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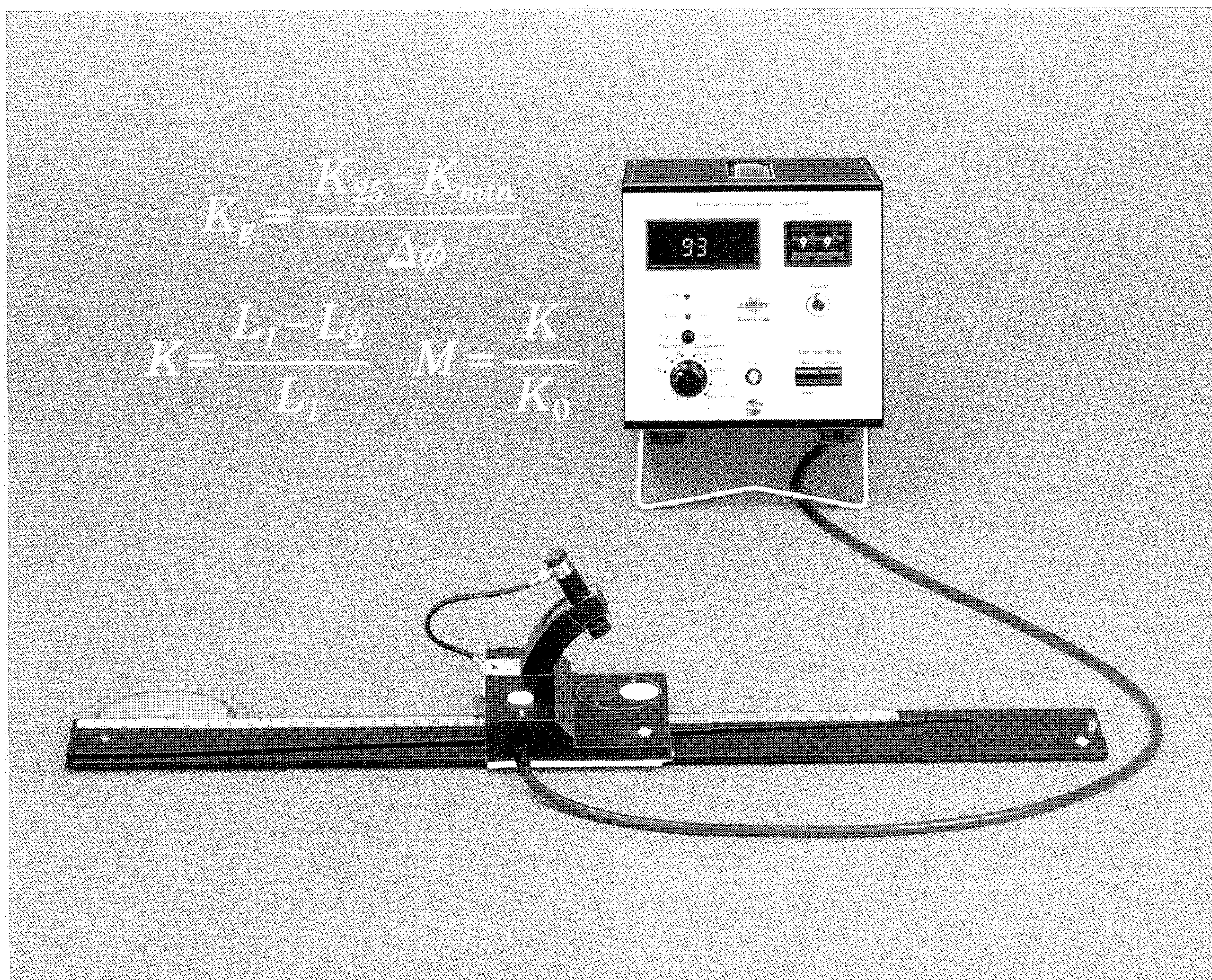
Contrast Meter for Quantitative Evaluation of Illumination Systems

Dr. Reiner Pusch



Contrast Meter for Quantitative Evaluation of Illumination Systems

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Illuminance, measured in lux, is the parameter which immediately comes to mind when considering the evaluation of illumination systems. Since it is easy to plan and measure, illuminance has become the subject of many standards and recommendations. For evaluating the visual comfort of a location, however, it is important to measure the luminance and the luminance contrast.

A test character with luminance L_2 in an environment with luminance L_1 is only visible if sufficient contrast

$$K = \frac{L_1 - L_2}{L_1} \qquad (1)$$

is present. The importance of contrast when performing visual tasks has been proven in a number of publications[1,2]. Good illumination should render high contrasts which are not impaired by reflected glare. A contrast meter is now available[3] for quantitative evaluation of contrast, .

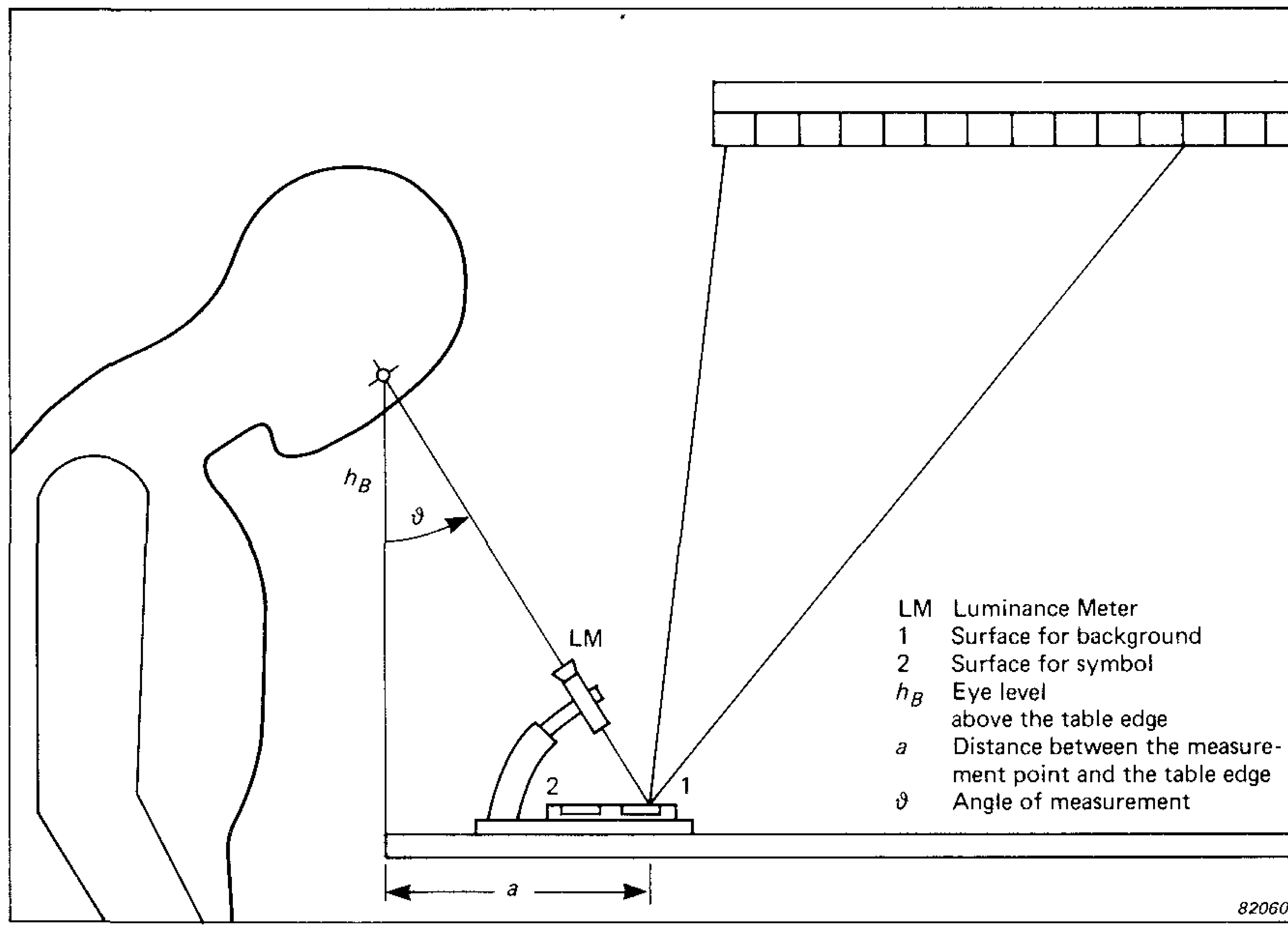

Fig.1. Measuring system with contrast meter

Principle of contrast measurements

From the given definition, contrast can be measured by measuring the luminance of a test symbol and the background luminance and calculating the contrast using equation 1.

When using the contrast meter (Fig. 1), two test surfaces (representing the background (1) and test symbol (2)) are positioned in front of a luminance meter (LM). The display unit then gives the value of contrast directly. The meter assumes an eye point at a height h_b = 40 cm above the edge of the table. Measurements are normally made with a measurement angle $\vartheta = 25°$. If more measurement points are required, ϑ is varied by moving the luminance meter. A constant observer position is thus obtained for all measurements ("angle true" measurement).

The results are dependent on the reflective characteristics of the test surfaces which have a distinct specular component for an angle of incidence $\gamma_i = 25°$. This is illustrated in Fig. 2 where the luminance factor β is given as a function of γ_i.

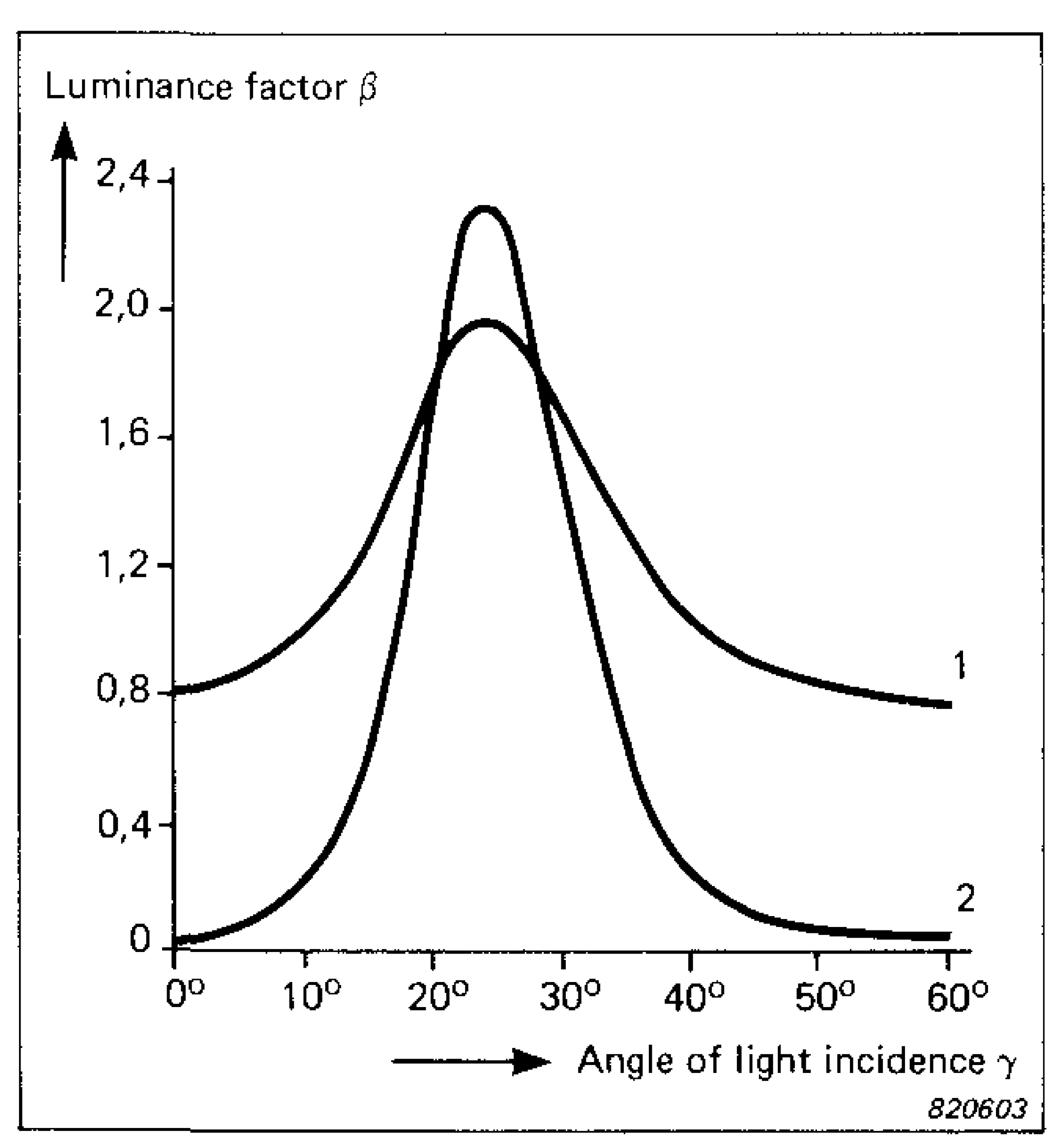

Fig.2. Luminance factor β for surfaces 1 and 2. β is the ratio between the surface luminance and the luminance of an ideal diffuse reflecting surface

The contrast can also be referred to a fixed value K_0. The ESI (Equivalent Sphere Illumination) method refers the measured contrast K to a fixed value K_0 which is the contrast of the visual task when illuminated with ideal diffuse light. A contrast rendering factor M, which may be determined directly using the contrast meter, can then be defined:

$$M = \frac{K}{K_0} \qquad (2)$$

Measurements in offices

The results of some practical measurements in a number of offices are given in Table. 1. For each work area in the three offices the contrast values and the contrast rendering factors give a measure of the viewing quality. In general, better values were obtained for the SiDEKO® 2K Illumination system and the SiDEKO lighting fittings with Batwing light distribution than for the lighting fittings with white louvres [5].

Fig. 4 shows the percentage contrast for an area of location 1 which is placed in a system with Batwing light distribution. The "angle true" measurements at this location show that the contrast decreases at the lateral edges, whilst high contrast values can be seen in the central working area, especially in the nearfield. Contrast values for $\vartheta = 25°$ (96%) and K_{min} (77%) are indicated in Fig. 4.

