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Position paper

UGR method – application and limits

Unified Glare Rating

Lighting Division

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UGR method - application and limits

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Content

Application and limitations of the UGR method for glare assessment in indoor lighting
(with focus on industrial lighting)

Motivation of this position paper

As a planner, it is important to know the limitations of the UGR method.

This position paper describes the essential aspects of the „Unified Glare Rating (UGR)" procedure for the evaluation of discomfort glare from artificial lighting in indoor spaces. The structure and application of the UGR method are presented in context.

1 Introduction – Quality characteristics of lighting – What is glare and limitation of glare?

Glare depends among other things on
- the luminance and size of the emitting surface,
- the relative position of the emitting surface to the direction of observation,
- the brightness of the environment, i.e. the luminance of the surfaces on which the observer is looking and to which his eye is adapted.

Glare is caused by excessive luminance (absolute glare) or excessive luminance differences (relative glare) in the visual field of an observer. A distinction is made between direct glare, caused for example by luminaires, and reflected glare, caused by specular reflections on surfaces.

Glare that causes an unpleasant sensation without necessarily being associated with a noticeable reduction in vision is referred to as discomfort glare.

Glare that results in a reduction of visual function without necessarily causing discomfort is referred to as disability glare.

For definitions, see also the CIE International Lighting Vocabulary ILV (CIE S 017, 2020. 17-22-098 ff.).

Glare creates a stressful situation for the observer and should therefore be limited to avoid fatigue, increased error rates and accidents.

Glare can be kept to a minimum by, among other things, the correct selection and arrangement of luminaires and an appropriate room design. For glare-controlled room design, the room surfaces should be as bright and matt as possible. Luminaires can be designed to reduce glare by means of shielding and controlled luminous intensity distribution. Information on this can be found in the „Leitfaden zur DIN EN 12464-1" (ZVEI 2013).

The degree of discomfort glare of a lighting installation can be determined using the UGR method.

2 Current status of the UGR method – principle and application

According to DIN EN 12464-1, the classification of discomfort glare caused by luminaires in an indoor lighting installation must be carried out using the UGR tabular method of the CIE Unified Glare Rating (UGR) procedure. The UGR method considers all luminaires in the installation that contribute to a glare impression. The UGR tabular method simplifies the procedure by applying restrictive boundary conditions: the values for the UGR table are calculated based on the UGR formula with fixed parameters, see also 2.2. The UGR formula is as follows:

$$R_{\mathrm{UG}} = 8 \cdot \log_{10} \frac{0{,}25}{L_{\mathrm{B}}} \cdot \sum_{i} \frac{L_i^2 \cdot \Omega_i}{p_i^2}$$

Where:

R_{UG}: The UGR glare value according to the internationally standardised method (CIE 117:1995) for describing discomfort glare

Application note: For comparison with the UGR limit values of DIN EN 12464-1, the UGR values of a lighting installation are to be determined using the UGR tabular method

L_B: The background luminance in cd/m² calculated from the vertical indirect illuminance E_{ind} at the observer's eye to $L_B = E_{ind}/\pi$

Application note 1: When applying the UGR tabular method, predefined reflectances are used; in real applications, these values and the resulting background luminances may be quite different, see 3.11

Application note 2: According to CIE 117:1995, the background luminance is determined by a highly simplified method which does not consider that the luminances on the longitudinal and transverse walls may differ significantly. CIE 117:1995 allows for other methods that take this into account. E.g. an inter-reflection model that distinguishes between the space boundary surfaces, see Haeger, Stockmar, 1980 and Gall, 2004

L_i: The mean luminance in cd/m² of the light-emitting surface of luminaire *i* in the direction of the observer's eye

Application note: The UGR formula only considers the average luminance of the light-emitting surface, regardless of whether there are local maxima and minima. See 3.6

Ω_i: The solid angle in sr (steradian) of the light-emitting surface of luminaire *i*, with respect to the observer's eye

p_i: Guth position index for luminaire *i*. It depends on the position of this luminaire with respect to the viewing direction

Application note: For the UGR tabular method, the viewing direction, observer position and eye level are fixed and are each located in the centre of the long or short side of the room or hall. See 2.2 and 3.5

All assumptions made when determining the UGR value must be listed in the planning documentation. The UGR limit values R_{UGL} specified in DIN EN 12464-1 depend on the difficulty and duration of the visual task and must not be exceeded by the rounded UGR values. The UGR limit values form a series whose steps represent a noticeable change in glare.

