Lighting Hazards:
what you don't see can hurt you

Version 2.0

Thomas Edison's brilliant 1879 invention the incandescent lamp has transformed the way we live and work in the industrialized world. As with any major innovation, however, there have been risks as well as benefits to artificial lighting.

From a health and safety standpoint, workplace lighting presents two major areas of concern. The most obvious is visibility, including all those factors that affect our ability to see clearly and comfortably in any work situation. The second pertains to make it lighting's invisible hazards: the possible link to skin cancer from exposure to fluorescent lights emitting ultra-violet (UV) rays; and increased incidence of breast cancer experienced by women working night shifts from exposure to light at night.

The first section of this hazard bulletin focuses on visibility issues, while the latter part is devoted to related cancer concerns.

What are the health effects of poor lighting?

Inferior lighting can cause numerous health problems. Below are some lighting problems commonly encountered in workplaces and their associated outcomes.

- **Insufficient light** can result from too little illumination from fixtures and low reflective levels from ceilings and walls. But the question of how much light is enough depends on the task at hand. The Illuminating Engineering Society Lighting Handbook provides extensive tables listing recommended lighting levels for a variety of activities. For instance, they recommend 3,000 lux for precise assembly work, 7,500 lux for very precise machine tool work and 750 lux for general office work. Regardless, insufficient light prevents workers from seeing details, which can cause accidents, eyestrain, headaches and musculoskeletal problems from adopting a poor posture to compensate for inadequate light.
- **Poorly distributed light** can make a workplace appear dark and gloomy, while vast differences in light levels in the same area force workers' eyes to constantly readjust when moving from one light level to another.

This adaptation reduces visibility momentarily until the eye fully adapts to the new light level. In addition, large differences in light can be a source of glare and visual discomfort.

- **Excessive light** can also be hazardous. More is certainly not always better, especially for office or computer workers. The results of one study of open-plan offices showed that very high levels of lighting increased the risk of troublesome reflections, deep shadows and excessive contrast, again causing eyestrain, eye irritation and associated headaches and fatigue. Too much direct or reflected light within the field of vision can also result in direct or indirect glare. A review of the physical layout of a workplace should ensure that lights are not placed directly in any worker's line of vision. Indirect glare is a common glare problem experienced by indoor workers. Over time it can cause deterioration of vision. Poor posture and resulting musculoskeletal injuries is also a problem when it comes to glare, as workers will adjust their posture to avoid glare.

How can we assess and improve poor lighting?

We are dependent on vision for almost everything we do. Our ability to see is affected by:

- the amount of light reaching a work area — illuminance;
- how well the light reflects from a surface — luminance;
- the relationship of an object to its background — contrast; and
- the sources and types of workplace lighting.

In most instances lighting is most effective if there is not a great difference between the luminance levels for the task and its surrounding work area. In a workplace the most reflective surface should be the ceiling, the least should be the floor.

Walls and furniture should be somewhere between. A totally black surface reflects no light; the reverse is true for a white surface. A matte finish reflects less light than a shiny one of the same colour.

Contrast in colour is especially important when some objects, such as traffic signs for forklift drivers, need to be very distinctive and highly visible.

A good ***general lighting system*** is most often provided by ceiling fixtures, and these should prevent major differences in brightness between the background and the specific task area. ***Local lighting*** should give individual workers flexibility and control over their own surroundings, making it easier to perform challenging visual tasks, such as detailed work.

Protected lighting

Safety around lighting is crucial, especially in work sites where various substances may evaporate or become airborne. (This said, every precaution should be taken to eliminate airborne substances.) Dust proof lights, with a protective lens and no vents are needed for dusty environments. Splash resistant or waterproof lighting is needed when the work environment is wet; for example, in a factory where lights are exposed to water spray. Explosion-proof lights, which cannot act as a source of ignition, are needed where volatile solvents are used, such as in paint booths.

Direct and indirect lighting

Direct lighting fixtures, which cast light downward toward the work area, should be covered with diffusers, lenses or louvres to provide uniform general lighting. Indirect lighting fixtures send the light upward onto the ceiling and walls, which reflect it back into the room. Using light-coloured walls for reflection, indirect lighting should produce soft, even, shadowless and glareless illumination. Glare can also be reduced by rearranging the configuration of work stations.

Sources of light

Daylight

While not always part of the lighting mix in a workplace, daylight is nearly always a welcome addition. Daylight contributes to the general well-being of workers by fulfilling the psychological need for humans to be outdoors. Natural light also provides for better colour perception of objects than other light sources do. Ironically, daylight

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— for all its benefits — is probably the most difficult type of light to control, given frequent weather changes, the shifting direction of the sun through the course of the day, and seasonal factors — longer, stronger sunshine in summer and shorter, weaker rays in winter. Blinds, drapes, tinted glass and awnings can all play a role in controlling daylight to the maximum benefit of workers.

