

Paul Murphy (QED) Vote on OP1.0110-12

OEOSC Feedback via R. N. Youngworth

We must address all comments sent back, even if the vote is affirmative. If we make changes to the draft, we must rebalot. Hence we only want to do that if necessary, but making sure the standard is correct is paramount.

We appreciate your drive to make these standards of the highest quality.

Key to actions: for this vote, can be done in the future, action response

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Title: BSR/OEOSC OP1.0110-12, Proposed American National Standard for Optics and Electro-Optical Instruments – Preparation of drawing for optical elements and systems – Part 12: Aspheric surfaces

Question 3: Do you approve the adoption of BSR/OEOSC OP1.0110-12 as an American National Standard?

√ Affirmative Comments, if any: (Attach extra comment sheets if necessary)

I'm not thrilled with this standard, but it is an improvement over the current one (so would that make the vote "grudgingly affirmative"?). There are a few corrections/clarifications I'd like to see, and some notes as well.

Use of an A2 coefficient: The A2 term alters the vertex and best-fit radii of an asphere, sometimes drastically so. I'd like to see a note to that effect somewhere. Really I'd like to see designers stop using it for anything but nominally plano aspheres, but as I am not a designer by trade I suppose there may be some use for A2 terms.

I agree with this comment. It is very unfortunate that Zemax includes this as a standard term as it is not necessary or helpful in the vast majority of aspheres. Is it worth a comment and rebalot? If so, PEM should draft the comment and RNY will proofread it and we can discuss. Dropping it out of the equation is more significant as it follows from the international standard form.

Action: Rich will put a note forth to clarify it in the draft. Adding it requires a re-ballot.

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RNY Add Note:

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While allowed, the use of an A2 coefficient is equivalent to adding a parabolic base to a given surface. It alters the vertex and best-fit radii of an asphere, and hence alters the paraxial properties, sometimes in a drastic fashion. Great care (or avoidance) should be exercised when using this term with the possible exception of cases where it definitely adds value, such as nominally plano aspheres.

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ANS Note 4: The variables are not entirely consistent and could lead to confusion. I quote from Greg: “The radius in the ‘basic equation’ for Qbfs is the same as Rbfs in the power series. {Clarifying note from me: one is labeled ‘R’ while the other is labeled ‘Rbfs’} I think all the cbfs and Rbfs stuff should just be dropped while just using c and R, or even just use c throughout. (The equation for cbfs is used when converting to Qbfs from some other specification, but is not needed when working with Qbfs itself. Perhaps a comment could be made to point out that axial curvature is 1/R for Qcon but not for Qbfs but I don't think that's needed.)”

I believe you are correct that if we are to define an Rbfs and cbfs, it is not used clearly with the base equation on p15 of the draft. The rationale for denoting them differently from a mere paraxial curvature is because the center and endpoint intersection criteria in Forbes’ seminal paper. Moreover, we wanted to make sure that the fact that the curvature and paraxial properties are NOT independent of the coefficients is clear. This is the primary rationale for denoting with the “bfs” subscript. In the standard denoting R or c one would imply it has the identical meaning to the monomial expansion or Qcon definition and it is different. We should discuss this point further live to come to a resolution if you still feel that changes are needed.

Action: The base equation needs to be fixed for bfs to be consistent. ‘bfs’ can be kept if wanted. This fix likely requires re-ballot (likely Rich).

I attach commentary (immediately following) from Greg regarding equations for Q polynomials. You may want to add a further note about alteration of paraxial properties.

In the notation of that Annex A, the few equations that I think we need have the same two to start:

$$R \left[1 + \sqrt{1 - (1 + \kappa) \frac{h^2}{R^2}} \right] \rho^4 [A_0 Q_0^{\text{con}}(\rho^2) + A_1 Q_1^{\text{con}}(\rho^2) + A_2 Q_2^{\text{con}}(\rho^2) + \dots]$$

and then on the second block, we’d have the first row as just

$$R \left[1 + \sqrt{1 - \frac{h^2}{R^2}} \right] \frac{1}{\sqrt{1 - \frac{h^2}{R^2}}} \rho^2 (1 - \rho^2) [A_0 Q_0^{\text{bfs}}(\rho^2) + A_1 Q_1^{\text{bfs}}(\rho^2) + A_2 Q_2^{\text{bfs}}(\rho^2) + \dots]$$