The sequence of UGR limit values in DIN EN 12464-1 is: 16, 19, 22, 25, 28. A suitable gradation according to the rounding rules for values R_{UG} determined with a UGR method results as follows:

level ≤ 16,	if		$R_{UG} \leq 16{,}4$
level ≤ 19,	if	16,5 ≤	$R_{UG} \leq 19{,}4$
level ≤ 22,	if	19,5 ≤	$R_{UG} \leq 22{,}4$
level ≤ 25,	if	22,5 ≤	$R_{UG} \leq 25{,}4$
level ≤ 28,	if	25,5 ≤	$R_{UG} \leq 28{,}4$
level > 28,	if	28,5 ≤	R_{UG}

Examples of upper UGR limits are given in Table 1.

Technical sign, precision work	≤16
Reading, writing, classrooms, computer work, control work	≤19
Work in industry and craft, reception	≤22
Rough work, storage rooms, machine halls, stairs	≤25
Corridors, traffic areas	≤28

When applying the tabular method, it is appropriate that luminaires are compared only based on their classification into these levels ≤ 16, ... ≤ 28. For example, two luminaires with the values 19.8 and 21.2 are to be classified equally in the group ≤ 22, whereas two luminaires with 19.1 and 19.6 fall into two groups (≤ 19 and ≤ 22). A numerical comparison only based on the values including one decimal place is not intended and alone does not allow a statement „better" or „worse".

2.1 The individual UGR data sheet value for the approximate luminaire comparison

In the data sheet of some luminaire manufacturers, only a single UGR value is specified. This reflects the use of a luminaire in a special standard room with a specified spacing-to-height ratio (4H/8H) and standard reflectances (see Fig. 1). Deviations from these reference parameters, when the luminaire is used in the actual application, have an influence on the UGR value. If the room to be illuminated does not deviate too much from this standard room, the UGR data sheet value is suitable for an initial, relative comparison of luminaires.

The special standard room of the UGR data sheet value is not comparable with industrial halls due to its dimensions and reflectances. The single UGR data sheet value is therefore not suitable for an evaluation of luminaires in industrial applications.

2.2 Compliance with the UGR limits according to DIN EN 12464-1 using the UGR tabular method

According to DIN EN 12464-1, the lighting designer must classify discomfort glare of a lighting installation using the tabular method of the CIE Unified Glare Rating Procedure (CIE 117:1995). The UGR table value determined in this way can be used to check compliance with the UGR limit values R_{UGL} according to DIN EN 12464-1. Apart from the requirement of the standard, the tabular method also represents a simplification for the planner in comparison to the numerically more complex UGR formula.

Application note: In DIN EN 12464-1:2021, the application of the formula is also permissible if the tabular method is not applicable. However, the UGR value determined in this way is not proof that the limit values are complied with.

To apply the UGR tabular method, a comparably sized standard room to the room that the designer has to plan, is chosen for the selection of data in the table. The reflectances selected in the table should be as close as possible to the planned ones, but smaller than them. Luminaire manufacturers provide UGR tables in catalogues or databases (see Fig. 1 for an example). The UGR tabular method is also supported by lighting calculation programs such as Relux or Dialux. The viewing direction and the observer position are fixed and are located on the longitudinal or transverse side of the room or hall (see Fig. 2). The limits of the UGR tabular method lie, among other things, in the room geometries and reflectances specified in the example table in Fig. 1.

