Unified Glare Rating (UGR) FAQs

1. What is UGR?

Unified Glare Rating (UGR) is a measure of potential discomfort glare experienced by an occupant in interior lighting spaces. UGR incorporates data from electric sources within an interior environment and assigns a value which represents the calculated glare rating. It only accounts for sources for which IES file data is included. It can be considered a supporting metric in addition to current IES recommendations to assess and potentially improve the quality of lighting for interior spaces.

2. What is the Unified Glare Rating System?

Submitted in 1995 by The International Commission on Illumination (CIE)[1], "The UGR formula produces a glare rating which is a psychological parameter intended to measure any adverse subjective discomfort response to a visual environment containing electric light sources (does not include daylight from windows or skylights)." The UGR scale has practical ranges from 10 to 30, with a higher value indicating greater visual discomfort and a lower value indicating little discomfort glare. A UGR of 19 is considered the upper level of acceptable discomfort glare when related to the Hopkinson's ratings scale[2], a narrative ratings hierarchy developed and refined over the 20th century that ranked glare with descriptions ranging from "just imperceptible" to "just intolerable".

3. Why is UGR important to consider in lighting design?

The harshness of bright light sources with high-angle glare has been shown to contribute to headaches, fatigue and other physiological issues due to the constant adjustment your eyes need to make within these spaces. Consideration of UGR as part of the product selection and application design process can assist in minimizing the undesirable effects of glare and provide improved lighting quality to the occupants of a space. UGR, however, should not be used without context to evaluate glare and the review of samples and consideration of the fixture in context is recommended.

4. Where did UGR originate from?

The International Commission on Illumination (CIE) Technical Committee 3-13 developed UGR in **CIE 117-1995, Discomfort Glare in Interior Lighting**[1] to attempt to quantify glare for interior lighting sources as it affected the occupants inside. **CIE 190:2010, Calculation and Presentation of Unified Glare Rating Tables for Indoor Lighting Luminaires**[3] was developed to assist luminaire suppliers and lighting designers in the production of UGR tables for luminaires, using the basic UGR equation described in CIE 117-1995. UGR is used throughout Europe and other regions as a lighting design standard and has recently appeared in lighting specifications in the United States.

5. In what codes, standards, and certifications is UGR referenced?

- The DesignLights Consortium® (DLC®) released its new Solid State Lighting Technical Requirements Version 5.1[4] on February 14, 2020 introducing UGR as a requirement for several indoor product categories to receive a DLC® Premium classification and/or products pursuing efficacy allowances. Lighting products such as troffers, linear ambient, low-bays, and high bays are required to meet corrected UGR thresholds to achieve a DLC® Premium classification.
- The International WELL Building Institute™ (IWBI™) references UGR rating in both the WELL v1™ and WELL v2™ points system.
- The International Association of Lighting Designers (IALD) recently published "**IALD + LIRC Guidelines for WELL Rating Systems**"[5] which provides a list of the minimum required documentation that should be provided by manufacturers to lighting designers in order to validate UGR and meet the WELL Building Standard v2 LIGHT Feature L04[6].
- The Illuminating Engineering Society (IES) has referenced UGR in publications of recommended practice such as ANSI/IES RP-7-17, Recommended Practice for Lighting Industrial Facilities.[7]
- State and local codes are beginning to include glare ratings for interior spaces.

6. What is included in the formula for calculating UGR?

The formula for calculating UGR is as follows:

$$\mathbf{UGR} = 8 \log \left[\frac{0.25}{L_b} \sum \left(\frac{L^2 \omega}{p^2} \right) \right]$$

L_b = Background luminance
L = Luminance value of luminaire
ω = Size of the luminous area
p = The Guth position index

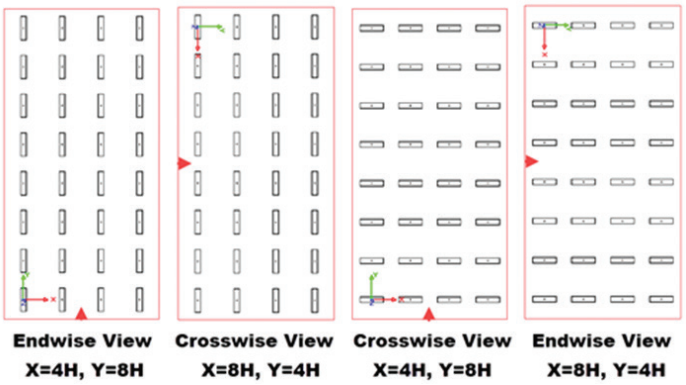
7. How is UGR calcuated?

There are 2 methods to calculate UGR:

- **Application Based UGR:** Generate a normal lighting design of the space with known fixture quantity, mounting heights, reflectances and appropriate lighting levels. Place individual observers in key locations of a building or an entire "grid" of observers in a space that will show the UGR measurement at each observer location. This is the ideal method for evaluating UGR compliance since it is based on actual room geometry, reflectances, and luminaire positions.
- **Luminaire Based UGR (also known as tabular method):** In this method a single luminaire IES file is used to produce a UGR table per CIE standards. The calculation is based on luminaires spaced on a 1x1 grid and from 2 observer locations at 1.2m above the floor and located as per Figure 1 below (CIE 117-1995). The resulting table consists of 190 values categorized by rectangular room proportions and room reflectance combinations. By cross referencing room dimensions and reflectance values in this table, UGR can be estimated considering endwise and crosswise view of the fixtures. If a single value is to be used, per CIE 117-1995, the largest value in the table must be used.

