

Lab Notes

Issue 3

How to Read a Photometric Report

1.0 Introduction :

The introduction of computer aided programs has made the possibility of lighting design an everyday event for building services engineers and designers of lighting installations. Lighting design is no longer the sole province of the lighting design specialist, since any interested person with some basic knowledge of Lighting can, with the aid of a computer, experiment with ideas.

However as in all areas associated with computer practice the old saying of "Rubbish in, rubbish out !" still applies, and not all lighting design presented from a computer print out should be believed. Several very important factors must be taken into consideration when using computer aided lighting design programs, and these are discussed below.

2.0 Quality of Photometric Data :

One of the primary data inputs to a lighting design program is the photometric data, and if this data has not been obtained by a very high quality of testing procedure of the luminaire, then it is certainly not worth including in the design process.

Similarly the matter of what format is used for the transition of the electronic data must be carefully considered, since it may or may not be compatible with the particular design program being used.

To ensure that the quality of the testing procedure is both of a very high standard and that the results from various laboratories are comparable, these two matters are addressed in an Australian Standard.

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Standards Australia has researched and published AS1680.3 - 1991 which is entitled "Interior Lighting, Part 3 Measurement, Calculation and Presentation of Photometric Data."

This Australian Standard closely follows the procedures set down in the CIE Publication No. 24 (TC 2.4) 1973, and so there is a full agreement between the Australian practice procedures and that of CIE international practice on the presentation of photometric data.

3.0 Presentation of Luminaire Intensity Data :

It is accepted practice in this and many other countries to use the CIE C-Gamma (C_γ) co-ordinate system for the specification of Intensity data for indoor commercial and industrial luminaires and street lighting lanterns. (Refer Figure 1)

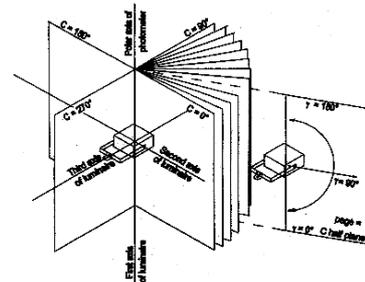


Figure 1. - C_γ co-ordinate system

The number and spacing of the azimuth planes (C planes) and the vertical angles (gamma angles) largely depend upon the accepted practice of the individual laboratories.

4.0 Components of the Test Report :

Test reports present a large amount of information in a number of different forms to the user. LightLab reports include a Summary page which yields a quick, concise overview of the data at a glance. See Figure 2 for a sample of the Summary page.

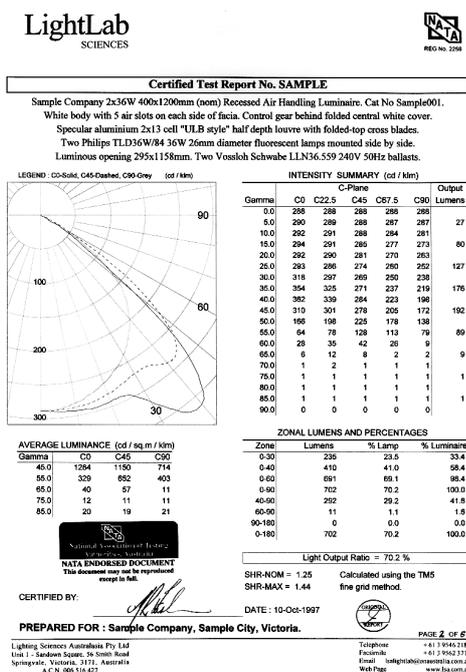


Figure 2. - Summary page of a test report on a batwing luminaire.

4.1 The Text :

The text includes all the descriptive information in the Test Report which is not measured or calculated. Never the less, it is just as important to the validity of the report as the numerical content. The text includes a description of the luminaire in what is called the "header" (see Figure 3) which is commonly at the top of each page. Other text components of a report are the certification including the signature of the person certifying the authenticity of the report, the dating of the document and the numbering of all pages.

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Certified Test Report No. SAMPLE

Sample Company 2x36W 400x1200mm (nom) Recessed Air Handling Luminaire. Cat No Sample001.
White body with 5 air slots on each side of fascia. Control gear behind folded central white cover.
Specular aluminium 2x13 cell "ULB style" half depth louvre with folded-top cross blades.
Two Philips TLD36W/84 36W 26mm diameter fluorescent lamps mounted side by side.
Luminous opening 295x1158mm. Two Vossloh Schwabe LLN36.559 240V 50Hz ballasts.