UGR table		standard room									
Reflectance ceiling		0,7	0,7	0,5	0,5	0,3	0,7	0,7	0,5	0,5	0,3
Reflectance walls		0,5	0,3	0,5	0,3	0,3	0,5	0,3	0,5	0,3	0,3
Reflectance floor		0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Room dimensions		viewing direction crosswise to the luminaire (C0)					viewing direction lengthwise to the luminaire (C90)				
x	y										
2H	2H	20,9	22,2	21,2	22,5	22,8	20,4	21,7	20,7	22,0	22,3
	3H	21,3	22,4	21,7	22,8	23,1	20,9	22,0	21,3	22,4	22,7
	4H	21,4	22,5	21,8	22,8	23,2	21,1	22,2	21,5	22,5	22,9
	6H	21,4	22,4	21,8	22,7	23,1	21,2	22,1	21,6	22,5	22,9
	8H	21,5	22,3	21,9	22,7	23,1	21,3	22,1	21,7	22,5	22,9
	12H	21,5	22,2	21,9	22,6	23,0	21,3	22,0	21,7	22,4	22,8
4H	2H	20,8	21,8	21,2	22,2	22,6	20,3	21,3	20,7	21,7	22,1
	3H	21,4	22,2	21,8	22,6	23,0	20,9	21,8	21,3	22,2	22,6
	4H	21,5	22,3	22,0	22,7	23,1	21,2	22,0	21,7	22,4	22,8
	6H	21,5	22,2	22,0	22,6	23,1	21,4	22,0	21,8	22,5	22,9
	8H	21,5	22,1	22,0	22,5	23,0	21,4	22,0	21,9	22,4	22,9
	12H	21,5	22,0	22,0	22,4	22,9	21,4	21,9	21,9	22,4	22,9
8H	4H	21,5	22,1	22,0	22,6	23,0	21,3	21,9	21,7	22,3	22,8
	6H	21,5	22,0	22,0	22,5	23,0	21,5	21,9	22,0	22,4	22,9
	8H	21,5	21,9	22,0	22,4	22,9	21,5	21,9	22,0	22,4	22,9
	12H	21,5	21,8	22,0	22,3	22,9	21,5	21,8	22,0	22,3	22,9
12H	4H	21,5	22,0	22,0	22,5	23,0	21,3	21,8	21,8	22,2	22,7
	6H	21,6	21,9	22,1	22,4	23,0	21,5	21,8	22,0	22,3	22,9
	8H	21,5	21,8	22,0	22,3	22,9	21,5	21,8	22,0	22,3	22,9

Figure 1: Example of a UGR table with the standard rooms for applying the UGR table method. The special standard room 4H/8H for the single UGR data sheet value is highlighted

Source: Siteco GmbH

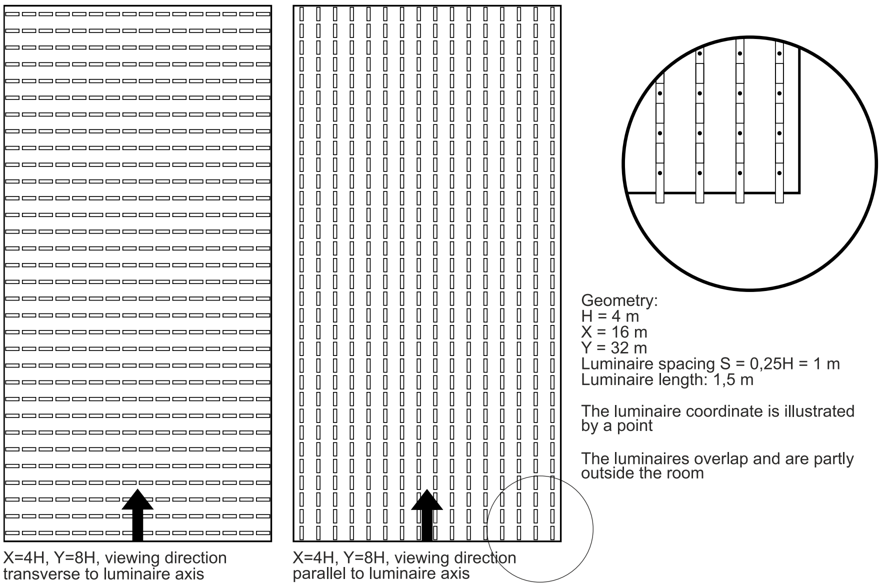

Figure 2: Lighting installation with uniform arrangement of luminaires in a horizontal plane whose centre of light is at height H above the observer's eye. The UGR calculation assessment points are at the centre of each luminaire, for which a UGR value was calculated using the UGR formula during the creation of the UGR table. The dimensions of the room refer to the respective viewing direction marked with an arrow, where X is transverse and Y is parallel to the viewing direction.

Source: TU Ilmenau, Lighting Engineering Group

Figure 2 shows lighting installations with a regular arrangement of luminaires for which the UGR table is calculated. The observer positions on which the UGR table is based are also shown as arrows. The luminaires' centre vertically is at height H above the observer's eye (Fig. 3). The room dimensions are given in the UGR table in multiples of the luminaire height H above the observer's eye.

