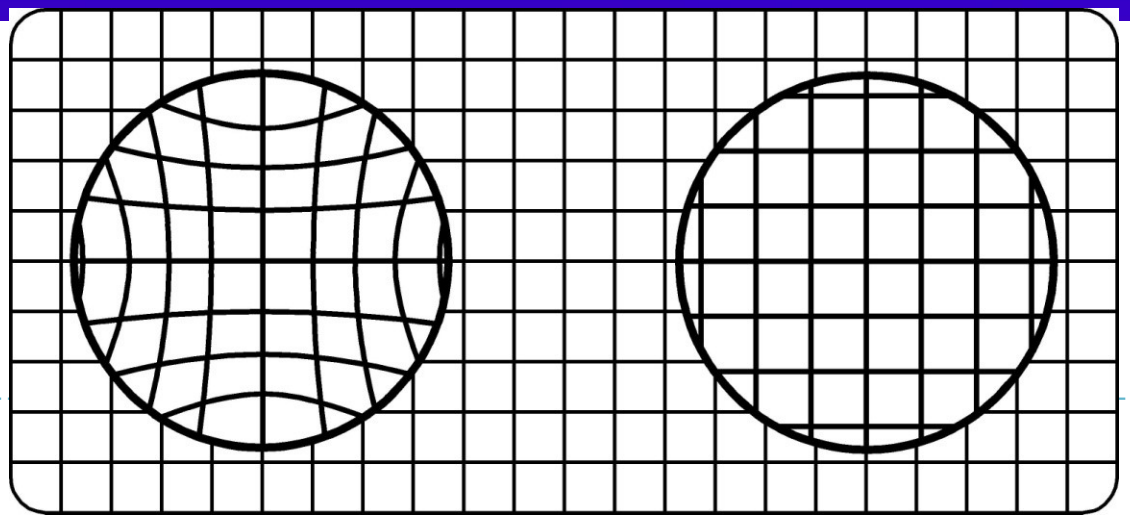
ASPHERIC VS. NON-ASPHERIC

PLUS SPHERICAL
Curve is Constant

PLUS ASPHERIC
Curves Flatten Towards Edge

MINUS SPHERICAL
Curve is Constant

MINUS ASPHERIC
Curves Steepen Towards Edge



Aspheric Curves: Three main uses

1. Optical Aberration Control
   - Improved off center optics for Rx's > +7.00 or -23.00D than spherical base curve

2. Cosmetic:
   - Allows the use of flatter base curves while maintaining good optics.

3. Power Changes:
   - Used for progressive addition lenses.

Aspheric Lenses

- Non-spherical surface that gradually changes in curvature from the center of the lens toward the edge
- Delivers the peripheral clarity of a "Best-Form" lens with a flatter profile.
- With high index, up to 25% thinner and 30% lighter

Aspheric vs Best Form Lenses

+4.00 D Lens Design Comparison*	Best Form Lens	Flat Lens	Aspheric Lens
Front Curve	9.75 D	4.25 D	4.25 D
Center Thickness	6.6 mm	5.9 mm	5.1 mm
Weight	20.6 grams	17.7 grams	14.8 grams
Plate Height	13.7 mm	6.0 mm	5.1 mm
Rx off-axis	+3.78 DS	+5.18 DS -0.99 DC	+3.77 DS

Aspheric Advantages:

- Plus Lenses:
  - Reduced lens thickness
  - Less bulge for Plus Rx's
  - Less magnification for plus Rx's

- Minus lenses
  - Less minification for minus
  - Lenses look and stay better in frames.
  - More frame choices.
  - Improved peripheral vision

Aspheric Lens Limitations

- Aspheric lenses, like spherical lenses, can be optimized for only one lens power. Each lens requires one of two unique base curves to deliver optimum optical performance in the periphery.

Aspheric Lenses & Astigmatism

- Tscherning's ellipse demonstrates that best-form or aspheric lens cannot optimize both powers

- Approximately 70% of all prescription require a cylinder correction.

Atoricity

- Atoricity = Essentially different amount/level of asphericiy in Sphere and Cyl power

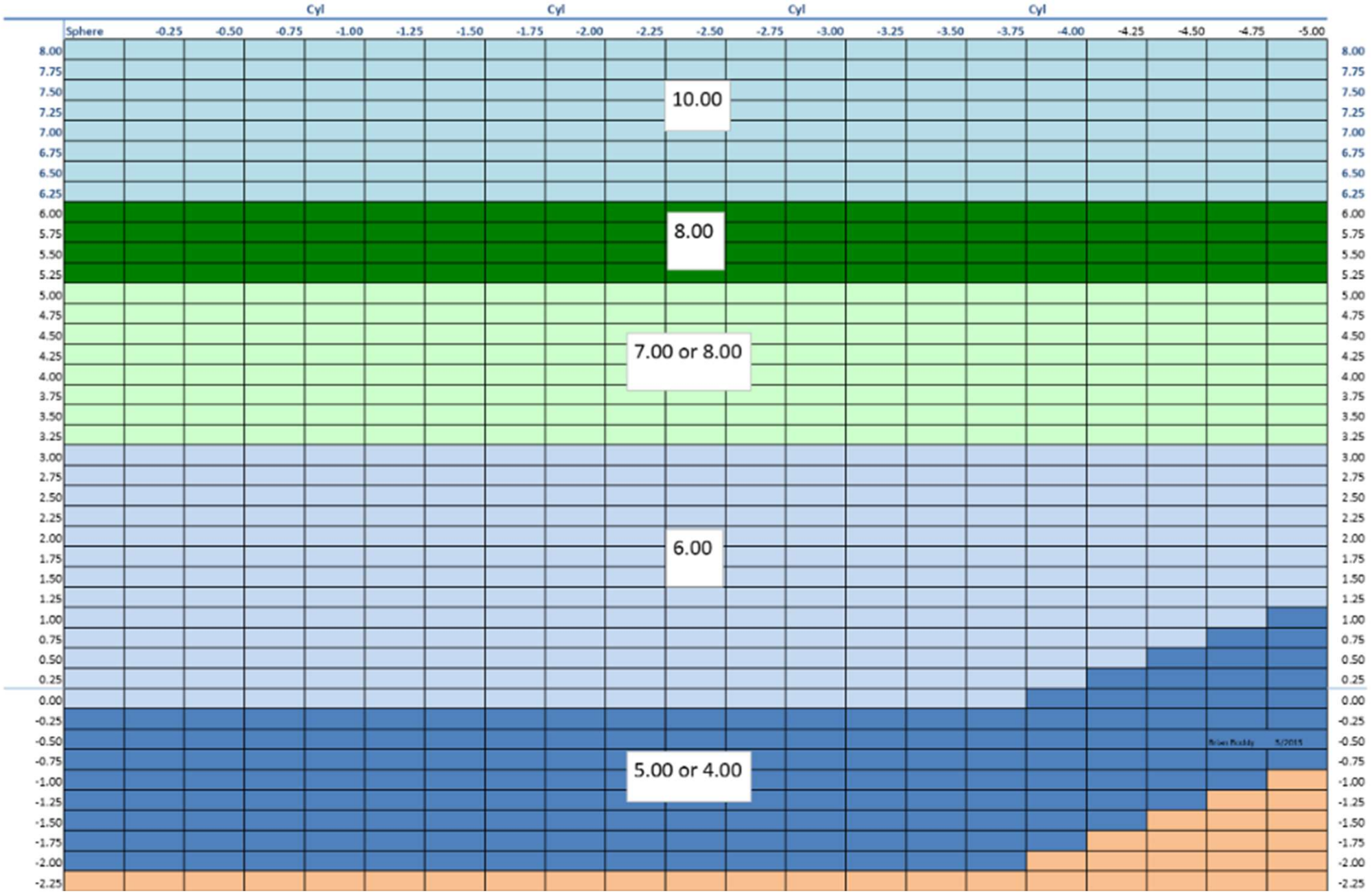
- Maximize benefit of asphericity in BOTH meridians