with a new row that re-uses Qbfs but includes a conic constant:

$$R \left[1 + \sqrt{1 - (1 + \kappa) \frac{h^2}{R^2}} \right] \frac{\sqrt{1 - \kappa \frac{h^2}{R^2}}}{\sqrt{1 - (1 + \kappa) \frac{h^2}{R^2}}} \rho^2 (1 - \rho^2) [A_0 Q_0^{\text{bfs}}(\rho^2) + A_1 Q_1^{\text{bfs}}(\rho^2) + A_2 Q_2^{\text{bfs}}(\rho^2) + \dots]$$

In my view, there is no need to talk about axial vs. bfs curvature here, nor in worrying about names given the fact that Qbfs can be used on a base conic instead of on a base sphere... the polynomials are the same! We could also talk about annular apertures where Qbfs can be scaled for orthogonality, but perhaps this is already enough to start. The only qualifier I’d consider putting on this is an encouragement to use kappa = 0 with Qbfs so that the coefficients do indeed relate to departure from a best-fit sphere.

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The form of Qbfs that includes a conic term is absent. It is a very small modification, and it would be good to allow designers to use it when appropriate.

We did not have an easily understood reference from which to draw this form. Moreover, this form is not currently even in numerous optical design codes. If we add it should it be a new form entirely or just a modification of Qbfs? We should discuss this point further.

Action: Paul Murphy will work to get a version that can be added to the standard from Greg Forbes. Addition of this content likely requires a re-ballot.

See note on the previous action.

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Along that same vein, it would be nice to see some guidance as to what the features and weaknesses of the various forms are. If it doesn't belong in the notes for the standard, where should such information be put? Do we need to write a journal article to spell it all out?

This is getting into the territory of being informative in the standard. A good route is to write an article and then reference it in the next draft. We agree that it is a very good idea and service to the industry. Your draft starting it is very good and we can discuss a venue. TF5 is willing to lend support, likely for publication in the next couple of years.

Action: Tabled and should be done separate to this vote.

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Some diagrams of the surfaces would be helpful. The examples are nice, but are of course confined to "official" drawings. More "cartoon" like diagrams would help visualization for the surfaces, especially in the future when we try to make distinctions for so-called "freeforms".

Agreed to avoid confusion – we rely on examples to show how to use the standard. If we put formal drawings in they are normative and need to show how the standard must be used. Otherwise, examples are the way to go. Dave did a good job on -8 with different options for surface ripple and other definitions. This topic may belong in the aforementioned journal article and can be added to the standard later if it adds value. We can discuss this point further.

Action: Can mention at the international level with respect to -19 during the next ballot.

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A conversion equation for a/b/c coefficients in the implicit surface equation to the radius and conic constants would be useful (I've derived one before...). I have occasionally seen prints that write a conic in the implicit form (e.g. an ellipsoid), but most fabrication and testing software don't support this form (maybe some design software too, I'm not familiar enough with it). On a side note, how does the standard allow for tolerancing a/b/c coefficients?

Boy do I agree on the conversion point. I would love to see an article doing it even if it is "obvious" to Greg and the mathematical sorts of people.

The standard does not explicitly cover tolerancing except with the small sections in the middle referencing other standards. It is an evolving topic with my lesser flawed paper from 2009 and John Rogers' better paper from 2010 covering it. We do somewhat get to

tolerancing in a few other places, specifically allowing notation for a slope error or PSD etc in -8 and discussion of datums in -6. The surface form standard -5 is also going to be reworked for aspheres on the international level. (Special note Ray is still working with other parties on the international version of -6.) This -12 draft is mostly, therefore, about defining the surfaces on drawings.

Action: Mention to Sven Kiontke and international group during a meeting. The point is that we have some forms here that may have definitions, but the standard lacks a means to facilitate practical ease of use. Otherwise it is not an issue for this vote. See section 3.3.1.2).

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O Negative w/reasons:

O Abstain w/reasons: