the portion of luminous flux emitted by the light sources, which falls on the working plane after interaction with luminaires and room surfaces. The deciding factor in this calculation is the utilance, which is derived from the geometry of the space, the reflectance of the room surfaces and the efficiency and the distribution characteristics of the luminaires used.

To be able to calculate the appropriate utilance in each individual case, there are tables available, which contain the utilance of a standardised space with changing room geometry, changing reflection factors and luminaires with a variety of distribution characteristics. The basic, idealised space is presumed to be empty and of regular shape and proportions, i.e. rectangular and having the ratio of length to width approx. 1.6 to 1. The luminaires are presumed to be arranged in a regular pattern on the ceiling, either mounted directly onto the ceiling or suspended from the ceiling. These standardised values have a decisive influence on the accuracy of the calculations for the application. If the conditions inherent in the basic concept are in line with those in the model space, the results will be reasonably accurate. The more the basic conditions deviate from the standardised conditions, e.g. if the lighting layout is distinctly asymmetrical, it must be accepted that an increasing number of errors will occur in the calculation.

When using the utilisation factor method an appropriate utilance table has to be used for each type of luminaire. The corresponding standard luminaire classification table can be used for this purpose. Luminaire classification in accordance with DIN 5040 and the German Lighting Engineering Society is made up of one letter and two digits, a combination indicates a number of luminaire qualities. The letter defines the luminaire class and indicates whether a luminaire emits light primarily in the upper or lower part of the space, i.e. direct or indirect lighting. The first digit refers to the proportion of luminous flux falling onto the working plane in the lower part of the space. The second digit indicates the corresponding value for the upper part of the space. It is often not necessary to use the standard table of luminaire classification, as exact tables are supplied by the lighting manufacturers.

$$E_N = V \cdot \frac{n \cdot \Phi \cdot \eta_R \cdot \eta_{LB}}{a \cdot b}$$

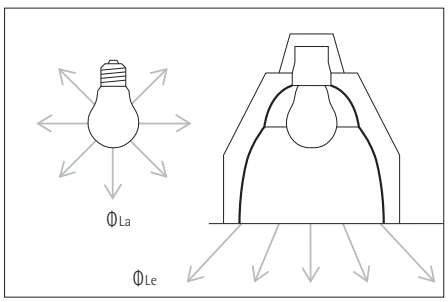
$$n = \frac{1}{V} \cdot \frac{E_n \cdot a \cdot b}{\Phi \cdot \eta_R \cdot \eta_{LB}}$$

Utilisation factor method: formula for calculating the nominal illuminance E_N for a given number of luminaires or the number of luminaires n for a given illuminance.

E_N (lx)	Nominal illuminance
n	Number of luminaires
a (m)	Length of space
b (m)	Width of space
Φ (m)	Luminous flux per luminaire
η_R	Utilance
η_{LB}	Light output ratio
V	Light loss factor

$$\eta_{LB} = \frac{\Phi_{Le}}{\Phi_{La}}$$

Light output ratio η_{LB}: ratio of the luminous flux emitted by a luminair Φ_{Le} under operating conditions to the luminous flux of the lamp Φ_{La}.



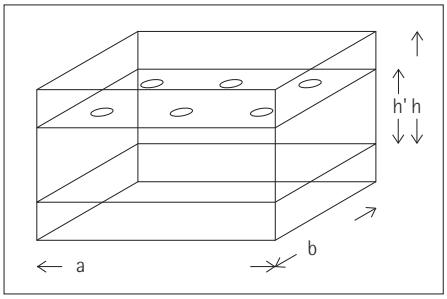
Typical light output ratios η_{LB} for direct luminaires with various cut-off angles and lamp types.

Luminaire	Lamp type	η_{LB}
Louvred luminaire 30°	T26	0.65–0.75
Louvred luminaire 40°	T26	0.55–0.65
Louvred lumin. square	TC	0.50–0.70
Downlight 30°	TC	0.60–0.70
Downlight 40°	TC	0.50–0.60
Downlight 30°	A/QT	0.70–0.75
Downlight 40°	A/QT	0.60–0.70

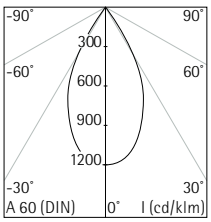
$$k = \frac{a \cdot b}{h\,(a+b)}$$

$$k = 1.5 \cdot \frac{a \cdot b}{h'\,(a+b)}$$

The room index k describes the influence of the room geometry on the utilance. It is calculated from the length and width of the room, and the height h above the working plane under direct luminaires (room index k) and height h' above the working plane under predominantly indirect luminaires (room index k').