Atoric Surface

- Asphericity varies for each power meridian.
- Every sphere and cylinder combination is optimized.

*Boddy base curve formula for Minus = **4.25 + ((Spherical equivalent + add)/2)*** *Boddy base curve formula for plus digital lenses = 3.50 + ((add power/2) + spherical equivalent)*

Vogel Rule for minus = 6.00 + (-spherical equivalent/2)



Manufacturing

Prescription to Lens Blank

- Material
- Minimum Blank Size
- Vertex Power Compensation
- Resultant Prism
- Nominal Power
- Sagittal Depth Formula
- Thick Lens Back Vertex Power

Minimum Blank Size:

MBS = ED + 2 x Decentration

Minimum Blank Size:

MBS = ED + 2 x Decentration

Example: A=54 DBL=18 P.D.=64 ED=58

Minimum Blank Size:

MBS = ED + 2 x Decentration

Example: A=54 DBL=18 P.D.=64 ED=58

A + DBL = GCD or Frame PD
54 + 18 = 72

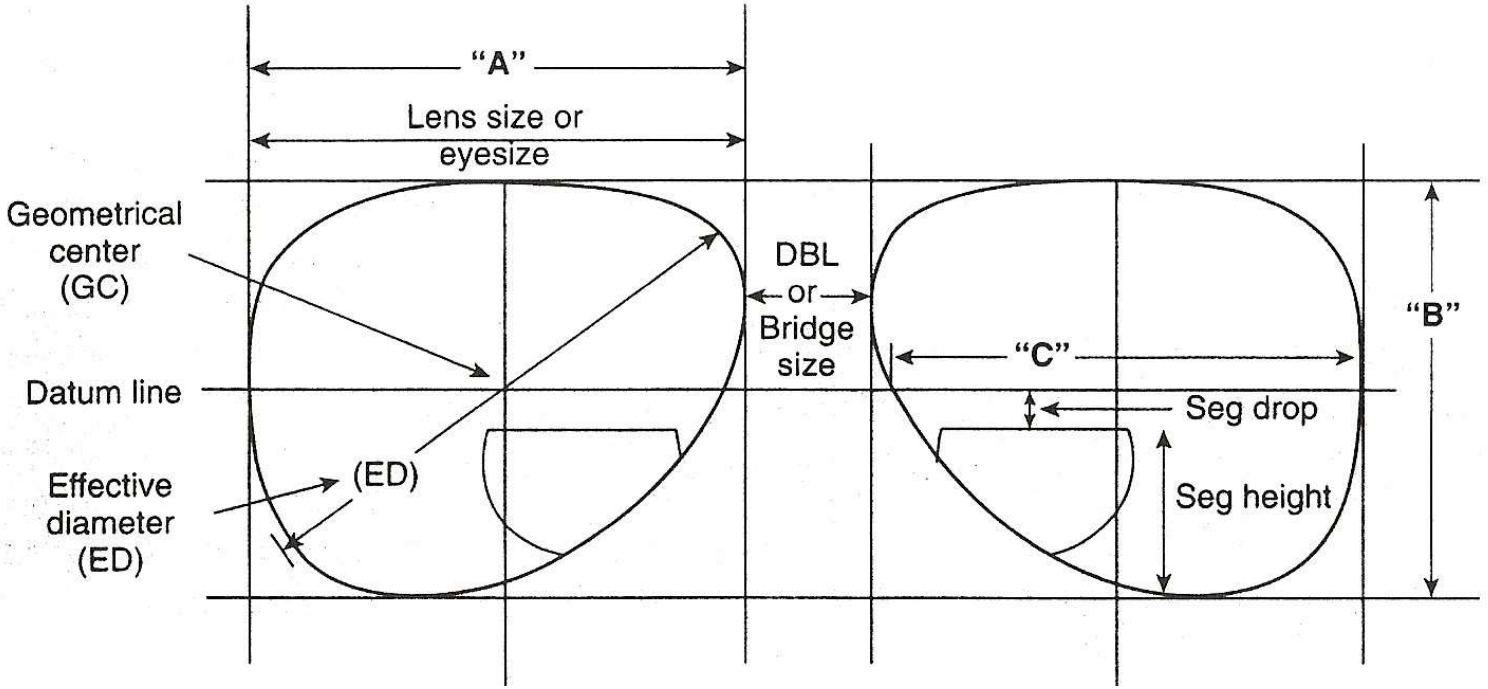
GCD - P.D. divided by 2 = decentration per eye

$72 - 64 = \frac{8}{2} =$ 4mm in per eye

ED + 2 x Dec. = MBS

58 + 2 x 4 = 66mm

Boxing System



Vertex Compensation

- A Distometer, millimeter rule, or digital device is used to measure vertex distance.

- If the power in any meridian is > 7.00D, an adjustment to power if the frame is fit at a distance different than the Rx vertex distance

- Simplified formula:
  - $D^2/1000$ =_the power change per mm of change

- Closer? Farther?
- Plus Lenses? Minus Lenses?

