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AMENDMENT 1
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Optics and photonics — Preparation of drawings for optical elements and systems —

Part 12:
Aspheric surfaces —

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Optique et photonique — Préparation des dessins pour éléments et systèmes optiques —

Partie 12: Surfaces asphériques —

AMENDEMENT 1

Reference number
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Foreword

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Optics and photonics — Preparation of drawings for optical elements and systems —

Part 12:
Aspheric surfaces

AMENDMENT 1

Page iv, Foreword

In the list of part titles of ISO 10110, update the part title of Part 8 to read:

— *Surface texture; roughness and waviness*

Page 2, 3.1.2

Number the NOTE to become NOTE 1 and add the following NOTE 2 after NOTE 1:

NOTE 2 In this case, “left” and “right” presume z is increasing from left to right. When the Z-axis is reversed as a result of a reflection (a 180° rotation about the Y-axis), the sign convention for radius and sagitta is also reversed. This is discussed further in 3.3.2.3.

Page 5, 3.3.2.1

Immediately after Equation (12), i.e. before the sentence about Schmidt surface, insert the following new paragraph:

The first order and second order aspheric terms, A_1h and A_2h^2, may be added to Equation (12).

Page 6, 3.3.2.3

Add the following new subclause after 3.3.2.3:

3.3.2.4 Combined surface based on an orthogonal polynomial

A surface of higher order can also be generated by combining a spherical surface [Equation (5)] with a set of orthogonal polynomials of the following type possessing orthonormal derivatives (see Reference [3]).

$$z = f(x,y) + f_1(x,y) \tag{17}$$

$$f_1(x,y) = \frac{\left(\frac{h}{h_0}\right)^2 \left[1 - \left(\frac{h}{h_0}\right)^2\right]}{\sqrt{1 - \left(\frac{h}{R}\right)^2}} \left[A_0 Q_0 \left(\frac{h^2}{h_0^2}\right) + A_1 Q_1 \left(\frac{h^2}{h_0^2}\right) + \cdots\right] \tag{18}$$

where h_0 marks the upper limit of h. The description z is valid for $0 \le h \le h_0$ only. R is the radius of curvature that intersects the surface at h_0.

For a detailed description of the recursion formulae, see Annex B.

NOTE Another description that combines a conic with a set of orthogonal polynomials, orthogonal in amplitude, is also permitted [see Reference [4], Equations (2) to (3) and (8) to (9)].

Page 14, Annex A

In the table, add a new row for “Sphere”, under “Surfaces rotationally symmetric about *Z*-axis”. For the sake of clarity, the amended table of Annex A is given hereafter in its entirety.

Class	Basic surface	Basic equation $f(x,y)$ =	Power series $f1(x,y)$ = [for toric surfaces, $g1(x)$]
Non-rotationally-symmetric surfaces	Ellipsoid Hyperboloid Paraboloid	$$\frac{\frac{x^2}{R_X}+\frac{y^2}{R_Y}}{1+\sqrt{1-(1+\kappa_X)\left(\frac{x}{R_X}\right)^2-(1+\kappa_Y)\left(\frac{y}{R_Y}\right)^2}}$$	$A_4x^4+B_4y^4+A_6x^6+B_6y^6+\dots$ $\dots C_3\lvert x\rvert^3+\dots+D_3\lvert y\rvert^3+\dots$
$R_X \neq R_Y$ [a] $\kappa_X \neq \kappa_Y$	Cone (a ≠ b)	$$c\sqrt{\frac{x^2}{a^2}+\frac{y^2}{b^2}}$$	
$A_{2i} \neq B_{2i}$ $C_{2i-1} \neq D_{2i-1}$	Cylinder	$$\frac{u^2}{R_U\left[1+\sqrt{1-(1+\kappa_U)\left(\frac{u}{R_U}\right)^2}\right]}$$	$A_4x^4+A_6x^6+\dots+C_3\lvert x\rvert^3$ for $u = x$ $B_4y^4+B_6y^6+\dots+D_3\lvert y\rvert^3$ for $u = y$
Surfaces rotationally symmetric about Z axis	Ellipsoid Hyperboloid Paraboloid Sphere	$$\frac{h^2}{R\left[1+\sqrt{1-(1+\kappa)\left(\frac{h}{R}\right)^2}\right]}$$	$A_3h^3+A_4h^4+A_5h^5+\dots$ where $h=\sqrt{x^2+y^2}$
$R_X = R_Y = R$ $\kappa_X = \kappa_Y = \kappa$	Cone (a = b)	$$\frac{c}{a}h$$	
$h^2 = x^2 + y^2$	Plane (Schmidt surface)	0	
	Sphere	$$\frac{h^2}{R\left[1+\sqrt{1-\frac{h^2}{R^2}}\right]}$$	$$\frac{\left(\frac{h}{h_0}\right)^2\left[1-\left(\frac{h}{h_0}\right)^2\right]}{\sqrt{1-\left(\frac{h}{R}\right)^2}}\left[A_0Q_0\left(\frac{h^2}{h_0^2}\right)+A_1Q_1\left(\frac{h^2}{h_0^2}\right)+\dots\right]$$
Surfaces of revolution; not coincident with coordinate axis	Toric surface	$f(x,y)=R_Y \mp \sqrt{\left[R_Y-g(x)\right]^2-y^2}$ $$g(x)=\frac{x^2}{R_X\left[1+\sqrt{1-(1+\kappa_X)\left(\frac{x}{R_X}\right)^2}\right]}$$	$g_1(x)=A_4x^4+A_6x^6+\dots+C_3\lvert x\rvert^3+C_5\lvert x\rvert^5+\dots$

a If at least one of these inequalities is valid.