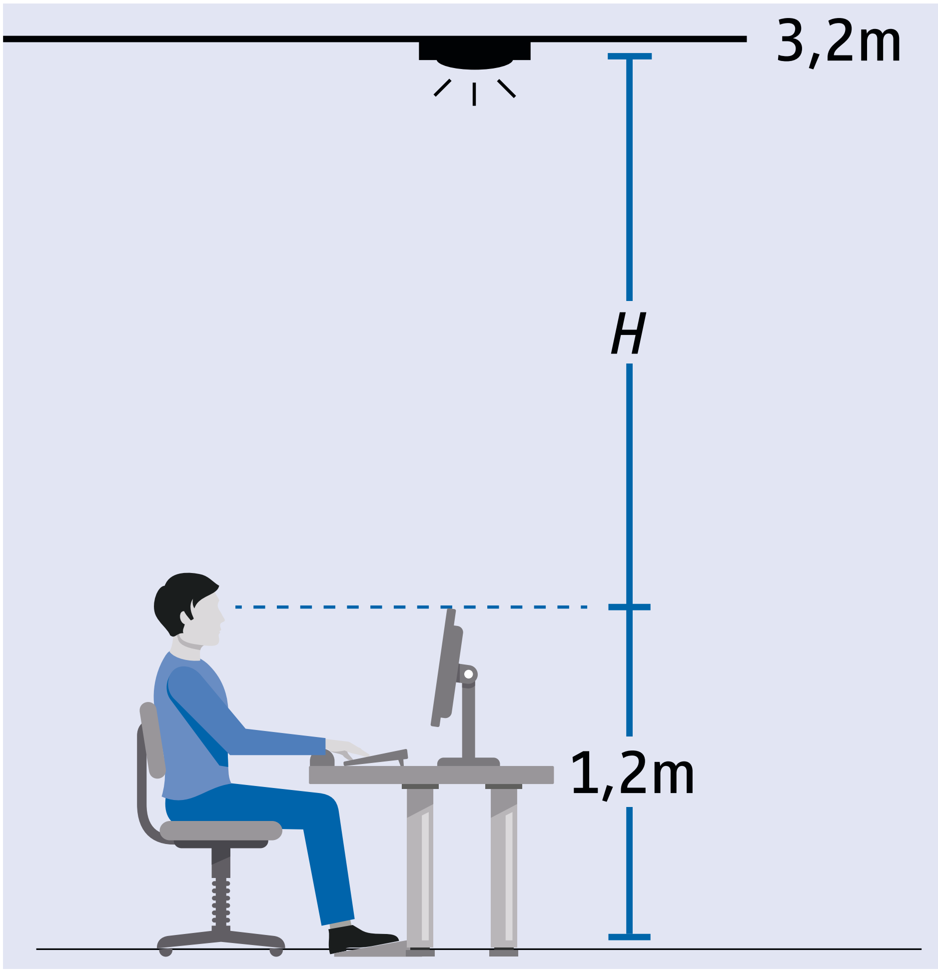

Figure 3: Representation of luminaire height H above the observer's eye. Source: Siteco GmbH

In view of the narrow luminaire grid in Fig. 2, it may be surprising that larger luminaires in this grid can even overlap or exceed the room boundary. In fact, the UGR value in the table is made up of two components: One component that is independent of the selected grid and a second component that corresponds to an average value over all grid points. The size of the luminous surface, like its luminous flux, is part of the first component. There is therefore no interaction between the choice of grid and the size of the luminous surface. The averaging in the second part is done by weighted values of the (squared) luminous intensity distribution and the grid should cover all possible potential positions in the field of view of an observer. This succeeds better in a narrow grid.

The fact that some individual values are always larger than the mean value makes it clear why the UGR tabular value cannot represent a worst case regarding individual luminaires. However, the most critical luminaires contribute disproportionately to the mean value. The UGR limit values of DIN EN 12464-1 refer to the UGR tabular method, i.e. to the mean value determined with a defined grid.

A UGR maximum calculated by a calculation software with the UGR formula is therefore not comparable with the UGR limits.

2.3 Application of the UGR formula

If the existing room or hall geometry of the lighting solution to be evaluated exceeds the scope of the UGR table, the tabular method cannot be used. If the observer position and viewing direction are known, the UGR value of the system can be determined using lighting calculation software (e.g. Dialux or Relux) according to the UGR formula. Since the evaluation grid of this calculation does not correspond to that of the limit values of DIN EN 12464-1 from the UGR tabular method, the limit values can only be regarded as guide values.

The UGR values determined with the light calculation software are no proof that the limit values are complied with.

