Meat technology update

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# Lighting in meat processing areas

Increasing emphasis on meat hygiene assessment, including zero faeces and ingesta, and on good processing procedures, means that an understanding of lighting is becoming more important.

The AQIS and Australian Standard regulations for construction give the minimum requirements for the meat industry. For areas where better than the minimum lighting requirement is desirable, a person suitably qualified in lighting should be consulted.

MEAT TECHNOLOGY UPDATE
Cutting edge technology for the meat processing industry

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## Quality of light

Adequate quantity of light (or illuminance) is only one of the necessary elements of a satisfactory lighting system, particularly for such tasks as inspection for meat classification, prevention of defects, detection of contamination, disease, colour and the like. Failure to achieve adequate light quality can reduce the efficiency of assessment and thereby, enhance the possibility of complaint. Poor *quality* lighting, even though there is *enough* of it, can also cause visual discomfort to meat processing operators.

Australian Standard® "Interior Lighting" AS.1680.1 - 1990 and AS.1680.2 - 1990 will reveal what the important quality requirements are. If a new plant is being planned, an existing one is being extended, or lighting installation is being renewed, reference should be made to the Standard.

Another important aspect is the vision of employees carrying out the tasks that are visually important. Good lighting will not necessarily compensate for deficient vision.

### Direct glare

*Direct glare* occurs when there is an over-bright source of light directly in the field of view. Factors that determine its severity are its inherent degree of brightness, its apparent area or size to the eye, its angular displacement from the general direction for the task, and the relative brightness of the background immediately surrounding it. An over-bright lamp in a meatworks should not be close to the line of sight. If it is, steps should be taken to shade it or otherwise limit the glare effect as the Standard advises.

The Australian Standard gives guidance on the assessment of whether a particular luminaire (the international term for light fitting), by rating and type, is too bright, and gives appropriate methods of controlling its brightness. These include the provision of luminance (brightness measured by instrument) limits on the luminaire and suitable shielding angles for shades and louvres. Unfortunately, the Australian Standard 1680 - 1990 has proven much harder to apply to the letter of the law than originally intended and some discharge luminaires with metal halide, mercury

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vapour and high pressure sodium lamps, i.e. light sources of sufficient power to economically illuminate large processing areas, may have difficulty meeting glare test criteria.

**Reflected glare**

In a survey, luminaires were seen in positions where possible troublesome *reflections* were directed to operators' eyes from wet surfaces of offal on the viscera conveyor, from polished stainless steel working surfaces, or from glossy wall tiles and even water laying on the floor. The Standard gives guidance on the ways of eliminating or minimising such effects. In many cases the solution is once again a practical one such as use of a matt surface instead of a highly polished or glossy one or, minor relocation of luminaires, addition of a diffusing refractor or visor, or simply, use of coated or diffuse lamps.

**Brightness distribution**

*Brightness distribution* (the pattern of brightness that appears in the field of vision) is an important factor for visual efficiency when undertaking demanding tasks in locations such as the boning room and the slaughter line.

It is important that the brightness of the object examined (the luminance) is greater than the remainder of the field of view. The background should present a comfortable brightness distribution. However, if the *difference* in luminance between the object examined and the immediate background is too great (i.e. greater than about four to one), the worker could have problems of adjusting back and forth between the two light levels, thus affecting visual performance.

**Uniformity of illumination**

Uniformity refers to the variation in illuminance (level read directly by a light meter in lux) which appears over work surfaces, and the total work space, e.g. the 'pooling' pattern created by the spacing of light fittings. Again, this can contribute to eye strain. Closer spacing of luminaires can improve uniformity. Luminaire manufacturers provide guidelines for spacing to mounting height ratios.

For example, as well as the concentrated directional light on the slicing and inspection operations of the boning room, it is important to have an adequate level of general illumination (illuminance), making ceilings and walls comfortably bright for those who glance up from task areas of high brightness.

**Colour**

The employees' reactions to their surroundings - how they feel when working in an area - can be very important in maintaining productivity. Colour, as already indicated, plays an important part in creating a good working environment and in contributing to the quality of the lighting. Apart from the finish on work surfaces, ceiling and walls, the correct choice of lamps can contribute in this regard.

Consideration of two light source characteristics - colour temperature and colour rendering - will provide some assistance in the achievement of optimum interior colour appearance of objects and surfaces. They are important criteria in the selection of the most appropriate source for the particular visual requirements of the task.

**Colour temperature**

***Colour temperature* is a figure that gives a measure of the colour appearance of the light from the lamp itself.**

The colour appearance of near white light sources is normally expressed in Degrees Kelvin (K). The higher the figure, the cooler the appearance of the source; the reddish-yellow flame of a candle is about 1900K, the ordinary incandescent lamp, about 2800K, and cold bluish-white southern sky daylight, over 6500K. Thus the colour of light changes from having mainly red/yellow components at about 2500K to light having mainly blue components at about 6500K, which approximates natural daylight with a blue sky.