(CAP)
Closer Add Plus

Nominal Power Formula (Thin Lens)

- $De = D_1 + D_2$
  - De = The effective, vertex or lensometer power of the lens in diopters
  - D_1 = The power of the front curve in diopters
  - D_2 = The power of the back surface power in diopters

- Example:
  - Front surface (BC) = +6.00D
  - Back Surface = -4.00D

  - Nominal Power = +6.00 + (-4.00) = +2.00D

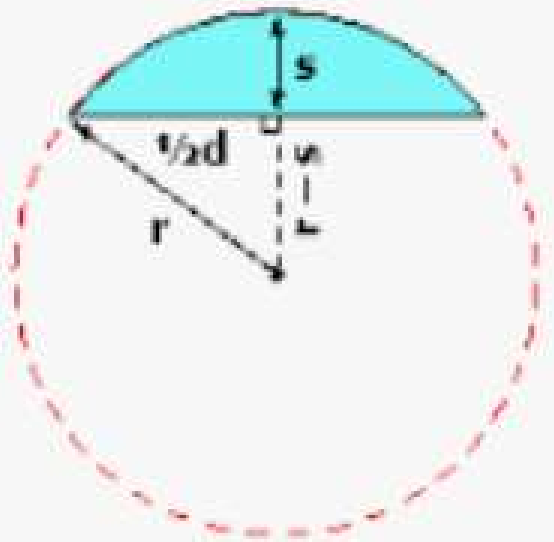
Sagittal Depth Formula (Lens Thickness)

$$r^2 = (\tfrac{1}{2}d)^2 + (r - s)^2$$

$$(r - s)^2 = r^2 - (\tfrac{1}{2}d)^2$$

$$r - s = \sqrt{r^2 - (\tfrac{1}{2}d)^2}$$

$$s = r - \sqrt{r^2 - (\tfrac{1}{2}d)^2}$$



www.Opticampus.com

Sagittal Depth Formula (Lens Thickness)

- Thickness $= \frac{\text{Radius}^2 \times \text{Power}}{2000\ (n - 1)}$
  - N = Index of refraction of lens material used
  - Thickness is mm

- Step # 1 Decentration x 2 + ED
- Step # 2 Radius = ½ of amount in Step # 1
- Step # 3 Calculate thickness using formula
- Step # 4 Add minimum thickness to answer (1.5 to 2.0mm)

Sagittal Depth Formula (Lens Thickness)Example

- Rx = -5.00 A= 54 DBL = 20 Frame GCD = 74 ED = 62mm
- Mono P.D. O.D. = 30mm Material = CR-39 Index 1.49
- Thickness $= \frac{\text{Radius}^2 \times \text{Power}}{2000\ (N - 1)}$
- Step # 1 54 + 20 = 74/2 = 37- 30 = 7 x 2 + 62 = 76mm
- Step # 2 Radius = ½ of amount in Step # 1 = 38mm
- Step # 3 Calculate thickness using formula
- Thickness $= \frac{38^2 \times -5.00}{2000\ (1.49 - 1)} = \frac{1444 \times 5}{2000 \times .49} = \frac{7220}{980} = 7.36\text{mm}$
- Step # 4 Add minimum thickness to answer (1.5 to 2.0mm)

Thick Lens Back Vertex Power

- $De = D_1 + D_2 + (t/n \times D_1^2)$
- De = The effective, vertex or lensometer power of the lens in diopters
- D_1 = The power of the front curve in diopters
- D_2 = The power of the back surface power in diopters
- t = Lens thickness in meters
- n = Index of refraction

Thick Lens Back Vertex Power Example:

- Front curve = +10.00
- Back curve = -4.00
- Lens thickness = 7mm or .007 meters
- Index of refraction = 1.60
- $De = D_1 + D_2 + (t/n \times D_1^2)$
- $De = +10.00 + (-4.00) + (.007/1.60n \times (+10.00^2)$
- De = +6.00 + (.0044) x 100
- De = +6.44

Formulae to Calculate the % of Change in Magnification

- Change in Thickness m% = t x D1
- 15
- Change in Front Curve m% = t x D1
- 15
- Change in Vertex Distance m% = z x Dv
- 10
- t = center thickness or change in center thickness
- (+ for increase, - for decrease)
- D1 = front curve or change in front curve
- Dv = back vertex power of the lens
- z = change in vertex distance (+ for increase, - for
- decrease)

- Change In Front Curve
- m% = t x D1
- 15
- D1 changed from +6.00 to +10.00, t = 3.0 mm
- m% = t x D1 = 3.0 x 4.00 = 0.8 % increase in magnification
- 15 15

- Change in Thickness
- m% = t x D1
- 15
- D1 = +9.00, t = 2.0 mm increase in thickness
- m% = t x D1 = 2.0 x 9.00 = 1.2 % increase in magnification
- 15 15

Use of Ophthalmic Instrumentation Part II

NFOS

Surfacing Choices

- Conventional Surfacing
- Digital Surfacing

Conventional Surfacing

- Spherical, Toric
- Calculations
- Layout
- Blocking
- Generating
- Fining
- Polishing

A Basic Surfacing Lab

- Layout Computer
- Marker
- Surface Tape
- Blocker
- Generator
- Cylinder Machine
- Laps
- Lens Inventory

Calculations

- Frame Measurements
  - MM Rule
  - “C” Gauge
- Frame Tracing Unit
- Software

Data Input : Tracer

- One or Two Eyes
- Number of Points
- Software
- Display

Tracing Points

- A database of frame information and trace files that allow optical laboratories to select a lens blank and begin surfacing without having the actual frames

Inventory

- Lens Materials
- Lens Coatings
- Lens Tints
- Blank Sizes
- Prescription Range

Sag Gauge

Data Input

Layout

Blocking

- Tape
- Alloy ,Wax or Thermoplastic

Generator

Fining and Polishing

Basic Surfacing Lab

Automated Surfacing Lab

Surfacing

- In conventional surfacing, a generator grinds away plastic on back of lens creating rough surface

- Final Rx on back surface is produced by rubbing against an aluminum tool and pad in fining and polishing steps

Surfacing

Grinding Curve Questions:

IF you have a -3.00 -2.00 x 180

Given a lens with a +3.00 Base Curve

- Transpose Rx:
- What are Grinding Curves
- What is Power at 180?
- What is power at 90
- Type of Astigmatism
- Orientation of Astigmatism

Digital Surfacing or Free Form Machining

- A natural diamond cutting tool produces a very smooth surface that requires only light polishing to create transparency

Digital Surfacing or Free Form Machining

- Each lens may require over 10 million calculations to generate the data file for the free forming machine to create the lens' surface
- The computer lens design is exact. Several companies use the same machinery. It is each company'ss computer program that determines the end product

Schneider HSC 100

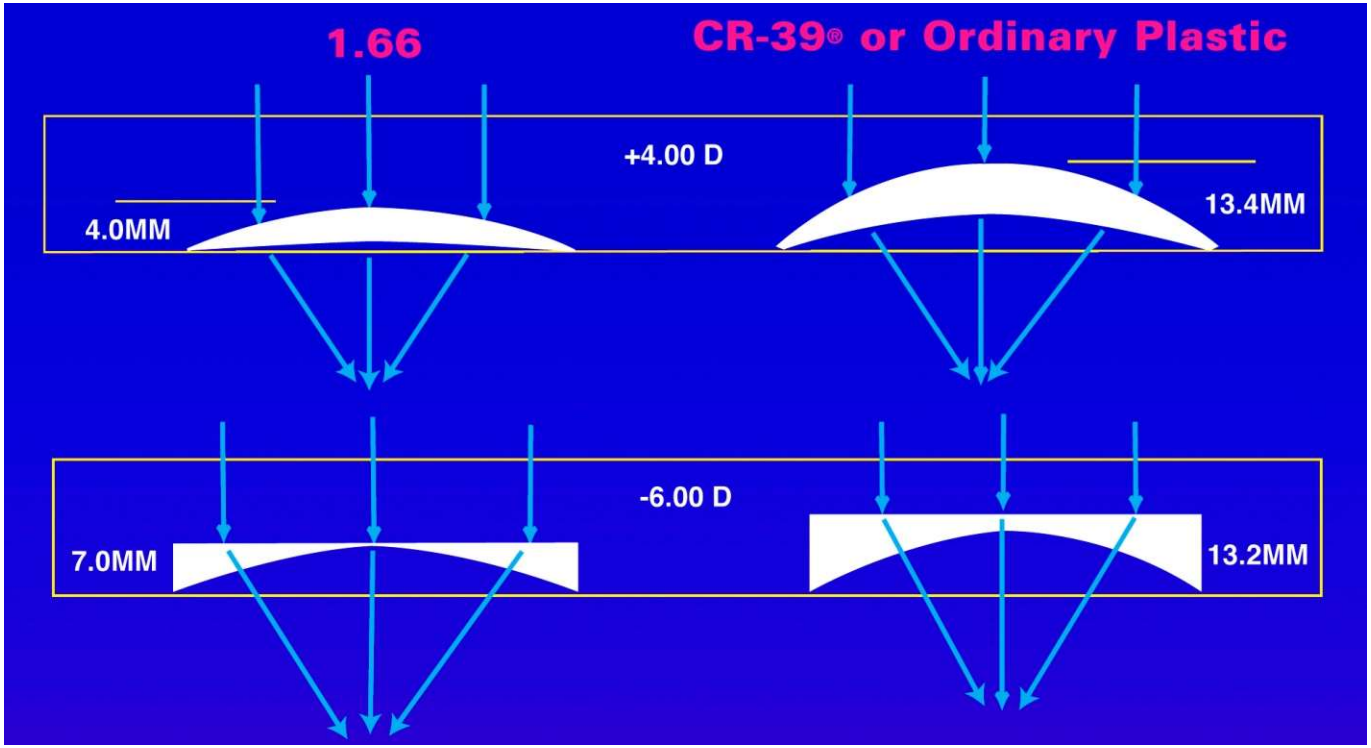
Schneider Auto Transport

Schneider Polisher

Free Form Machining

- Create the Following Curves on the back of lens
  - Spherical
  - Aspheric
  - Atoric
  - Progressive
  - Other?
    - Slab off
    - Round/blended on back side
    - etc

High Index Lenses



Wrap Around Sunglasses

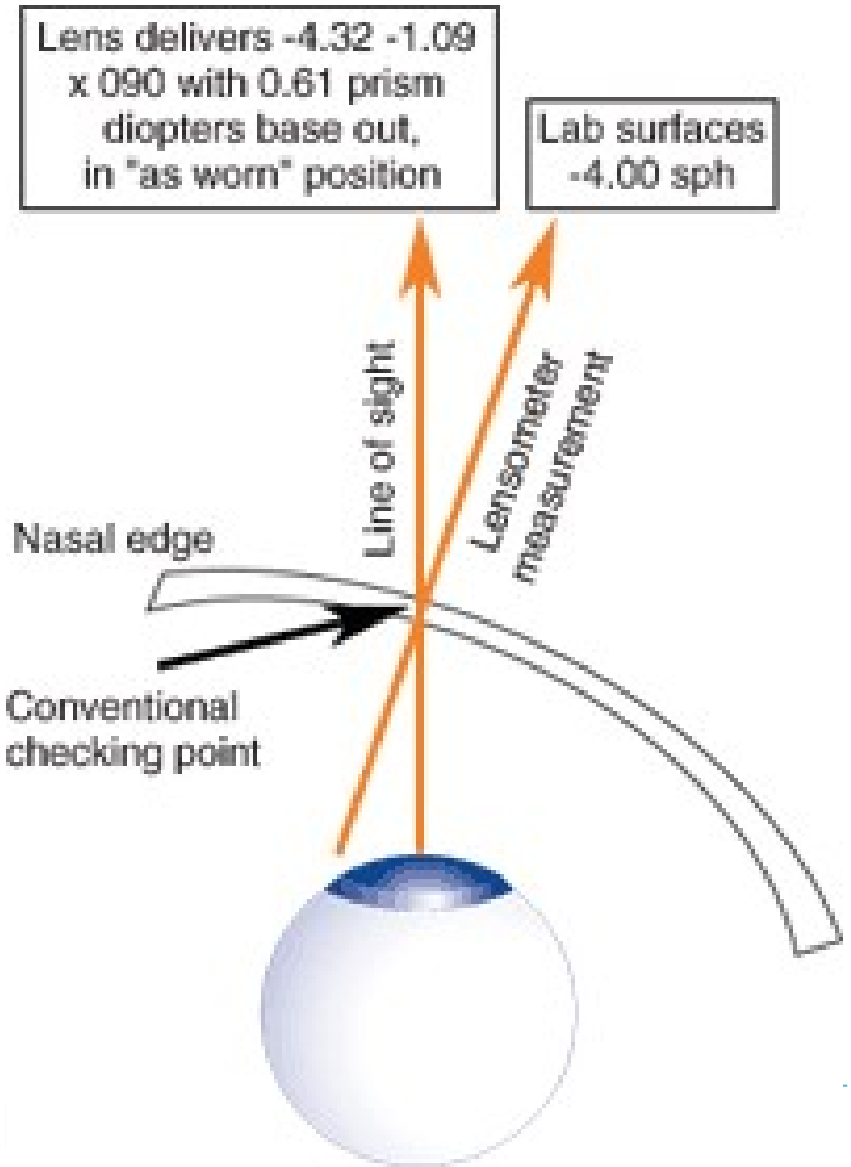
- Frame requires approximately
- +8.00 or higher Base Curve

  - Remember that BEST optics are on a SPECIFIC designed base curve (Tsherning's Ellipse)….Artificially increasing BC will affect optics

Rx Wrap Sunglasses

- Oakley
- Costa Del Mar
- Maui Jim
- Bolle'

Correction for Wrap Rx Lenses



A Basic Finishing Lab

- Lens Layout
- Blocking
- Pattern Making
- Edging
- Grooving
- Polishing
- Tinting
- Inspection

An Automated Finishing Lab

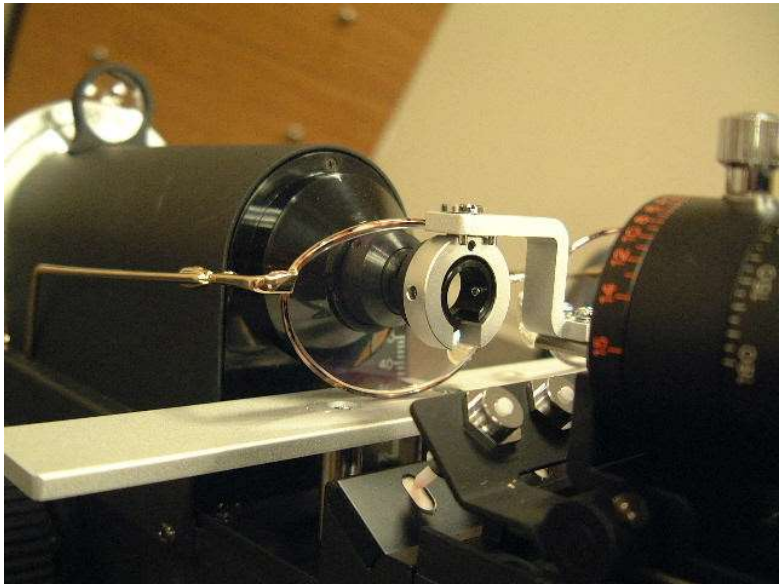
- Order Input
- Tracing
- Blocking
- Patternless Edging
- Polishing, Grooving
- Tinting, Coating
- Inspection

Inspection & Verification

Auto Lensmeter

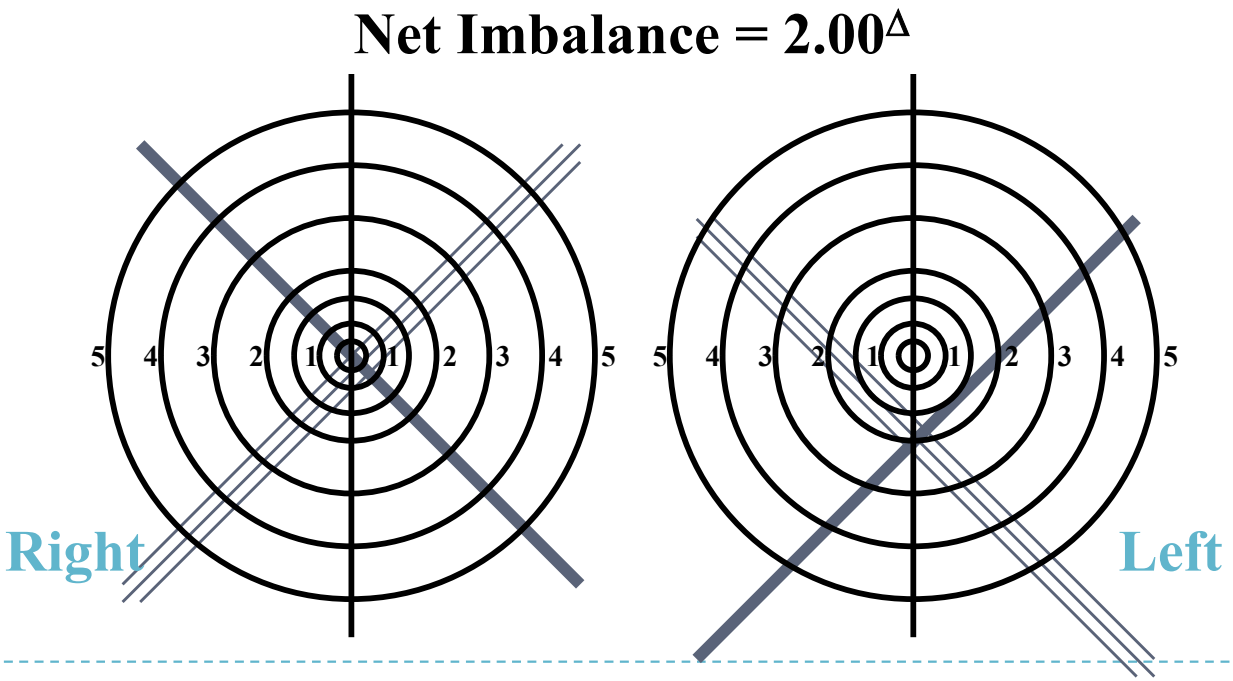
Lens Verification

1. Focus the Eyepiece
2. Check distance prescription with convex surface facing operator and concave against the lens stop.
3. Always start with the lens with the most power in the vertical meridian
4. Prism: The target is always displaced in the direction of the base.
5. Check add power with the concave surface facing the operator.