3 The limits of the UGR method

For an application-related glare assessment, especially for industrial applications, it is important for a planner to know the limits of the UGR method (UGR tabular method and application of the UGR formula).

An evaluation of disability glare is not possible with the UGR method.

3.1 Limits of individual UGR data sheet values

Glare is a property of a lighting installation, not of an individual luminaire. An individual UGR data sheet value is only a property of the luminaire if it is in its special standard space with defined properties. In practice, the UGR value can be significantly different, it only serves as an approximation or rough indication for the planner.

Even if the UGR value is not a product property per se, information such as „UGR < 19" can often be found in the data sheets of various manufacturers. The obvious conclusion that this is a luminaire property gives the misleading impression that the luminaire would comply with the specified limit for all applications. Unless the manufacturer provides further information, however, this is the UGR value that the luminaire achieves in a standard room with room dimensions 4H/8H and reflectances floor 20%, walls 50% and ceiling 70%. In real applications, UGR values can therefore also be lower or higher.

The UGR tabular method extends the number of rooms to standard rooms with 19 different room dimensions, each with five reflectance combinations for two luminaire orientations. This means that a UGR table published as a data sheet can be used for significantly more applications.

3.2 Limits of the UGR tabular method

Since the UGR tabular values are based on an average value over different viewing directions, there may be positions in the room where individual luminaires cause more glare than the calculated UGR tabular value would suggest.

The UGR tabular method is limited to room dimensions between 2H and 12H (where H is the luminaire height above the observer's eye, see Fig. 3). For room dimensions smaller than 2H, discomfort glare is unlikely. For room dimensions > 12 H, 12H can be assumed as a representative value according to DIN EN 12464-1:2021. In production facilities with large height differences between the user's eye level and the luminaire mounting plane (e.g. > 7 m), it should be checked in accordance with DIN EN 12464-1:2021, Annex A.2.7 whether the UGR method can be used or whether in these cases disability glare could be more important than discomfort glare.

The UGR tabular method uses a ‚virtual' luminaire arrangement to determine the UGR value. The actual luminaire arrangement is not considered. In extreme cases, e.g. such as narrow luminaire groupings, the UGR tabular method cannot be used.

Even in those applications where the UGR tabular method can be used, the correct UGR tabular value does not always result. According to DIN EN 13032-2, it is sufficient to consider the UGR with angular intervals ΔC=15° and $\Delta \gamma$=5°. With modern luminaires, the actual luminous intensity can change considerably within these intervals, which is then not reflected in the calculated tables. In these cases, the luminous intensity distribution should be documented with smaller angular intervals (e.g. steps of 2.5° or 1° each).

3.3 Limits of the UGR formula

The UGR formula can be used to calculate UGR values for many cases for which the UGR tabular method is not suitable. However, since the limit values of DIN EN 12464-1 are based on the UGR tabular method, the UGR values determined with the formula cannot be used as evidence that the limit values are complied with. However, a comparison of different lighting solutions or a classification of luminaires for a specific case is possible.

An evaluation of the subjectively perceived glare of each individual user is not possible with the UGR method. In individual cases, e.g. with glare-sensitive persons, disturbing glare can occur even if the limit values are complied with.

3.4 Limits on the size of light sources

The UGR method cannot be used for large light sources whose perceptible luminous surface occupies a solid angle of more than 0.1 sr. This limit results from the fact that too large glare sources influence the adaptation state of the eye in addition to the background luminance, which the UGR method does not consider.

The UGR method is not applicable for small light sources whose luminous surface occupies a solid angle of less than 0.0003 sr. The squaring of the luminance contained in the UGR formula is no longer valid for very small glare sources. This can be the case in large halls, for example, if the luminaires are located at a great height, i.e. far away.

The UGR method is therefore not applicable to:

- Wallwasher (wall as passively luminous surface),
- completely indirect luminaires (ceiling as passively luminous surface),
- luminous ceilings (too large an area),
- adjustable headlights (too small an area),
- other very small or very large luminous surfaces.

Based on studies by the German Federal Institute for Occupational Safety and Health, The German Lighting Society LiTG also advises against using the UGR method for lighting systems with luminaires that have an indirect component of more than 65% (LiTG Publ. 20). These may be more or less fully illuminated ceilings.

In large halls, some luminaires may be located so far away from the observer that their luminous surface falls below the lower limit for the solid angle. Due to a recommendation of the LiTG (LiTG Publ. 20), such luminaires are nevertheless considered when creating the tables. Which table values are affected by this has not yet been indicated.

