Kreischer Optics, Ltd.

1729 Oak Drive, McHenry, IL 60050 Office: 815-344-4220 • FAX: 815-344-4221 www.kreischer.com • optics@kreischer.com • ISO 9001:2008

Tolerances
Guidelines for Aspherics

The tolerances to follow are only guidelines because many factors come into play to determine the cost and difficulty of making any given part. What may be a "slam dunk" for one part can be a "half court shot" for another, depending on size, shape, glass type, etc.

Avoid multiple tight tolerances, they compound difficulty. For example, requiring a 1/10-wave accuracy, center thickness of ± .025mm, surface quality of 10-5 scratch-dig and a difficult glass type may each individually cause only a modest price increase but requiring them all on the same part will make for a very expensive optic.

Specification	Tolerance	Difficulty	Comment
Form error/Irregularity	5 microns	Easy	Any shape/size
	2 microns	Moderate	
	1 micron	Standard	Most shapes
(peak to valley)	1 wave	Precision	
	1/2 wave	Precision plus	
	1/4 wave	High precision	Shape dependent
	1/8 wave	Extreme precision	Special cases only
Base radius	5 - 10 microns	Easy	* Tolerance given in terms of
(In addition to form error) *	2 - 4 microns	Standard	the sag difference across
	1 micron	Precision	the aperture.
	.5 microns	High precision	
Center thickness	± .25mm	Easy	
	± .10mm	Standard	
	± .05mm	Precision	
	±.025mm	High precision	
Diameter	+0 / -.2	Easy	
	+0 / -.1	Standard	
	+0 / -.05	Precision	
	+0 / -.025	High precision	
Wedge **	5'	Easy	See note concerning centration
(ray deviation)	3'	Standard	vs. wedge
	2'	Precision	
	1'	High precision	
	30"	Extreme precision	
Surface quality	120/60	Easy	Glass type is a big factor
	80/50	Standard	
	60/40	Precision	
	40/20	High precision	
	20/10	Very high precision	

Tolerances: Guidelines for Aspherics
The tolerances to follow are only guidelines because many factors come into play to determine the cost and difficulty of making any given part. What may be a "slam dunk" for one part can be a "half court shot" for another, depending on size, shape, glass type, etc.

Avoid multiple tight tolerances, they compound difficulty. For example, requiring a 1/10-wave accuracy, center thickness of .025mm, surface quality of 10-5 scratch-dig and a difficult glass type may each individually cause only a modest price increase but requiring them all on the same part will make for a very expensive optic.

Please view our *Aspheric Tolerances Guidelines*, availalble on our website in the Products/Asphere tab (www.kreischer.com).

General Comments & Guidelines:

Tolerances tend to be independent from each other in their effect on system performance but have a compounding effect on manufacturability. ***DON'T PICK ALL HIGH PRECISION TOLERANCES UNLESS NECESSARY!***

Base radius is a separate tolerance from form error since it can be focused out in most systems. Avoid specifying a tighter radius tolerance than needed.

Give a larger share of your "error budget" to the aspheric surface. For example, when designing a lens system with 7 spherical and 1 aspheric surface, calling for -wave surface irregularities, instead of specifying -wave on all 8 surfaces, specify .5 microns on the asphere and 1/8-wave on the spherical surfaces. The net tolerance is tighter and the system is more manufacturable.

Try to use a mainstream glass (BK-7 if possible) for the aspheric element(s).

In general, not just for aspheres, avoid letting the computer pick the glass. Check on glass availability during the design process; many "new" glasses (Ohara "S" type and Schott "N" type) are not readily available.

** Centration vs. wedge. For spherical lenses, centration and wedge are the same thing. This is not true for aspheres. The process we use at Kreischer Optics insures the aspheric surface is VERY WELL CENTERED relative to the outside diameter.

Testing Methods:

Profilometry: This is the most convenient method and is suitable for testing both ground and polished surfaces. The profilometer traces the surface shape across a diameter, subtracts the desired profile and produces a modified trace showing the form error. The only setup needed is entering the desired shape into the talysurf computer, so non-recurring cost is trivial. Multiple traces are used to confirm rotational symmetry of the part. Kreischer Optics has three Taylor-Hobson PGI 1240 and S4 form talysurfs and Zeiss/OptiPro Surfcom 5000.

S4: Horizontal range 120mm, vertical range 12.0mm; suitable for testing down to wave form accuracy.

PGI 1240 and Surfcom 5000: Horizontal range 195mm, vertical range 22mm; suitable for testing down to wave form accuracy.

Zygo GPI: Very mild aspheres (up to about 8 waves departure) may be tested without null optics, otherwise, a null lens (designed in house at KOL) or a computer generated hologram will be needed. This has the advantage of [potentially] full aperture testing to 1/8-wave accuracy or better, but not all aspheric shapes can be tested this way. Null lenses can add $1k - $7k of non-recurring cost and may add to lead-time. CGH nulls will cost $9k and up and take 6 – 8 weeks. With either null lenses or CGH nulls, only polished surfaces may be tested.

Final note: Call, email or fax your preliminary specifications as early in the design process as you can. We are always happy to discuss design consideration.

1729 Oak Drive, McHenry, IL 60050 Office: 815-344-4220 • FAX: 815-344-4221 www.kreischer.com • optics@kreischer.com • ISO 9001:2008