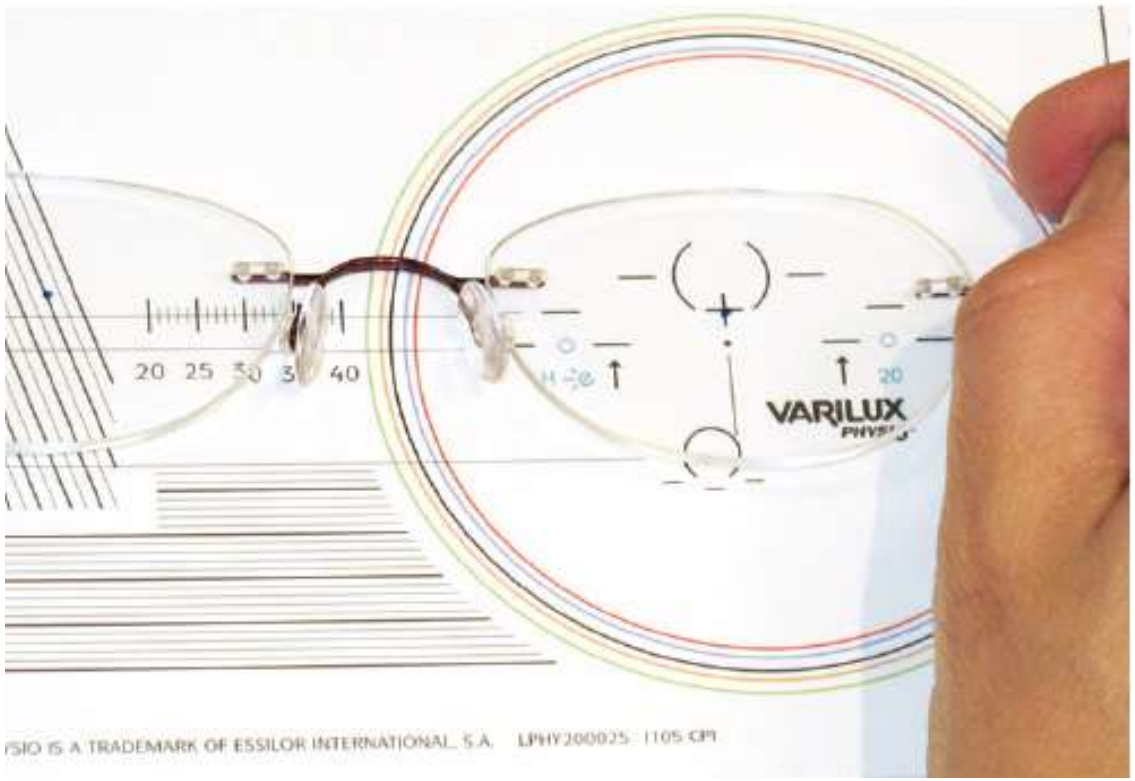
Verifying Prism

- Target Displaced in Direction of Base
- Auxiliary Prisms over 5.00 Prism Diopters



Verification: Progressives

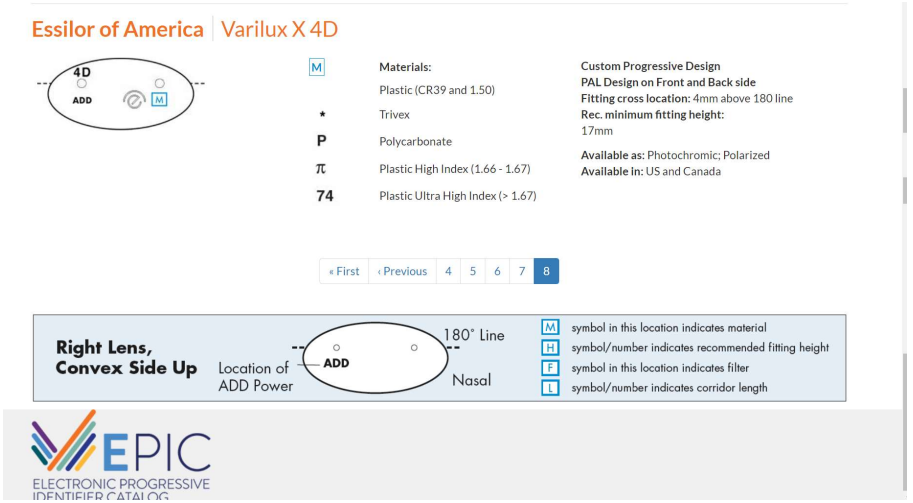
- Remark Lenses



Essilor PAL Identifier

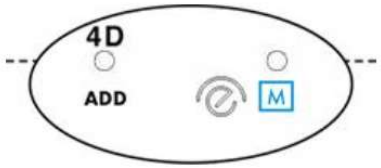
Identifying the Lens

- Locate all markings
- The Vision Council Electronic Progressive Lens Identifier
- Shows picture of each type of progressive lens with all hidden markings.



Identifying the Lens

Essilor of America | Varilux X 4D

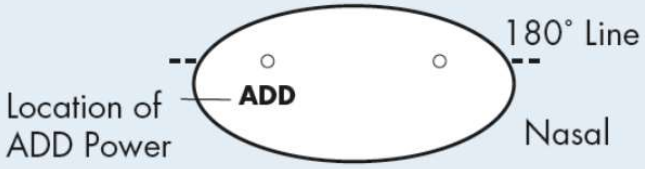


M	**Materials:** Plastic (CR39 and 1.50)
*	Trivex
P	Polycarbonate
π	Plastic High Index (1.66 - 1.67)
74	Plastic Ultra High Index (> 1.67)

Custom Progressive Design
PAL Design on Front and Back side
Fitting cross location: 4mm above 180 line
Rec. minimum fitting height: 17mm

Available as: Photochromic; Polarized
Available in: US and Canada

Right Lens, Convex Side Up



- M symbol in this location indicates material
- H symbol/number indicates recommended fitting height
- F symbol in this location indicates filter
- L symbol/number indicates corridor length

EPIC
ELECTRONIC PROGRESSIVE IDENTIFIER CATALOG

Verification: Progressives

- Locate laser-engraved circles and add power.
- Confirm monocular Pd. and fitting height
- Check distance power
- Check prism at O.C./P.R.P., unle prescribed, prism should be equ in each lens(Prism used for thinning should equal 2/3 the ac power)

Verification: Progressives

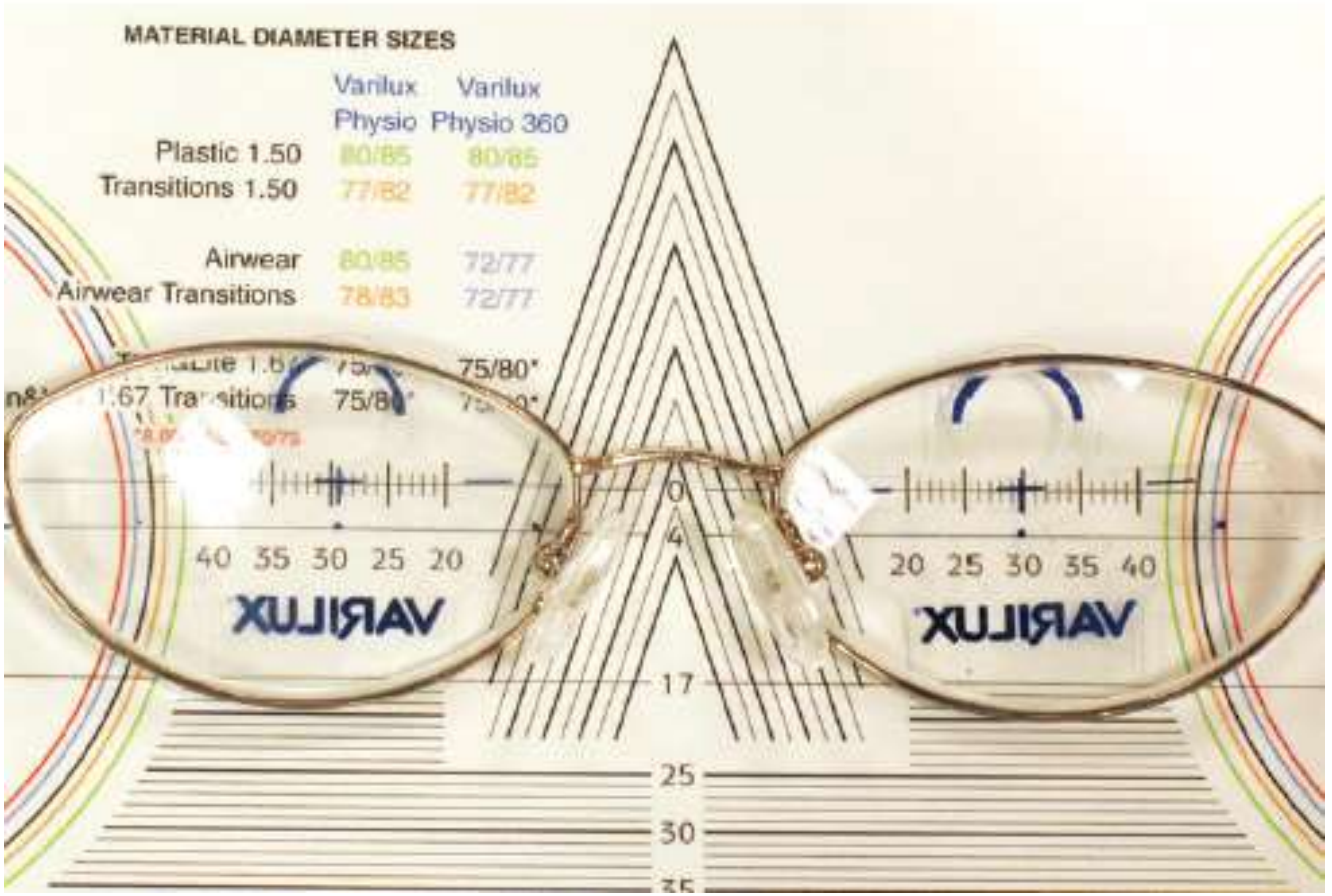
- Check Distance RX through Distance Verification Circle

Verification: Progressive Add Power

- For Front Surface PAL, Verify with CX Surface against Lens Stop.
- For Back Surface PAL, Verify with CC Surface against Lens Stop.

Verification: Progressives

- Monocular P.D.
- Fitting Height



ANSI Standards

- ANSI Z80.1 Prescription Ophthalmic Lenses
- ANSI Z87.1 Occupational & Safety Eyewear

- Note on ANSI…generally viewed as "voluntary" standards….However,
  - ANSI Z80 may be a STATE requirement for Opticians
  - ANSI Z87 Adopted by OSHA, so is FEDERAL REQUIREMENT.

THE VISION COUNCIL

QUICK REFERENCE GUIDE – ANSI Z80.1-2020

1. **Tolerance on Distance Refractive Power (Single Vision, Multifocal and Power Variation Lenses with a single reference point)**

Sphere Meridian Power (minus cylinder convention)	Tolerance on Sphere Meridian Power (minus cylinder convention)	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%

2. **Tolerance on Distance Refractive Power (Power Variation Lenses "Progressive Addition Lenses" with more than one reference point)**

Sphere Meridian Power (minus cylinder convention)	Tolerance on Sphere Meridian Power (minus cylinder convention)	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%

3. **Tolerance on direction of cylinder axis**

Nominal value of the cylinder power (D)	< –0.12 D	≥ –0.12 D ≤ –0.25 D	> –0.25 D ≤ –0.50 D	> –0.50 D ≤ –0.75 D	> –0.75 D ≤ –1.50 D	> –1.50 D
Tolerance of the axis (degrees)	Not Defined	± 14°	± 7°	± 5°	± 3°	± 2°

4. **Tolerance on addition power for multifocal and progressive addition lenses**

Nominal value of addition power (D)	≤ 4.00 D	> 4.00 D
Nominal value of the tolerance on the addition power (D)	±0.12 D	±0.18 D

5. **Tolerance on Prism Reference Point Location and Prismatic Power**

The prismatic power measured at the prism reference point shall not exceed 0.33Δ or the prism reference point shall not be more than 1.0 mm away from its specified position in any direction.

6. **Tolerance on Prismatic Imbalance (mounted)**

Single Vision And Multifocal Lenses	Vertical	Vertical	Horizontal	Horizontal
	0.00 to ≤ ±3.375 D	> ±3.375 D	0.00 to ≤ ±2.75 D	> ±2.75 D
Tolerance	≤ 0.33Δ	≤ 1.0 mm difference in height of PRPs	≤ 0.67Δ	≤ ± 2.5 mm from specified distance interpupillary distance

https://thevisioncouncil.org/sites/default/files/ANSI%20Z80%201-2015_Quick%20Reference%20v2.pdf

Laws governing Opticianry

- Remember that our “RULES” that we have to follow are broken into :

1) **Laws** (passed by lawmakers and signed off on by an executive)

2) **Regulations** (rules and guidelines written to enforce or clarify laws, generally by a specific officer or department, and have the SAME legal standing, and can be enforced, just like “laws”)

- And these Laws and Regulations can be passed by:

1) Federal Gov

2) State Gov

3) Local Gov

- **Federal Laws**
- **Federal Regulations**

- **State Laws**
- **State Regulations**

- **Local Laws and regulation (less applicable normally)**

Example of FEDERAL LAW

- Fairness to Contact Lens Consumer Act
  - Must release CL Rx
  - Online can sell, but must verify (1 business day and is filled)
  - ENFORCED by FEDERAL TRADE COMMITTEE (FTC)

Example of FEDERAL REGULATION

- FTC
  - EYEGLASS RULE
    - ODs and OMDs must give copy of Rx at conclusion of exam, even if not asked for
    - https://www.ftc.gov/business-guidance/resources/complying-eyeglass-rule
- FDA (food and Drug Agency)
  - Impact resistance standards 1971
    - Batch testing of plastic/resin lenses, individual drop ball testing of Glass Lenses
- OSHA (occupational Safety and Health Administration)
  - Require Eye and Face Protection on worksites when required
    - ADOPTED ANSI Z87 for these purposes

Example of State Laws

- ALL states have laws and regulations on Optometrists, Dentists, Medical Doctors, nurses, Etc

- Some states have laws and regulations (ex licensing requirements) for Opticians

  - CT for example adopted ANSI as a STATE law for Opticians

Other professional Requirements

- In addition to
  - Federal Laws (FCLCA, Federal Law)
  - Federal Regulations (FTC eyeglass rule, FDA impact, OSHA)
  - State laws if indicated

- There are also OTHER requirements:

Other professional Requirements

- It is the against the law to sell any lens other than polycarbonate or trivex lenses for children or monocular patients?

- TRUE or FALSE

Other professional Requirements

- Actually there is generally no "law" (as far as I am aware).

- There IS, however, a legal concept called **"duty to warn"**

- in CIVIL cases, a professional can be held liable for injuries caused to another, if the practitioner had the opportunity to warn the patient of a hazard and failed to do so.

Duty to Warn

- Optician has a duty to investigate what a patients needs are and to recommend the appropriate lens or lenses.

- IN absence of documentation, the practitioner can be held liable AND potentially revocation or action against license

- Many companies, concerned about liability, especially in minors, will set company policies to mandate using ONLY impact resistant lenses for minors, both to satisfy this "duty to warn" and to mitigate any potential liability (prevent lawsuits from injured patient, especially a child)

- Back to ANSI
- Recall that OSHA controls workplace safety (Eye and Face protection)
- Simply ADOPTED the "voluntary" ANSI Z87 standards to simplify process

- ANSI z87

Basic Impact vs High Impact

Basic Impact	High Impact
Z-87 markings	Z-87-2 markings (all now)
3.0 mm min CT	2.0 mm min for HI mat poly/trivex/tribri
	3.0 mm for all others CR-39, etc

- Lens Markings:

- Upper temp corner includes:

- Manufacturer's initials
- "+" if Hi Impact Material (Poly, etc)

- Add'l
  - V for Variable
  - S for Special Purpose
  - etc

ANSI Z87.1-2020

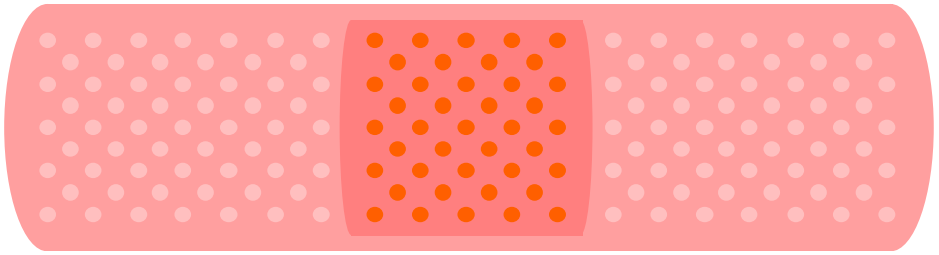
- Called Z87+
- 1/4" Steel Ball at 150 Feet/Second
- Lens Thickness: 2.0mm.
- Lens Markings: Sandblasted manufacturer's I.D. and "+"
- All Frames, Basic or High Impact must meet High Impact Standards
- Frame Markings: Front - A, DBL, Z87-2 or Z87-2+, Manufacturer's I.D. Temples - Length, Z87-2 or Z87-2+, , Manufacturer's I.D. On one temple

Table 3. Marking Requirements				
Type of Mark	**Lenses & Replacement Lenses**		**Frame[1]**	**Marking for Complete Device (no replaceable components)[2]**
	Spectacles	**All Other**		
All protectors shall bear the markings below.				
Manufacturer's Mark or Logo	Yes	Yes	Yes	Yes
Standard				
Plano, Readers, Magnifiers		**Z87**	**Z87**	**Z87**
Rx		**Z87**	**Z87-2**	**Z87-2**
Coverage (small head sies)[3]	**H**		**H**	
The following shall be required only when claims of impact rating, a specific lens type and/or use are made by the manufacturer.				
Impact Mark				
Impact Rated Plano, Readers Magnifiers	+	**Z87+**	**Z87+**	**Z87+**
Impact Rated Rx	+	**Z87+**	**Z87-2+**	**Z87-2+**
Relaxed Optical Level[6]	**O2**	**O2**		**O2**
Lens Type				
Clear				
Welding Filter (see table 7)[5]	**W** *shade*	**W** *shade*		**W** *shade*
UV Filter (see table 8)[4]	**U** *scale number*	**U** *scale number*		**U** *scale number*
IR Filter (see table 9)[4]	**R** *scale number*	**R** *scale number*		**R** *scale number*
Visible Light Filter (see table 10)[4]	**L** *scale number*	**L** *scale number*		**L** *scale number*
Variable Tint	**V**	**V**		**V**
Special Purpose Lenses	**S**	**S**		**S**
Anti-Fog	**X**	**X**		
Use				
Splash / Droplet			**D3**	**D3**
Dust			**D4**	**D4**
Fine Dust			**D5**	**D5**

1. Frame components subject to marking vary by type of protector

OSHA: Occupational Safety and Health Administration

- Federal agency charged with regulating safety practices in the work place and in educational settings.
- OSHA has adopted the Z-87.1 standards making them a federal requirement.



FDA: Food and Drug Administration

- Began mandating impact resistance of ophthalmic lenses in 1971.

FDA: Food and Drug Administration

- Plastic and others can be "batch" Tested

- Glass ALL have to be
  - Tempered:
    - Either Heat or Chemically
  - Drop Ball Tested

FDA: Food and Drug Administration

- Glass Drop Ball Test:

- Lenses must be capable of passing Drop-Ball Test:
  - 5/8"steel ball,
  - .56oz,
  - Height of 50 inches

  - Safety Glass, 3.0 = 1.0" steel ball

- Records must be keep three years after purchase.

FDA: Food and Drug Administration

- Glass drop ball exceptions:
  - Prism Segment Multifocal
  - Slab Off
  - Lenticular Cataract,
  - Iseikonic
  - Depressed segment one-piece multifocal
  - Biconcave
  - Myodisc and minus lenticular
  - Custom laminate
  - Cemented assembly lenses

FDA: Food and Drug Administration

FTC: Federal Trade Commission

- Established to prevent unfair business practices.
- Eyeglasses I and Eyeglasses II investigational studies.
- Doctor must give the patient a copy of their prescription immediately after the exam.