Lab Notes

Issue 5

The Use of Luxmeters

The Meter

Illuminance is readily measured by a portable instrument called a lightmeter, or luxmeter. The instrument is simply held in the plane of measurement and the illuminance in lux is read on the scale. Instruments of this kind commonly read from 1 lux to 20,000 lux although more sensitive types are available for reading the much lower levels as used in emergency lighting.

To assist in achieving reasonably reliable outdoor illuminance readings some meter manufacturers also supply a “times 10” (x 10) multiplying filter, thus theoretically allowing readings up to 200,000 lux.

However it is important to understand that at these very high illuminance values there can also be very high heat values, and this heating can seriously effect the performance of the cell.

For accurate measurements, photometers of the photocell type should be used which have been cosine and colour corrected. The cosine correction is to allow for the effects of light falling on the cell at oblique angles. Colour correction is necessary in order to match the spectral sensitivity of the human eye, and is defined by the spectral response of the CIE Vλ (“V-lambda”) curve.

There are a number of lightmeters on the Australian market. Many are cheap in price and construction, and these have a very poor quality colour correction filter. They are considered poor quality because they generally do not fit either the Blue or Red ends of the CIE V, lambda curve.

Errors in these regions of up to 500% are not uncommon. While this is usually not a significant problem with broad band white light sources, it can produce large errors in illuminance readings under High Pressure Sodium or Metal Halide Lighting.

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How to Measure the Average Illuminance

A lightmeter indicates the illuminance at the point of measurement only, not the average in the space. To find the average illuminance in an area at the time, it is necessary to divide the area into a number of equal areas which should be as nearly square as possible. The illuminance at the centre of each square is then measured, and the results averaged. The minimum number of equal areas required for accuracy can be determined by first working out the *room index* (k), thus

$$k = \frac{\text{Length} \times \text{Width}}{H_m \times (\text{Length} + \text{Width})}$$

where H_m is the height of the luminaires above the plane of measurement. The working plane is usually taken to be 0.85m for work benches or 0.72m for desk top height unless the main plane of the work is known to be some other height above floor level. If the work is performed down to floor level, then the floor is taken as the working plane and plane of measurement.

The number of measurement points relates to the *k* value as follows:
If *k* is less than 1, only 1 measurement point is required.
If *k* is between 1 and 2, 9 measurement points are needed.
If *k* is between 2 and 3, 16 measurement points are needed.
If *k* is more than 3, 25 measurement points are needed.

Table 1 : Relationship between room index and number of measurement points for given degrees of accuracy.

Room index (*k*)	**Minimum No. of Measurement Points**	
	± 5 %	**± 10 %**
$k < 1$	8	4
$1 \leq k < 2$	18	9
$2 \leq k < 3$	32	16
$3 < k$	50	25

If the proposed points coincide with luminaire positions, or are in constant relationship with the luminaire positions, increase the number of measurement points.

Calibration of the Meter

As a general rule Silicon Diode type meter should be re-calibrated every two years. Companies conforming to the ISO9000 Standards should have their meters calibrated every 12 months. If a meter is to be used in a legal case it should have been re-calibrated within the preceding 12 months. It is good practice to have the meter's calibration checked either just before or just after the photometric survey if the results are likely to be subject to litigation.

Older Selenium cell type meters must be re-calibrated every 6-12 months. This is because this type of cell fatigues very quickly, resulting in drifting responsiveness. It is also important that the meter be re-calibrated in a NATA accredited photometric laboratory which is properly equipped for this procedure.

Care of Meters

Although the present day luxmeter is a fairly robust device, especially the digital meter with the Silicon Diode cell, all meters need to be handled carefully.

Similarly they should not be left in places where they are subject to excessive heating. For example, they should NEVER be left in the glove box of a car for long periods in the summer months. Not only will this upset the calibration, but the cell can also be destroyed by the heat.

Field Measurement

The initial checks which should be carried out before commencing any field measurements are -

* the zero setting of the scale
* the condition of the battery in the Silicon Diode type meters

It is good practice to carry a spare battery if the survey is to be a lengthy process.

Measurements of illuminance in an electric lighting system should be made after dark. With outdoor installations this is essential. For interior installation it is often possible to exclude the daylight by blinds or curtains.

The old “lights ON, lights OFF” technique of measurement can be reasonably accurate, provided the daylight is not varying too widely, or the survey time is not too long.

An installation of discharge or fluorescent lamps should be switched on at least half an hour before the measurements are taken to allow for the lamps to be completely warmed up. If the luminaire is of the fully enclosed type, a longer stabilization time may be needed.

Similarly, new lamps of either HID or fluorescent type should have a “Burning In” time of at least 100 hours before measurements are taken. GLS or Tungsten Halogen lamps need a 10 hour pre-measurement period.

The procedure to be adopted for the measurement process will depend on whether the space is furnished or unfurnished, occupied or unoccupied. In some instances the effects of body shadow should be taken into account.

In some cases the purpose of the measurements may be to ascertain compliance with Tender Documents or a Lighting Standard. Measurements may also be for comparison with a previous photometric survey, or to ascertain if the maintenance or replacement point has been reached.

Errors in Readings

Lightmeters, like all other measuring devices, have errors which must be considered when attempting to determine precise illuminance values.

For example, with the analog type meter the error is generally a percentage of the Full Scale Value. However, with the digital meter the error is usually a percentage of the actual reading. Re-calibration usually does not mean that the meter is now correct. It simply indicates what was the percentage error in a particular range when the re-calibration was carried out.

Following a re-calibration, it is important to check the previous calibration report to see if there has been a significant shift in the percentage error. This error could have a bearing on the readings taken since the last calibration, and may indicate that the meter has suffered some damage since the last calibration.

All calibration reports should be carefully filed for future reference and to build a history of the performance of a particular meter.

If the error is consistently large, greater than 15%, or if the error rate is erratic, then consideration should be given to replacing the meter.

Recording of Data

It is important to remember that the field measurements are only valid **for the conditions which exist at the time of the survey.** Therefore it is important to record the following information :

- meter make and serial number
- a detailed description of the surveyed area
- details of the luminaire, including ballast type and lamp age, if possible
- date of last cleaning or replacement, if possible
- supply voltage
- room or luminaire temperature
- condition of interior surfaces, clean or dirty

If these measurements are to be a part of an ongoing survey process they should be kept in a proper log book, or the results keyed into a computer spread sheet. Photographs showing the prevailing conditions and the state of luminaires may be useful.

Aids to Measurements

In many situations the measuring plane is either not specified or is non-existent. Therefore some measurement height must be predetermined so that consistent readings can be taken. A height of one metre above ground or floor level is generally considered to be an acceptable height.

Another example is for tennis court lighting where the recommended measuring height is one metre above the ground but there is no one metre high measuring plane apart from the net.

In these situations it is convenient to have a portable device which can give a reasonably accurate measure of the height at a particular location, in the factory, warehouse or tennis court.

A support for the luxmeter may be used to ensure the correct measuring height during a survey. A single pole with a small platform to support the meter is recommended. The overall height is determined so that the desired height includes the height of the cell of the light meter.