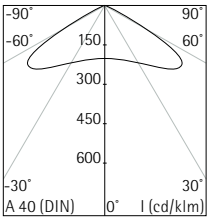


Utilance values η_R for typical interior luminaires (from the top downwards): narrow-beam luminaires (A 60, DIN 5040)



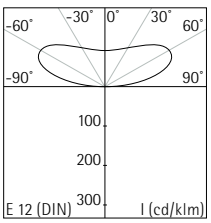
η_R	ϱ_C	0.70	0.70	0.70	0.70	0.70	0.50	0.50	0.20	0.00
	ϱ_W	0.70	0.50	0.50	0.20	0.20	0.50	0.20	0.20	0.00
	ϱ_F	0.50	0.20	0.10	0.20	0.10	0.10	0.10	0.10	0.00
k										
0.60		1.04	0.86	0.84	0.81	0.80	0.84	0.80	0.80	0.78
1.00		1.17	0.95	0.92	0.90	0.88	0.91	0.88	0.87	0.85
1.25		1.26	1.06	0.98	0.98	0.95	0.97	0.95	0.94	0.92
1.50		1.30	1.04	1.00	1.00	0.97	0.99	0.97	0.96	0.94
2.00		1.35	1.07	1.02	1.04	1.00	1.01	0.99	0.98	0.97
2.50		1.38	1.09	1.03	1.06	1.02	1.02	1.01	0.99	0.97
3.00		1.41	1.11	1.05	1.08	1.03	1.03	1.02	1.00	0.99
4.00		1.43	1.11	1.05	1.09	1.03	1.03	1.02	1.00	0.98

Wide-beam luminaires (A 40, DIN 5040)



η_R	ϱ_C	0.70	0.70	0.70	0.70	0.70	0.50	0.50	0.20	0.00
	ϱ_W	0.70	0.50	0.50	0.20	0.20	0.50	0.20	0.20	0.00
	ϱ_F	0.50	0.20	0.10	0.20	0.10	0.10	0.10	0.10	0.00
k										
0.60		0.63	0.43	0.42	0.31	0.31	0.41	0.31	0.30	0.26
1.00		0.87	0.63	0.61	0.51	0.50	0.59	0.49	0.49	0.44
1.25		0.99	0.73	0.70	0.62	0.61	0.68	0.60	0.59	0.55
1.50		1.06	0.79	0.76	0.69	0.67	0.74	0.66	0.65	0.61
2.00		1.17	0.88	0.83	0.79	0.76	0.81	0.75	0.73	0.70
2.50		1.23	0.93	0.89	0.86	0.82	0.86	0.81	0.79	0.76
3.00		1.29	0.98	0.92	0.91	0.87	0.90	0.86	0.84	0.81
4.00		1.34	1.02	0.96	0.96	0.91	0.94	0.90	0.88	0.85

Indirect luminaires (E 12, DIN 5040)



η_R	ϱ_C	0.70	0.70	0.70	0.70	0.70	0.50	0.50	0.20	0.00
	ϱ_W	0.70	0.50	0.50	0.20	0.20	0.50	0.20	0.20	0.00
	ϱ_F	0.50	0.20	0.10	0.20	0.10	0.10	0.10	0.10	0.00
k'										
0.60		0.27	0.14	0.14	0.07	0.07	0.11	0.05	0.03	0
1.00		0.43	0.25	0.25	0.15	0.15	0.19	0.11	0.05	0
1.25		0.50	0.31	0.30	0.20	0.20	0.23	0.14	0.07	0
1.50		0.56	0.36	0.35	0.25	0.24	0.26	0.18	0.08	0
2.00		0.65	0.43	0.42	0.32	0.31	0.30	0.22	0.10	0
2.50		0.71	0.49	0.47	0.38	0.37	0.34	0.26	0.11	0
3.00		0.76	0.53	0.51	0.43	0.41	0.36	0.29	0.12	0
4.00		0.82	0.58	0.55	0.49	0.47	0.40	0.34	0.14	0

The appropriate utilance is calculated from the specific room index k (k') and the combination of the reflectance factors of ceiling (ϱ_C), walls (ϱ_W) and floor (ϱ_F).

V	Degree of Deterioration
0.8	Normal deterioration
0.7	Increased deterioration
0.6	Heavy deterioration

Light loss factor V in relation to the degree of deterioration in the space.