Using the values K_{25}, K_{min} and the angle $\Delta\phi$ (the bearing referred to the viewing point) the contrast gradient K_g, and therefore a measure of the contrast uniformity, can be found:

$$K_g = \frac{K_{25} - K_{min}}{\Delta\phi} \qquad (3)$$

K_g should be low for good uniformity of contrast rendering. Values of K_g are also given in Table 1. It can be seen that the visual quality varies considerably for the work areas equipped with lighting fittings with white louvres. For all three systems, however, satisfactory or good values for contrast and uniformity were obtained. No location was found to have extremely "bad contrast".

The contrast meter can also be used to produce a measurement contour. Fig. 5 shows the contrast rendering factor M for two illumination systems. A large reduction in the contrast rendering factor was found under the light bands of lighting fittings with large louvres (curve 2). For an illumination system with SiDEKO Batwing light distribution, a nearly constant value of M is obtained across the room (curve 1). This measurement contour can show preferred positions for working areas. For example, worktops or desks should be placed in the area at least 80 cm from each of the lighting fittings with louvres. For the SiDEKO Batwing system the desks may be placed anywhere.

Conclusion

The contrast meter enables a check of the contrast rendering characteristics of existing illumination systems. By measuring the contrast K, the contrast rendering factor M and the contrast gradient K_g, different illumination systems can be compared and individual work areas can be evaluated. Contrast measurements, therefore, can conveniently be made with a portable instrument and the results give a direct indication of contrast rendering. Critical situations can be thoroughly investigated by choosing various reflecting surfaces as test symbols.

Literature

[1] Pusch, R.; Reitmaier, J.: Visual Contrast as the Criterion for Optimalizing the "Light Field" for Indoor Lighting. — Siemens Forschungs- und Entwicklungsberichte 6 (1979), pp. 313 to 320

[2] Reitmaier, J.: Untersuchungen über Glanz- und Lichtreflexe. — Dissertation, Techn. Universität Karlsruhe 1977

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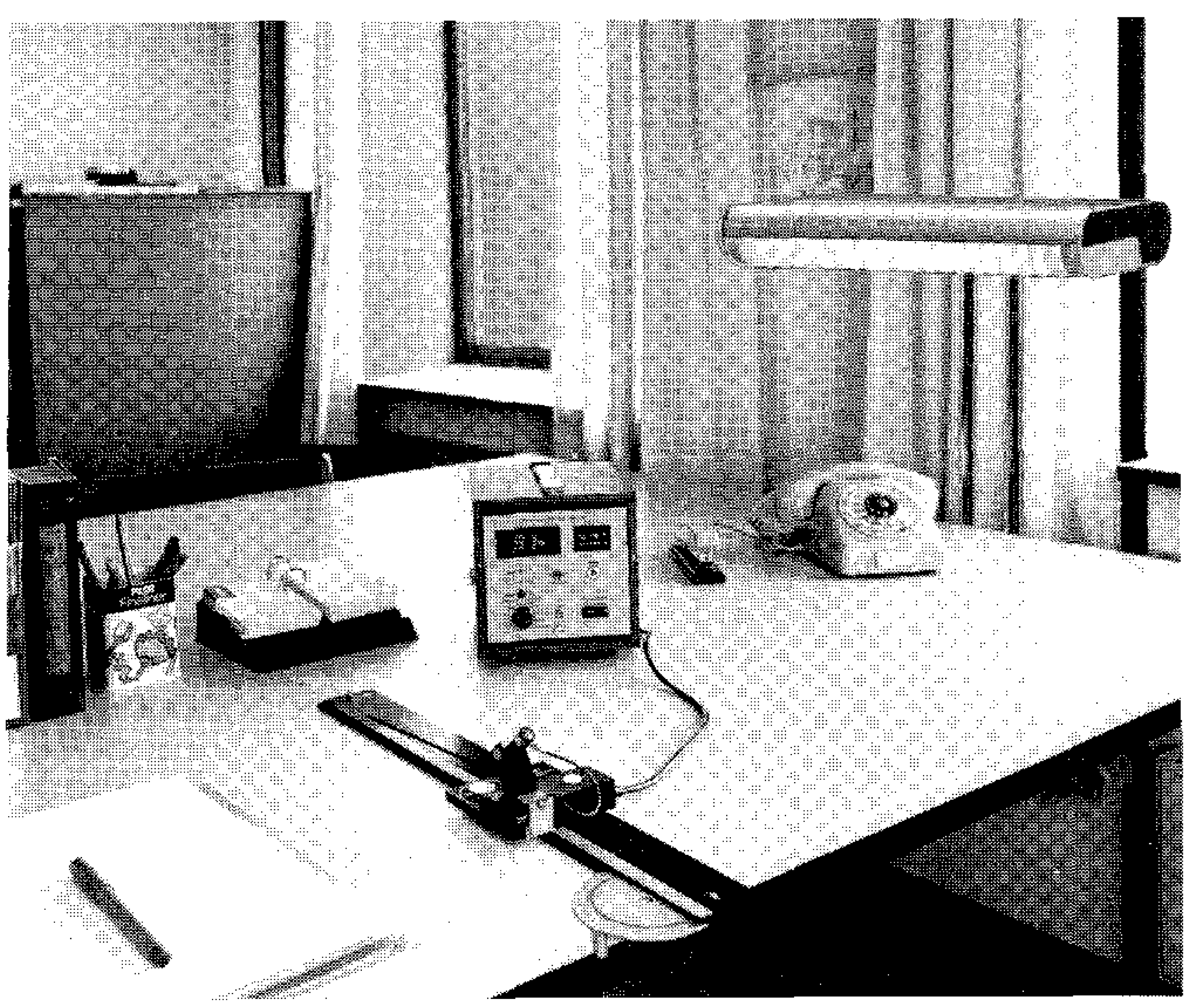