  This UGR calculation method is popular because it is based solely on luminaire characteristics within a prescribed set or application variables. Luminaire specification sheets that show a single number or grid of numbers are assumed to be using this method and being reported as per CIE 117-1995 recommendations. Currently, this method is acknowledged by DLC, WELL Building Standards and LEED certifications. While this method provides a range of values and references for luminaire comparison, these values represent a generalized assessment. UGR varies by a luminaire's lumen output, color temperature, lens options, finish, and lighting distribution. Do not assume that a single number is representative of all luminaire configurations.

Figure 1:
Observer Positioning for UGR Calculation (CIE 117-1995)[1]



8. What limitations are there to UGR calculations?

- UGR is not applicable to indirect-only lighting systems or luminous ceilings.
- UGR cannot be calculated for thin, narrow distributions pointed downward.
- UGR is only calculated for electric lighting sources, not daylighting.

9. What common approaches help achieve more acceptable UGR scores?

- Use luminaires with lower lumen packages.
- Consider tighter fixture spacings to achieve light levels needed with less brightness per fixture.
- Choose luminaires with larger luminous surfaces like 2'x4' products vs a 1'x 4' or 2'x 2'.
- Use products with lower candela at angles of 60 degrees and higher compared to volumetric distributions.
- For small aperture luminaires (downlights), choose optics that are well-shielded.
- Choose higher room surface reflectances to increase background luminance.
- When possible, promote higher ceilings and thus higher luminaire positioning.

10. What should you be aware of?

- Balancing brightness of surfaces within a space will help reduce glare. Beware using only narrow distribution fixtures (perhaps because of their low UGR) as cave-like appearance may result.
- Use Application Based UGR calculation method (as explained in question 7) as a primary methodology to evaluate glare. Utilize the UGR tabular method only to get an initial assessment of products.
- Beware companies suggesting a single UGR value tied to a fixture. It is possible to manipulate data to show "compliance" by choosing limited variables (i.e. room size, room reflectances, observer position, etc.). Since UGR tables are to be calculated based on several room variables, a single value cannot be compared honestly without knowing the variables chosen to yield that number.
- For products publishing a singular UGR value, validate using the tabular method and make sure to follow up with a full application layout with any other luminaires planned for the space.
- The CIE documentation for UGR was originally adopted to address florescent troffer products with uniform lensing materials. Products with intentional changes in brightness cannot be calculated to reflect this variance of luminance because a single IES file cannot identify these variances.
- The CIE documentation does not reference IES illuminance levels or uniformity criteria as factors within the glare calculation.
- UGR should not be considered the primary factor for product selection but should be evaluated along with other metrics and aesthetic considerations.

11. How can Acuity Brands help?

Professional Lighting Design Calculation Softwares can be used to generate UGR tables and do application based calculations. Visual Design Software has been updated to include these features. **Get a 30-day free trial of Visual Design Software** to learn more about how this tool can be used to address UGR concerns and discover on-demand training videos.

Additionally, Acuity Brands has a team of professionals to help calculate UGR values for your project. As part of a normal lighting design request submitted through your local Acuity Brands agents, we can calculate UGR values for your space and our products. **Find your local agent by clicking here.**

12. How do I know what Acuity Brands products have a low unified glare rating?

When on the Acuity Brands website, look for the low UGR icon.

The following are products with low UGR:

- Troffer, linear ambient and low bay fixtures with a UGR of ≤ 19*
- High bay fixtures with a UGR of ≤ 22

*Enhanced energy credit and WELL building UGR ≤ 16 required for troffer and linear ambient.

The above numbers are industry guidelines, always confirm which standard and target number is required for your particular job.

[1] International Commission on Illumination. CIE 117-1995, Technical Report: Discomfort Glare in Interior Lighting, Vienna, Austria 1995. http://cie.co.at/publications/discomfort-glare-interior-lighting

[2] R.G. Hopkinson, Discomfort Glare in Lighted Streets, 1940. Illuminating Engineering Society, Volume 5: Issue 1-9, pp. 1-32.

[3] International Commission on Illumination. CIE 190 :2010, Technical Report: Calculation and Presentation of Unified Glare Rating Tables for Indoor Lighting Luminaires, 2010. http://cie.co.at/publications/calculation-and-presentation-united-glare-rating-tables-indoor-lighting-luminaires

[4] DesignLights Consortium. DLC SSL Technical Requirements Version 5.1, 2020. https://www.designlights.org/solid-state-lighting/qualification-requirements/technical-requirements-V5-1/V5-1-tech-req-PDF/

[5] International Association of Lighting Designers. IALD + LIRC Guidelines for Well Rating Systems, 2020. https://indd.adobe.com/view/545dd7eb-ec98-4dfc-b3e2-7a337eb16ca7

[6] International WELL Building Institute pbc. The WELL Building Standard version 2 pilot (WELL v2), Q3 2019. Feature L04: Glare Control. https://v2.wellcertified.com/v/en/light/feature/4

[7] Illuminating Engineering society. ANSI/IES RP-7-17, Recommended Practice for Lighting Industrial Facilities, 2017. https://www.ies.org/product/recommended-practice-for-lighting-industrial-facilities/