Page 15, new Annex B

Add the following annex:

Annex B
(informative)

Description of an orthogonal polynomial

$$Q_{m+1}\left(\frac{h^2}{{h_0}^2}\right)=\frac{P_{m+1}\left(\frac{h^2}{{h_0}^2}\right)-g_m Q_m\left(\frac{h^2}{{h_0}^2}\right)-k_{m-1}Q_{m-1}\left(\frac{h^2}{{h_0}^2}\right)}{l_{m+1}} \tag{B.1}$$

starting with $Q_0\left(\frac{h^2}{{h_0}^2}\right)=1$ and $Q_1\left(\frac{h^2}{{h_0}^2}\right)=\frac{13-16\left(\frac{h^2}{{h_0}^2}\right)}{\sqrt{19}}$

$$P_{m+1}\left(\frac{h^2}{{h_0}^2}\right)=(2-4\frac{h^2}{h_0^2})P_m\left(\frac{h^2}{{h_0}^2}\right)-P_{m-1}\left(\frac{h^2}{{h_0}^2}\right) \tag{B.2}$$

starting with $P_0\left(\frac{h^2}{{h_0}^2}\right)=2$ and $P_1\left(\frac{h^2}{{h_0}^2}\right)=6-8\left(\frac{h^2}{{h_0}^2}\right)$.

The following auxiliary polynomials (B.3), (B.4) and (B.5) have to be solved in the order given here and are valid for $m \geq 2$.

$$k_{m-2}=\frac{-m(m-1)}{2\,l_{m-2}} \tag{B.3}$$

$$g_{m-1}=\frac{-(1+g_{m-2}k_{m-2})}{l_{m-1}} \tag{B.4}$$

$$l_m=\left[m(m+1)+3-g_{m-1}^2-k_{m-2}^2\right]^{1/2} \tag{B.5}$$

starting with $g_0=-\frac{1}{2}$, $l_0=2$ and $l_1=\frac{1}{2}\sqrt{19}$.

Based on the recursion the first six Qs are the following:

$$Q_0\left(\frac{h^2}{{h_0}^2}\right)=1$$

$$Q_1\left(\frac{h^2}{{h_0}^2}\right)=\frac{13-16\left(\frac{h^2}{{h_0}^2}\right)}{\sqrt{19}}$$

$$Q_2\left(\frac{h^2}{h_0^2}\right)=\sqrt{\frac{2}{95}}\left[29-4\left(\frac{h^2}{h_0^2}\right)\left(25-19\left(\frac{h^2}{h_0^2}\right)\right)\right]$$

$$Q_3\left(\frac{h^2}{h_0^2}\right)=\sqrt{\frac{2}{2545}}\left\{207-4\left(\frac{h^2}{h_0^2}\right)\left[315-\left(\frac{h^2}{h_0^2}\right)\left(577-320\left(\frac{h^2}{h_0^2}\right)\right)\right]\right\}$$

$$Q_4\left(\frac{h^2}{h_0^2}\right)=\frac{1}{3\sqrt{131831}}\left(7737-16\left(\frac{h^2}{h_0^2}\right)\left\{4653-2\left(\frac{h^2}{h_0^2}\right)\left[7381-8\left(\frac{h^2}{h_0^2}\right)\left(1168-509\left(\frac{h^2}{h_0^2}\right)\right)\right]\right\}\right)$$

$$Q_5\left(\frac{h^2}{h_0^2}\right)=\frac{1}{3\sqrt{6632213}}\left[66657-32\left(\frac{h^2}{h_0^2}\right)\left(28338-\left(\frac{h^2}{h_0^2}\right)\left\{135325-8\left(\frac{h^2}{h_0^2}\right)\left[35884-\left(\frac{h^2}{h_0^2}\right)\left(34661-12432\left(\frac{h^2}{h_0^2}\right)\right)\right]\right\}\right)\right]$$

Page 15, Bibliography

Add the following bibliography references:

[2] Kross, J., Oertmann, F.-W., Schuhmann, R., *On aspherics in optical system*, SPIE Proceedings 656 (1986)

[3] Forbes, G.W., Robust, efficient computational methods for axially symmetric optical aspheres, Opt. Express 18, 19700-19712 (2010)

[4] Forbes, G.W., Shape specification for axially symmetric optical surfaces, Opt. Express 15, 5218-5226 (2007)