Lamps with colour temperatures in the range 3500K to 5000K are generally preferred for commercial and industrial applications, the higher colour temperature lamps being used where a lively/cool environment is required. Colour temperatures in the region of 4300K are most suitable for tasks in abattoirs, especially where visual efficiency is critical, e.g. inspection. These lamps may be called 'white' or 'cool white'. Higher colour temperatures may be called 'daylight'. The colour temperature of 'warm white' lamps (below 3500K) is generally considered to be suited to comfortable/warm environments (residences) and does not suit the critical visual tasks in processing areas.

Colour temperature does not affect illumination. However, many people will perceive an identical illumination level under a low colour temperature lamp, e.g. high pressure sodium, as being much lower than that provided by the high colour temperature lamp, e.g. metal halide. Also, in a warm climate, a low colour temperature lamp can create a feeling of warmth. At inspection points a colour temperature of 4000K-5000K is recommended, provided that the lamp has suitable colour rendering properties.

**Colour Rendering**

Colour rendering is the **ability of a light source to reproduce colours of objects accurately,** e.g. the meat and fat colour, or contaminants on a carcase. To determine the colour rendering index (CRI), a series of tests is conducted with the light source in question compared with reference sources of light with known or calibrated colour rendering properties. This is determined over a set of eight standard colours. The CRI is, in fact, an average colour rendering.

Lamps with identical CRI values of 85 from two different manufacturers may, in fact, have widely differing spectral distributions in spite of the common CRI value of 85, i.e. one make might have a high CRI in the red band and a low CRI in the blue band, and the other make vice versa.

Field tests are necessary to determine if the lamps are suitable for specific tasks. A weakness in one lamp in a particular colour band may be a strength in the other lamp. We must remember that an average is a 'mean' and very high results in, for example, six out of the eight tests may give the lamp a very high CRI and yet the colour band most important to your visual task may fall into the poor area of colour rendition.

Lamps which are highly efficient for colour rendering (say, CRI equal to or greater than 90), by comparison, often have lower efficacy, i.e. are lower in lumen or light output. As an example, a typical coated metal halide lamp with a CRI of 65 has an output of 38,000 lumens; a lamp with a CRI of 80 produced by the same manufacturer has an output of 24,500 lumens.

That is to say, a lamp that is necessary to ensure that defects and diseases are detected as a result of faithful colour rendering of these elements to the inspector will be more costly to purchase and run because for a given light output (lumens) it consumes more power.

General production areas could be illuminated by lamps with a reasonable colour rendition ability and with high lumen output (efficacy), whereas areas with very stringent inspection needs could be locally illuminated by lamps with a very high CRI or colour rendering ability. This is much easier if the colour-sensitive tasks are isolated in separate rooms or sections of the building.

## Quantity of light (illuminance)

This Update has made reference to luminance (brightness measured with an instrument). Unfortunately, luminance cannot be measured with a normal light meter as the latter measures the amount of light falling on a surface (illuminance measured as lux). A luminance meter measures the brightness of an object as it appears in the field of view (reflected light). It is similar to a photographic exposure photometer used to measure reflected light; however, the luminance meter is calibrated in candelas per square metre. The luminance meter would measure 'brightness distribution' or difference.

The accurate field measurement of the luminance of existing luminaires or interior surfaces is generally not practical. It requires a very expensive laboratory-type instrument. It is far more appropriate to do this work before the installation is complete.

It is important to remember that illuminance readings, taken with a light meter, should be taken in the plane (horizontal, vertical or inclined) of the object being examined, as viewed by the operator and as close to the object as practicable. Hence, a light meter reading on a meat carcase hanging on the slaughter line should be taken with the meter lying in the vertical plane of the carcase, because it is the illuminance on the vertical sides of meat as seen by the operators that determines visibility.

Unfortunately, most of the meat industry regulations refer to illuminance values (lux) on a plane one metre above the floor or on an imaginary horizontal work plane, which is often not where the operator is viewing the task. Using computer technology, the lighting engineer can comply with this requirement, yet do additional vertical or slope plane illuminance calculation checks to determine if the illuminance in these planes is of sufficient quantity and uniformity.

A sufficient number of illuminance measurements should be made over the task area to provide a representative average illuminance value, and allow assessment of the uniformity.

## Maintenance

Maintenance of lighting systems keeps the performance of the system within the design limits, promotes safety, and, if considered at the design stage, can help to minimise the electrical load and capital costs.

Lighting systems deteriorate without regular maintenance. The output of the lamp decreases as the length of time it has been in operation increases. Different lamp types deteriorate at different rates.

Further, dirt deposition will occur on lamps, luminaires and other surfaces.

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# Contact us for additional information

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