Fig.3. Measurement with the contrast meter in a 2K illumination system

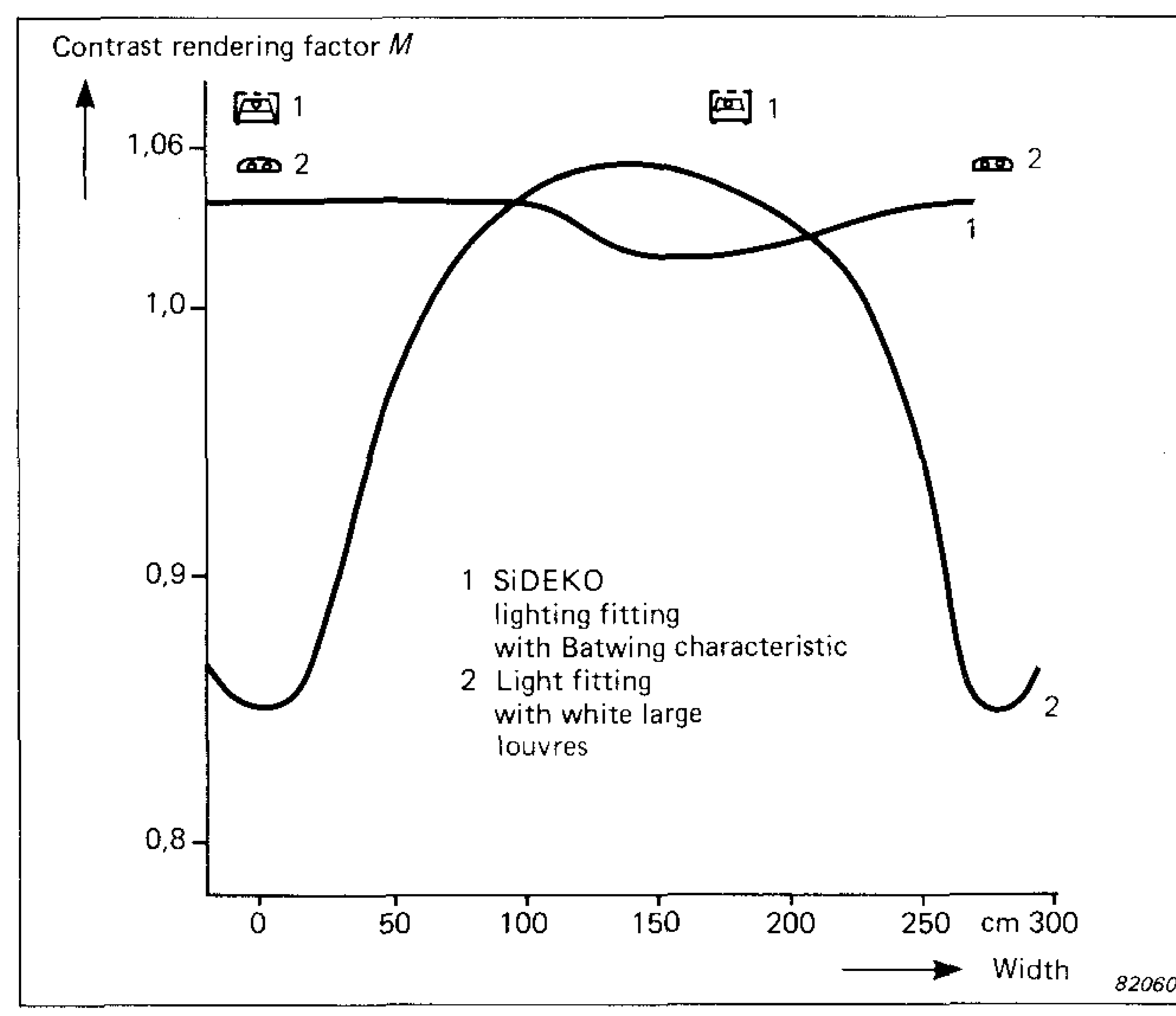

Fig.5. Contrast rendering factor M for two Illumination systems, measured between the light bands