3.5 Limits to the lines of sight, in particular for industrial applications

The usual application of the UGR method is based on a horizontal line of sight and assumes that the luminaires are not located below the line of sight. The UGR tabular method is usually based on a static observer with an eye height of 1.2 m, with a viewing direction along and across the luminaires, but e.g. no diagonal viewing direction. Standing or walking persons with an eye height of more than 1.2 m are also not considered.

Application note: According to CIE 117:1995, an eye height of 1.7 m can be assumed for standing persons. Even in high halls, the distance between the eye and the luminaire mounting plane can be small, e.g. with roof-mounted work platforms in vehicle maintenance halls.

This means that the UGR method does not reproduce any variance in the direction of gaze, as is the case, for example, in many industrial applications (e.g. assembly work, gantry crane operation, forklift driving). Special care must be taken to avoid glare if the viewing direction is above the horizontal. In this case, glare should be reduced to a minimum by the designer by means of an adapted luminaire arrangement and luminaire selection regarding suitable shielding angles. Possible glare when looking directly into the light emitting surface, e.g. when working overhead, is also not accounted for by the UGR method.

Application note: It has been proven in some such cases that luminance values do not exceed 10 000 cd/m².

To take other viewing directions into account, it may be useful, e.g. for industrial applications, to calculate the glare for a higher number of viewers and viewing angles. For this purpose, the results can be presented graphically in a floor plan for further clarification (see e.g. Stockmar, 2000).

3.6 Limits with different lighting techniques

The UGR method only takes into account the entire luminous surface of a luminaire, regardless of whether it contains local luminance maxima or minima. Lens-based and prism-based luminaires are often assessed differently by the user in terms of discomfort and disability glare, depending on the application, structural conditions and viewing direction, even if they have the same UGR data sheet value.

In the periphery of the field of vision, structures within the luminaire cannot be detected. Only when the luminaire is close to the viewing direction can the structures increase the glare impression. For luminaires with inhomogeneous luminance structure, the CIE has therefore supplemented the UGR method with a correction factor (CIE 232:2019). Instructions for the practical implementation of this correction factor are currently being prepared by the CIE.
For asymmetric and double asymmetric luminaires, the UGR formula is applicable but not the UGR tabular method.

3.7 Limits due to different types of luminaires in a room

The UGR tabular method must be applied individually for each luminaire type if there are different luminaires in a room. This is because each luminaire type has its own UGR table.

Application note: In accordance with DIN EN 12464-1:2021, Annex A.2.5, a comparison can then be made with the limiting value for the luminaire type with the highest UGR value for the worst-case scenario.

Calculations using the UGR formula can also be used if the lighting installation being assessed has different luminaires.

3.8 Limits due to age-related visual changes and vision correction aids

Since the UGR method only provides glare classes for an average population, individual deviations such as age-related changes in vision are not considered.

In particular, the visual acuity and the accommodation amplitude of the eye are strongly age dependent. It is also known that older people need more light than younger people to be able to perform the same visual task equally well. The sensitivity to glare also increases with age due to the higher scattering of the ocular media.

According to LitG Publ. 20, the deviations that may result when the above factors are considered for the UGR method are not known. Studies have shown a tendency towards increased glare sensitivity for spectacle wearers.

3.9 Limits for high spaces, e.g. sports and industrial hall lighting systems

In high halls, e.g. from 7 m upwards, luminaires appear to the observer at small solid angles due to the large light spot height. In particular, luminaires with very high luminous flux and luminance can cause a sensation of disturbance, even if they appear at very small solid angles. According to CIE 117:1995, the UGR method cannot be used for such cases.

Application note: According to the proposal of LiTG Publ. 20, the lower solid angle limit can be omitted. For maximum transparency, however, table values affected by this would have to be marked (e.g. with an asterisk), which is not the case so far. In high halls, this may also affect room dimensions < 12H.

3.10 Limits due to „dynamic glare" from luminaires with a sharp optical cut-off

The UGR method does not represent dynamic changes in the position of the observer; a static observer is always used for calculations. So-called „dynamic glare" can occur when people move around the room under luminaires with strongly changing luminous intensities within small angular ranges. If a person sits in the corresponding beam area of a luminaire, head movements can cause a luminaire to be experienced sometimes as dark and sometimes as bright. This disturbance caused by luminance levels suddenly appearing in the periphery for people moving around the room is not detected by the static UGR value.