Artificial light

- Incandescent lamps are the modern version of Thomas Edison's original light bulb. They require a lot of electricity and, at the same time, produce a great deal of heat. Halogen lamps are a type of incandescent light offering intense and consistent light levels to work areas.
- Fluorescent lighting: The chief appeal of this lighting is its low cost. Fluorescent tubes that are old or defective often develop a slow, visible flicker, which causes visual discomfort. They must be replaced according to manufacturers specifications. Since most fluorescent lights also contain toxic materials, like mercury, disposal is also an issue.
- Full spectrum light, is one type of fluorescent lighting. Nonetheless it seems to address many workplace illumination problems. It reportedly increases visual perception, reduces eye strain, and relieves headaches and fatigue. Full spectrum, as the name implies, is also said to imitate the benefits of natural light, reportedly causing the body to produce neuro-chemicals for stress regulation. One U.S. company also reported that after installing full spectrum lighting in its computer operation, the error rate of the department fell significantly. Worker productivity and satisfaction also increased.

Lighting regulations

As is the case with many occupational hazards preferred lighting can also be achieved by meeting legal workplace standards. Unfortunately for the most part Ontario's rules on workplace lighting are general in nature. By contrast, the British Columbia regulation — and to a lesser extent, Saskatchewan's — includes very precise guidelines, spelling out minimum lux levels for specified tasks ranging from work in freight elevators to bakery mixing rooms to fine hand painting.

What about the links between cancer and lighting?

UVB radiation and skin cancer

There is strong scientific evidence that supports a relationship between malignant melanoma and other skin cancers and exposure to ultraviolet (UV) radiation. Although most of these studies focus on UV rays from the sun, there are many non-solar sources — including fluorescent lighting — which emit radiation in the various UV ranges, particularly the UVB class (characterized by wavelengths from 280 to 320 nanometers in the electromagnetic spectrum).

UVB light is known to alter DNA sequences and gene expression, and has been found in animal experiments to be the most effective in inducing skin cancers of both the melanoma and non-melanoma types. Some annual workplace exposures in the UVB range from fluorescent lighting have been reported to exceed annual solar exposures of outdoor workers.

But the human studies investigating skin cancer among workers exposed to fluorescents have been mixed. Some of this research has shown positive links, while other studies have concluded there is no correlation. To this point, the International Agency for Research on Cancer (IARC) has determined that — based on available evidence —exposure to fluorescent lighting is not classifiable as to its carcinogenicity to humans.

As with all contradictory data however, it makes sense to err on the side of caution. The most effective way to control potentially hazardous exposures is to purchase lights with minimal emissions. Secondarily, UV radiation from fluorescent lights can be reduced by using acrylic filters or diffusers, and performing regular maintenance and inspection of all fluorescent lights in the workplace.

Light at night and breast cancer

Recent studies have shown that women who work more night shifts in artificial light seem to experience a higher incidence of breast cancer.

This 'light at night' (LAN) hypothesis offers another possible contributing factor for the higher rate of breast cancer experienced by women in industrialized countries. According to the LAN theory, exposure to light at night (and the electromagnetic fields, or EMFs accompanying this light) may significantly decrease the production of the melatonin. Melatonin is a hormone that is secreted chiefly during the night by the pineal gland in the brain. Since numerous laboratory studies have shown that melatonin blocks the growth of human breast cancer cells — especially those induced by estrogen — it is feasible that decreased melatonin production may lead to an increased risk of breast cancer development.

Two medical studies reported during 2001 in the Journal of the National Cancer Institute, seem to verify this melatonin-LAN-EMF hypothesis. Researchers in one investigation examined the relationship between breast cancer and women working on rotating night shifts, with participants from the Nurses' Health Study in the United States. This research concluded that the women who worked on rotating night shifts at least three nights per month, in addition to days and evenings, had a moderately increased risk of breast cancer, after extended periods of working such rotating night shifts. The risk increased among women working 30 or more years on the night shift.

The second study, performed at the Fred Hutchinson Cancer Research Center in Seattle found similar results — that "graveyard" shift work was associated with increased breast cancer risk. Similar to the nurses' study, this risk also increased as the years of night work and the number of hours per week on the night shift similarly increased.

Four previous studies have in similar fashion reported an increased risk of breast cancer among women who work at night.

There are no easy solutions to the issue of light at night, particularly for workers engaged in the delivery of essential services such as health care. However, these studies challenge us to explore options to reduce — if not eliminate entirely — the adverse effects.

EDITOR'S NOTE: The Workers Health & Safety Centre offers training on lighting, its hazards and controls. To learn more visit their web site or contact a Training Service Representative in an office nearest you.

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