Lightmeters and Office Lighting

Along with indoor air quality, office lighting has attracted a great deal of recent scrutiny. Clinicians are raising questions about the effects of working in environments that are too bright, too dark, or inconsistently lit. Others are concerned that the recent trend to replace traditional incandescent bulbs with energy-efficient LED and fluorescent lights may be increasing the risk of eye strain and related symptoms. While new lighting can significantly reduce energy costs, its long-term visual effects have prompted some to explore ways to limit worker exposure to this type of illumination.

Beyond health issues, researchers have studied the psychological impact of different lighting levels. Findings indicate bright lights tend to make employees feel more alert, which helps them concentrate on the task at hand. Conversely, dimming the lights can make people more creative, especially useful for brainstorming sessions. Therefore adjusting illumination to the level appropriate for the activity may (at least in theory) promote worker performance.

This Application Note is a brief review of some measures you can take to help minimize the effects of poor quality lighting. And we briefly review AEMC lightmeters that enable you to monitor illumination in your facility, to ensure your employees are provided with a well-lit and healthy environment.

Lighting Measurement Primer
When discussing lighting, it's important to understand the distinction between the terms illuminance, luminous flux, and luminous intensity:

- ***Luminous flux*** is the total amount of energy emitted from a light source in all directions. Luminous flux is measured in units called lumens.

- ***Luminous intensity*** is the amount of light emitted by a light source in a specific direction. This is measured in candelas

- ***Illuminance*** is the amount of incident light spread over a given area. This is measured in lux (equal to one lumen per square meter) or footcandles (one lumen per square foot).

To help visualize the relationship between these terms, it may be useful to compare a light source to a lawn sprinkler that sprays water in all directions. Luminous flux is analogous to the total amount of water the sprinkler sprays. Luminous intensity corresponds to the amount of water that flows out of a single hole in the sprinkler head. And illuminance is the amount of water that falls on a given area of the lawn.

Recommended Lighting Levels
The U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) standard calls for minimum illumination levels for the following venues:

Table D-3. Minimum Illumination Intensities in Footcandles (fc)	
fc	**Area of Operation**
5	General construction area lighting.
3	General construction areas, concrete placement, excavation, waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas.
5	Indoor warehouses, corridors, hallways, and exit ways.
5	Tunnels, shafts, and general underground work areas. (Exception: minimum of 10fc is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved cap lights shall be acceptable for use in the tunnel heading.)
10	General construction plant and shops (e.g., batch plants, screening plants, mechanical and electrical equipment rooms, carpenters shops, rigging lofts and active store rooms, barracks or living quarters, locker or dressing rooms, mess halls, indoor toilets, and workrooms).
30	First-aid stations, infirmaries, and offices.

In addition to these minimum levels, it can be equally important to be mindful of the appropriate *maximum* illumination for environments such as workplaces, as explained in the following section.

Health Effects of LED and Fluorescent Lighting
Although research is still ongoing, evidence appears to be mounting about the potential health risks associated with LED and fluorescent lighting.

For example, medical researchers have found that prolonged exposure to LED lights may cause irreparable damage to the retinas of the human eye. LEDs typically produce light in the high-energy blue and violet end of the visible light spectrum. Light from this spectral region can be particularly damaging to structures within the eye. In addition, LEDs do not produce near-infrared radiation, which many medical professionals believe is necessary for overall health.

Fluorescent lighting is also being studied for its potential detrimental health effects. For instance, some fluorescent lights emit high levels of ultraviolet (UV) radiation, which has been cited as potentially damaging to vision. One study estimates that fluorescent lighting may increase UV-related eye diseases by up to 12%. And as with LEDs, fluorescent lights produce a rather limited spectrum.

As a result of these and other potential health issues, many are paying special attention to the levels of LED and fluorescent lighting in their facilities.

Office Lighting and Computer Screens
The typical office environment where employees spend hours on computers presents special lighting challenges. The average office illumination ranges between 75 and 150fc. This is significantly higher than the recommended levels for working with computers.