3.11 Limits due to constraints in spatial geometry and reflectances

The UGR tabular method is only applicable for rectangular rooms. L-shaped rooms can be evaluated by calculating the partial rooms separately. The UGR tabular method is not suitable for polygonal or round room geometries. The UGR formula can be used to determine UGR values in such rooms, but these cannot be used as evidence of compliance with the limit values of DIN EN 12464-1.

The UGR tabular method is only an estimate for typical room geometry conditions with categories of typical reflectance. For example, according to the UGR tabular method, the floor has a maximum reflectance of 20 %. Walls have a reflectance of 30 % or 50 % and ceilings 30 %, 50 % or 70 %. White walls or ceilings with a reflectance of around 75 % to 90 %, as can occur in industrial halls, are not considered with the UGR tabular method. However, the glare effect is lower in light environments than in dark ones. Conversely, for dark ceilings, e.g. in industrial halls with reflectances below 30 %, the UGR tabular method is not applicable.

This also shows the problem of using a single UGR data sheet value for the specific standard room. For example, a luminaire which has a low glare effect ($R_{UG} \leq 19$) in the data sheet with reflectances of the office and thus of the standard room, appears to also have a low glare effect ($R_{UG} \leq 19$) in the data sheet for an application such as an industrial hall, although this in reality has a larger UGR value. This is due to the clear deviation between the boundary parameters of the standard room and the application of the industrial hall because an industrial hall typically has significantly darker ceilings and different room geometries than the standard room. The luminaire should therefore always be evaluated at the room size of the real space and not in the standard room.

3.12 Limits due to ageing of equipment

Particularly in industrial halls with harsh ambient conditions, the reflectance of the room surfaces can change considerably through time due to soiling. Bright walls with a high reflectance ϱ_W become darker over time, which can result in an increase in glare. Very dark walls, on the other hand, can also become lighter in very rare cases due to soiling. Depending on the lighting technology used, the luminous flux Φ of the installation also decreases to a greater or lesser extent with operating time, which would mean a reduction in glare. The greatest glare is to be expected at the time when the quotient Φ / ϱ_W reaches its maximum.

4 Conclusion and outlook

The individual UGR data sheet value can be used for an initial relative comparison of luminaires with each other if the room of the planned installation does not deviate too much from the standard data sheet room. The UGR tabular method can be used to estimate the discomfort glare rating of a luminaire in different installations. For assessment at specific positions and viewing directions in the room, the UGR formula for that viewing direction must be used. Even with irregular luminaire arrangements and simultaneous use of different luminaire types, the UGR formula can be used to determine a UGR value that is suitable for comparing different lighting solutions. However, this value cannot be used as proof that the limit values of DIN EN 12464-1 are complied with.

It is important for a designer to know the method, the assumptions, and the limits of the UGR tabular method. A simulation of the installation with the selected luminaire in a lighting design program with variation of the viewing directions at significant positions can help here. Sampling of the planned luminaire in the real application can provide further guidance for the selection.

Disability glare, which is essential for visual performance and thus for occupational safety and accident prevention, is not covered by the UGR method. It is true that it is claimed that in bright rooms, compliance with the UGR value also prevents disability glare. However, this assumption cannot be made for darker environments, such as industrial halls. In industrial halls, disability glare can be much more critical than discomfort glare. The UGR method is not suitable for disability glare assessment because it was not developed for this purpose. The UGR method also cannot be used to evaluate reflected glare on screens or other reflective surfaces in the work area.

According to the German Workplaces Ordinance (ArbStättV), workplaces must be equipped with facilities that provide adequate artificial lighting so that the safety and health of employees are guaranteed. Lighting systems need to be selected and arranged in such a way that they do not endanger the safety and health of employees. From this, the Technical Regulation for Workplaces ASR A3.4 derives the requirement that disturbing glare or reflections are to be minimised and that glare which can lead to accidents must be avoided.

The evaluation of discomfort glare with the UGR method can capture the subjective disturbance but not the objective disturbance of visual performance, which in extreme cases can also lead to accidents. The disturbance of visual performance, whether caused by scattered light in the eye or by after-images following a glare event, is currently not assessed in lighting design in industrial facilities despite the legal requirements.

The evaluation of disability glare can play a decisive role for occupational safety and error prevention, especially in industrial applications. Suitable methods should be developed for these applications in the future.

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