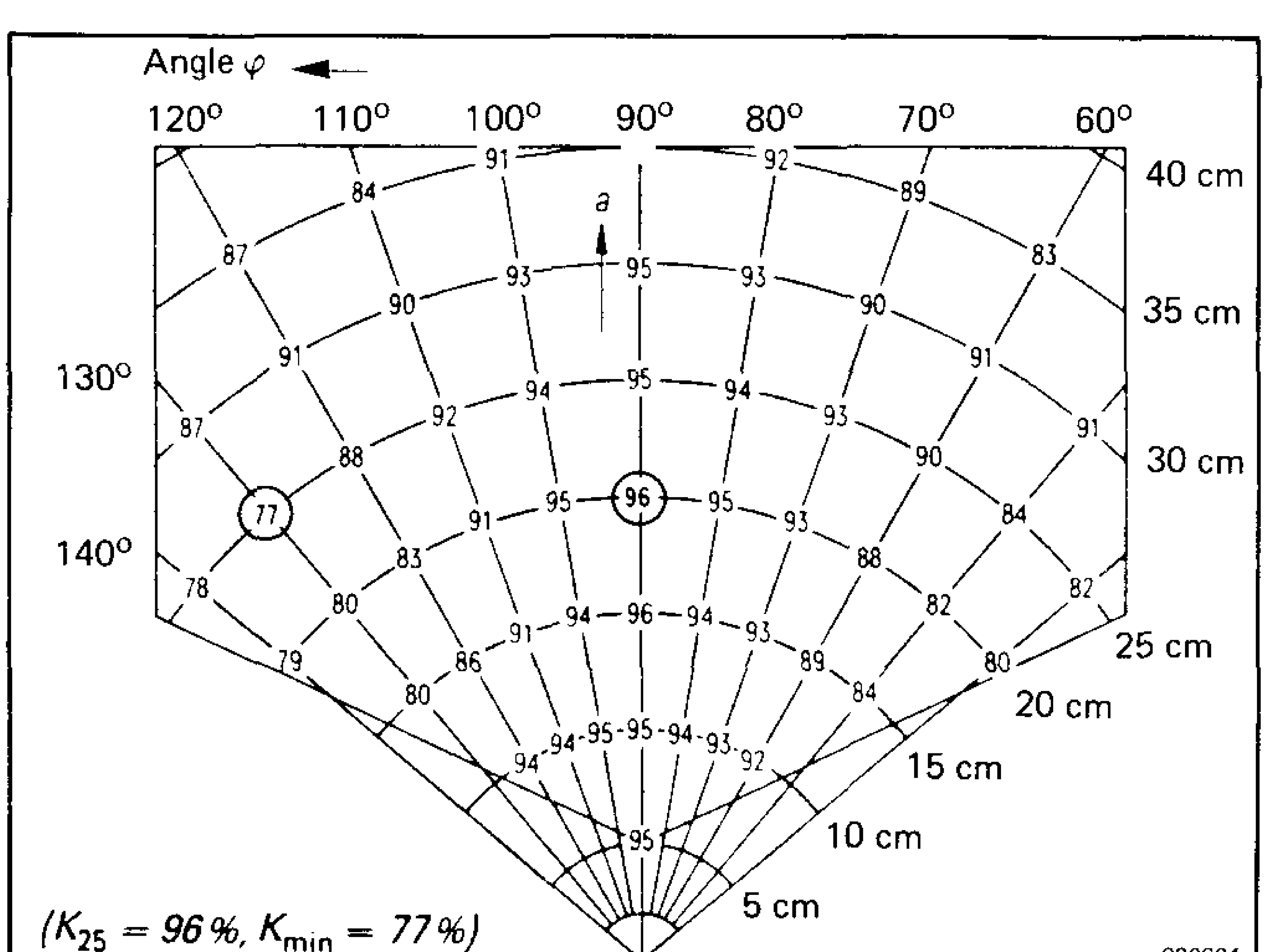

Fig.4. Contrast K at a work area with SiDEKO lighting fittings with Batwing light distribution (location 1). The measurements are "angle true" measurements

Illumination system	Place	Contrast K (%)	Contrast rendering factor M	Contrast gradient K_g
white lighting fitting with louvres deep/broad light distribution	1	93	1,02	0,56
	2	87	0,96	0,233
	3	91	1,0	0,125
	4	76	0,84	0,425
	5	93	1,02	0,5
2K-lighting fitting broad light distribution	1	94	1,03	0,42
	2	90	0,95	0,325
	3	92	1,01	0,42
	4	94	1,03	0,42
	5	95	1,04	0,32
SiDEKO-lighting fitting Batwing characteristic	1	96	1,05	0,475
	2	96	1,05	0,475
	3	93	1,01	0,5
	4	95	1,04	0,475
	5	89	0,98	0,73
	6	87	0,96	0,4

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Table.1. Measured values for three illumination systems

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