Figure 3. - The header of a typical test report.

The primary information in the header is who is the manufacturer, and the catalogue number of the luminaire tested. The description of the luminaire describes the body and its overall dimensions, how the control gear is mounted, and how the luminaire itself is to be mounted, i.e. recessed or surface mounted.

Also described are the luminaire components, including whether the inner reflecting surfaces are painted or powder coated and the nature of reflectors and louvre if used or the plastic light control panel such as a prismatic inlay.

This information is provided so that the luminaire can be easily identified. A certified Test Report also carries a document reference number (e.g. LightLab Sciences photometric reports always bear the test number 'LSAxxxx'). This should also be checked against manufacturer's published information.

The make and type of lamps and ballasts with their appropriate identifications are also included, as are the luminous opening dimensions. In the case of emergency luminaires tested to AS/NZS 2293 a diagram showing which lamp is activated may also be included.

The luminous opening data is used to calculate the average luminance values (units are cd/sq.m/klm) and this is shown in a separate table on the Summary Page.

Other important textual information is the signing of the report. If the report includes an official NATA emblem to show that it is an Endorsed Document, then the signatory must be a person accredited by NATA. While this person is signing on behalf of the testing laboratory, it is that person who is responsible for the validity of the document.

The report must also be dated at the time of signing. This is important because it is generally accepted that the life of a report is about five years. This is not because the report itself is outdated, though Standards may have changed in that time, but because it is highly unlikely that the manufacturer will produce exactly the same luminaire with the same components five years later.

Each page is numbered (e.g. "Page 1 of 5", "Page 2 of 5" etc.). This is important because the document is only valid as a NATA certified report if it is reproduced in full. Where a partial or incomplete reproduction of a report is offered, one must wonder why was the rest of the report was omitted.

The last line of the Summary page carries the name of the person or company for whom the report was prepared and who commissioned it. While that person or company is free to distribute the report (in full) to whom they wish, the bond of confidentiality held between LightLab and its client demands that LightLab can only discuss the contents of the report with a representative of the client company, unless the express approval of the client is received.

4.2 Measured Data :

The fundamental measured data consists of intensities in given directions.

The expression of Intensity data in candelas per 1000 lamp lumens (cd / klm) is of common usage to all laboratories. This is because only one set of photometric data will be necessary for any one luminaire with lamp/s of the same generic type i.e. Tubular or compact fluorescent lamps. These lamps may come from different manufacturers or have differing configurations, and so provide different lumen outputs.

For example : lamps may be coated with either tri-phosphor or a halo phosphate and they may be of White, Warm White or Daylight colours. In these cases the only variables are the lumen outputs, and how and where the luminaires are applied.

Measured data is presented in photometric reports in graphical and tabular form (see Figure. 4). The graph is usually in the form of a polar diagram, where the "Gamma" angles are listed around a central axis and the intensities at each Gamma angle determines the distance of the trace from the central point. Data from a number of different "C" planes may be overlaid on the graph. The graph can give the reader of the report a good representation of where the light from the luminaire will go.

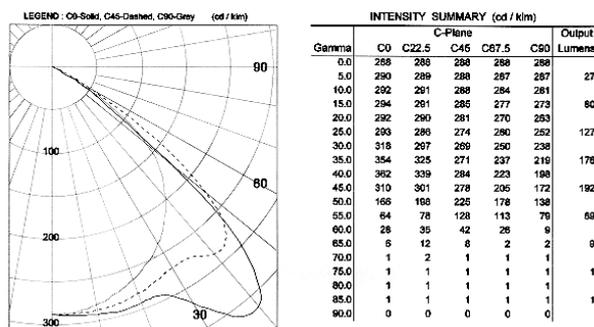


Figure 4. - Typical polar graph and intensity table

The table of luminous intensities can be used for making quick checks and comparisons between different luminaires. This data is also offered to the client in the form of an "IES" format file for use with PC based computer design programmes.

4.3 Derived Data :

Another part of a laboratory photometric report includes derived data, and this is in general as required by the Australian Standard AS1680.3 - 1991 in Section 8 "Derived Luminaire Data."

The major derived values for a luminaire are the Utilisation Factors, the Spacing to Mounting Height Ratios, Average Luminances, Zonal Flux and the Light Output Ratio. The determination of the Light Output Ratio (LOR) is usually in accordance with Appendix A of AS1680.3.

4.3.1 Light Output Ratio :

The Light Output Ratio (LOR) is the measure of the quantity of light which is emitted from the luminaire, as compared with the quantity of light generated by the lamps.

Generally there are three primary factors which determine this particular parameter of the LOR. They are :

1. the light absorption within the luminaire
2. the change in light output of the lamps due to the thermal conditions within the luminaire
3. the difference between the lamp power delivered by the normal proprietary ballasts and the laboratory Reference ballast.

If factors 1 & 2 are only considered, then this is known as the LORL or the "Light Output Ratio Luminaire."

This is defined as the ratio of the LOR of the luminaire with normal ballasts, as compared to the total light output of the lamps using the same ballasts, but operating outside the luminaire under reference conditions.

When all three factors are to be taken into account this is known as LORW or the "Light Output Ratio Working."

This is the ratio of the light output of the luminaire operating under specific conditions with reference ballasts, as compared with the total light output of the lamps, operating outside the luminaire, under reference conditions with the same reference ballasts.

At the present time there is no international agreement on a standard method of determining LOR, and as a general rule the LORL is the parameter which is used in Australian photometric reports.

4.3.2 Zonal Flux :

The Summary Page includes a table which shows the number of lumens per 1000 lamp lumens in a number of zones i.e. 0° - 30°, 0° - 60°, 0° - 90° 90° - 180° for example.

ZONAL LUMENS AND PERCENTAGES			
Zone	Lumens	% Lamp	% Luminaire
0-30	235	23.5	33.4
0-40	410	41.0	58.4
0-60	691	69.1	98.4
0-90	702	70.2	100.0
40-90	282	28.2	41.0
60-90	11	1.1	1.6
90-180	0	0.0	0.0
0-180	702	70.2	100.0

Figure 5. - Zonal flux table

The table also includes percentages of the lamp lumens and luminaire lumens in each of the zones. See Figure 5 for a typical report presentation of zonal lumens.

The sum total of the lumen and percentage lamp columns equates to the overall light output ratio (LOR) of the luminaire tested.

These zonal lumen values are very useful when comparing two luminaires, which although they may have the same LOR can actually have a totally different light distribution. One may have all its light output concentrated in a

very narrow zone i.e. 0° - 30°, whereas the other may have a significant proportion of its light in the 60° - 90° zone. These two luminaires will create a totally different visual environment, even though they have the same LOR.

4.3.3 Spacing to Mounting Height Ratios :

The CIBSE Publication TM 5-1980 also presents the proposed methods for the determination and presentation of Spacing to Mounting Height Ratios (SHRs) as shown in AS1680.3 - 1991.

The Australian Standard AS1680 series 2 Standards include recommendations on preferred uniformity ratios for specific tasks or interiors.

Uniformity is defined as the ratio of the minimum illuminance, compared with the average illuminance in the space.

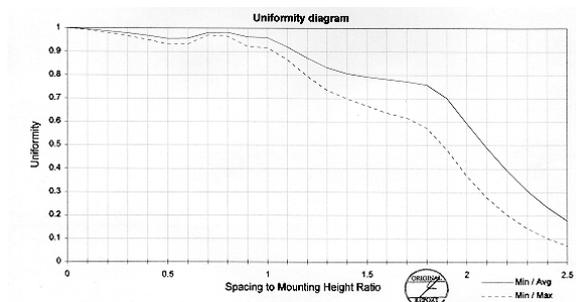


Figure 6a. - Uniformity diagram. The SHR max is related to the spacing between luminaires with a uniformity of 0.8.

This uniformity is related to the ratio of the spacing of the luminaires, to the mounting height of the luminaires. Generally there are two values given. A nominal spacing to mounting height ratio (SHR NOM) and a maximum value (SHR MAX). (See Figure 6a for the Uniformity Diagram presented in LightLab reports, and Fig 6b for SHR values as presented on the Summary page of a typical report).

Light Output Ratio = 70.2 %	
SHR-NOM = 1.25	Calculated using the TM5
SHR-MAX = 1.44	fine grid method.

Figure 6b. SHRs (and LOR) as presented

This subject is discussed, very comprehensively in our Lab Notes, Issue 1, "Uniformity of Illuminance" and is recommended for further reading on this matter.

4.3.4 Average Luminance Table :

Generally for bi-symmetric interior lighting luminaires the Summary page includes a table of average luminance values (cd/sq.m/klm) in the zones from 45° to 85°. See Figure 7 for a typical average luminance table shown in a LightLab photometric report.