For instance, the suggested illumination for working with a computer display with a dark background is 18 to 46fc, while the recommendation for displays with white backgrounds is 50 to 75fc (all measurements should be made at desktop level). When the room is too bright for the computer, users often experience visual discomfort and related symptoms.

Perhaps even more important than brightness level is intensity evenness – in other words, maintaining an environment in which all objects in your field of view are more or less of equal brightness. Bright LEDs can often illuminate objects unevenly, causing high contrast images that can produce eye strain.

There are a number of measures you can take to help maintain illumination at an appropriate and consistent level:

- Use smaller desk lamps with incandescent bulbs rather than bright overhead lights. If you use auxiliary desk lighting, use low wattage and aim the light in a direction that does not directly enter your eyes or illuminate the computer display screen.

- Add blinds or drapes on windows. Adjust these throughout the day to admit the appropriate level of light.

- Orient workstations to avoid direct viewing of bright lights, while minimizing screen glare and reflections.

- Avoid white reflective surfaces in favor of matte desktops, furnishings, ceilings, and walls.

- If bright overhead lights cannot be dimmed or eliminated, advise employees to wear a visor to shield their eyes.

- When working with a computer, adjust its screen brightness and contrast to maximize character definition and resolution. Brightness should match the general background brightness of the room. If the screen appears to flicker, turn down its brightness level.

Finally, advise your employees to take regular breaks from their computer and mobile screens. Some clinicians suggest “20/20/20” breaks: every 20 minutes, take 20 seconds and look 20 feet away.

AEMC Lightmeters Data Logger Model 1110, Models C.A 811, and C.A 813

To help measure and monitor light in your facility, AEMC offers portable, easy-to-use lightmeters that incorporate optical sensors designed to match the response of the human eye. This makes them ideal for workspace analysis and planning.

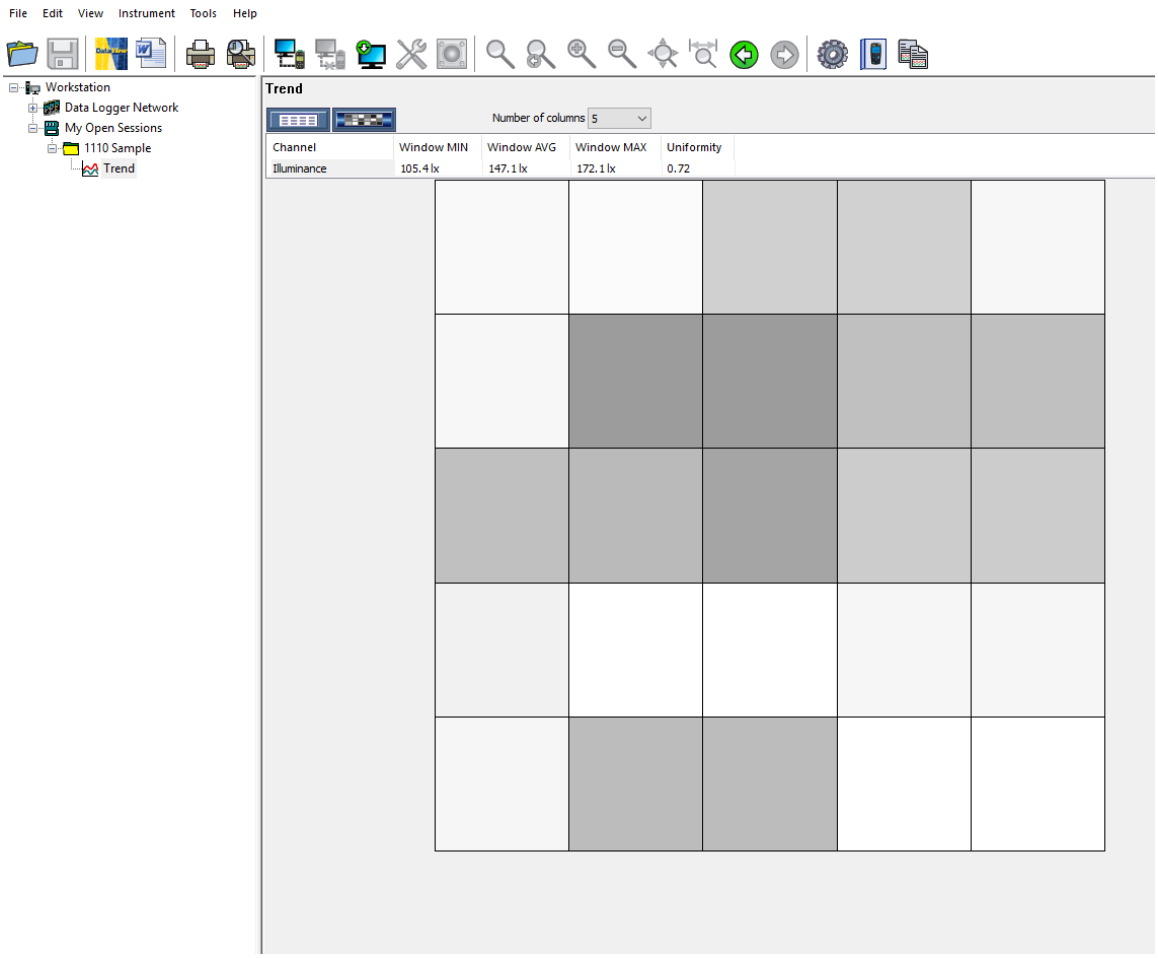
Each instrument features one-hand operation with an ergonomically designed case, large 3 1/2 digit backlit LCD display, and intuitive function selection including LCD, HOLD, and MAX. Other features are model-dependent, including PEAK, MAP, and data logging.

The following table compares the features of the AEMC lightmeters Models C.A 811, C.A 813, and 1110:

Instrument	C.A 811	C.A 813	Model 1110
Range	20fc, 200fc, 2000fc, 20kfc		0.01 to 18,580fc
Display resolution	0.01fc		0.01 to 10fc beyond
Sensor	Silicon photodiode		
Spectral response	CIE photoptic curve		Optical filter
Accuracy: 2856K light source Common light source	±5% R (reading) ±10cts ±18% R ±2cts	±5% R ±10cts ±11% R ±2cts	±3% R on incandescent sources (default) ±6% R on LEDs (3333k to 6666k) ±9% R on fluorescent sources
Sample rate	2.5 times per second nominal		1 second
Display	3 1/2 digit LCD 2000 count		custom digital
Operating temperature	32° to 122°F (0° to 50°C), RH without battery		14° to 140°F (-10 to 60°C)
Polarity	Automatic		
Power source	One 9V alkaline		Three 1.5AA alkaline
Low Battery indication	✓	✓	✓
Dimensions	6.81 x 2.38 x 1.5" (173 x 60.5 x 38mm)		5.9 x 2.8 x 1.26" (150 x 70 x 32mm)
Measures fc & lux	✓	✓	✓
Range button	✓	✓	
HOLD function button	✓	✓	✓
MAX function button	✓		✓
Peak function button		✓	✓
Measures incandescent	✓	✓	✓
Cosine corrected	✓	✓	
Backlight button	✓	✓	✓
Spectral compensation for LED and fluorescent lighting			✓
User-selectable light source			✓
Auto power OFF			✓
MAP mode			✓
Data logging			✓
Removable light sensor	✓	✓	✓
Wall power adapter			✓

Note that the Lightmeter Data Logger Model 1110 can perform a variety of recording tasks with easy and intuitive setup from a computer using AEMC's DataView® software (provided free with the instrument in the Americas and Australia).

The Model 1110 also includes the MAP feature. This lets you plot the illumination for a 2-dimensional space or surface. For example, in MAP mode you can measure the illumination at specific points within a room. You can then download the recording to a computer running DataView, and display the measurements as a 2-dimensional matrix, creating a "map" of the illumination within the room. This helps you quickly identify areas of dark, overly bright, and uneven lighting as indicated by the shading in the blocks (see below). Hovering your mouse or pointing device over one of the blocks will display the actual measurements.



The Model 1110 can also be set up to measure specific types of lighting sources, including LED and fluorescent.

For more information about AEMC lightmeters, please visit our web site at www.aemc.com.