This is included because the Australian Standard AS1680.1-1990, "Interior Lighting Part 1: General Principles and Recommendations, Section 8, "Glare and Related Effects" includes a luminance limiting system as a means of limiting the degree of discomfort experienced by the occupants of a space from glare created by ceiling mounted luminaires. Tables 8.2 and 8.3 of AS1680.1 set out a scale of maximum average luminance values for various tasks and interiors.

AVERAGE LUMINANCE (cd / sq.m / klm)			
Gamma	C0	C45	C90
45.0	1294	1160	714
55.0	329	652	403
65.0	40	57	11
75.0	12	11	11
85.0	20	19	21

Figure 7. - Average luminance table from the Summary page of a typical report.

The luminance values quoted on the Summary page can, *providing the correct total lamp lumens per klm multiplier is used*, be equated with the limits set down in Table 8.2 and 8.3 of the Standard.

4.3.5 Utilisation Factors :

It is common usage in Australia to adopt the method for the derivation and presentation of Utilisation Factors in accordance with the British CIBSE Publication TM 5-1980.

Appendix C of the AS1680.1 - 1990 sets out assumptions and limitations which apply to the use of utilisation factors in the design of interior lighting. Utilisation factors are used to define the effectiveness of a luminaire in a particular space. They are included in the report for use in the "Lumen Method" used to approximate the number of luminaires required in a particular space. Figure 8 shows a representation of a Utilisation Factors table from a typical report.

Utilisation factors UF(F)											
SHR NOM = 1.25											
Room Reflectance			Room Index								
C	W	F	0.75	1.00	1.25	1.50	2.00	2.50	3.00	4.00	5.00
0.70	0.50	0.20	0.46	0.54	0.59	0.63	0.67	0.70	0.72	0.74	0.75
0.30			0.41	0.60	0.55	0.59	0.64	0.67	0.69	0.72	0.74
0.10			0.38	0.46	0.52	0.56	0.61	0.64	0.67	0.70	0.72
0.50	0.50	0.20	0.46	0.53	0.58	0.61	0.65	0.67	0.69	0.71	0.73
0.30			0.41	0.46	0.54	0.58	0.62	0.65	0.67	0.70	0.71
0.10			0.38	0.46	0.51	0.55	0.60	0.63	0.65	0.68	0.70
0.30	0.50	0.20	0.44	0.52	0.56	0.59	0.63	0.65	0.67	0.69	0.70
0.30			0.41	0.48	0.53	0.56	0.61	0.63	0.65	0.67	0.69
0.10			0.38	0.46	0.51	0.54	0.59	0.62	0.64	0.66	0.68
0.00	0.00	0.00	0.38	0.44	0.49	0.52	0.56	0.59	0.61	0.63	0.64

Rating : Photometrically tested without ceiling board.
 Multiply values by service correction factors.
 Calculated in accordance with CIBSE Technical Memorandum No. 5 1980 using the fine grid method.
 Luminaire discretisation employed. Ceiling/Wall/Floor reflectances not used in calculations.

Figure 8. - Utilisation Factors Table

5.0 Uncertainties and Measurement Methodology :

The final page of the test report states the conditions under which the test was conducted. For example, the test distance, test temperature, testing procedure including the applicable standards or recommended international practices.

The uncertainties of measurement are also included. The estimation of uncertainties is a very complex subject, with many books offered on the subject. Standards Australia is currently preparing a proposed Australian Standard which is expected to be entitled "Lighting Systems Performance - Accuracies and Tolerances".

LightLab include uncertainties of measurement of temperature, light output ratio, luminous intensity and angular displacement. There are other uncertainties which may be included such as physical dimensions and electrical parameters.

The particular uncertainties quoted on the final page of LightLab reports are the result of the laboratory's careful assessment of the performance of each piece of equipment or system used to obtain the values reported.

NATA assessors examine the laboratory's equipment and documentation to check the validity of the claimed uncertainties. The laboratory staff is required to carry out regular calibration checks to ensure that the equipment is within the range of uncertainties which are claimed.

While the matter of accuracy of the system may be disputed, the repeatability of the testing procedure is really the most significant factor. At LightLab we are proud to be able to say that our repeatability is greater than 99%, that is, the variation between two tests conducted separately on the same luminaire can confidently be expected to be less than 1%.

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