LIGHTING CONTROL CORRECTION FACTORS IN APPROVED DOCUMENT PART L

by Paul Littlefair **January 2000**

INTRODUCTION

The current (15/12/99) draft of Part L for non-domestic buildings includes a recommendation (section 2.2.15.2) for the efficacy of general lighting in offices, factories and warehouses. This is given in terms of a luminaire efficacy which incorporates the combined efficacy of the lamp and control gear, the luminaire light output ratio (LOR) and correction factors which depend on the type of lighting control in operation. The purpose of this note is to explain the basis for these lighting control correction factors. Correction factors are proposed for two different types of situation:

(a) daylit spaces with daylight linked lighting control, either photoelectric or local manual;
(b) infrequently occupied spaces with absence detection. Here a sensor switches off the lighting after it detects the absence of occupants, but switching on is done manually.

THE BASIS FOR THE CORRECTION FACTORS

The correction factors should be chosen to satisfy the following criteria;

(a) They do not result in an energy penalty. The combination of a less efficient lamp or luminaire with lighting control should use the same or less energy than an efficient uncontrolled lamp/luminaire combination.

(b) They should give important extra benefits in flexibility to the designer. There is little point in a correction factor which simply encourages less efficient lighting of the same type. However if they can allow the designer to use a broader range of types of lighting this can give flexibility to the way Part L is applied, without compromising overall energy consumption. The ‘carrot’ of flexibility can also encourage the designer to choose controls that are tailored to the needs of the space, and to consider daylight provision as an energy efficient option.

To tie in with the ACMV requirements in Part L, the correction factors have been proposed as decrement factors, less than 1. They are to be included in an equation of the following form:

$$f_{lum} = \frac{1}{P}.\sum \frac{L.O.R.* \, l_{lamp}}{CF}$$

where
ϕ_{Lum} = the luminaire efficacy (luminaire lumens/circuit Watt)
L.O.R = the light output ratio of the luminaire
λ_{lamp} = the sum of the average initial (100hour) lumen output of all the lamp(s) in the luminaire
P = the total circuit watts for all the luminaires
CF = the lighting control factor.

Thus if CF is less than 1 the calculated luminaire efficacy improves, so it would be possible to have a slightly lower L.O.R or λ_{lamp} and still meet the requirement.

ENERGY SAVINGS FROM CONTROLS

In nearly all non-domestic spaces lighting controls can give some energy savings, for example outside working hours or during the day when workstations are unoccupied. However there are two particular situations when substantial energy savings can be expected. These are in daylit spaces, and rarely occupied spaces. In each case, an appropriate form of lighting control is required. For daylit spaces, Crisp et al (ref 1) have reviewed the likely savings in depth. For offices and factories they identified lighting energy savings from exploiting daylight of between 20-40%. This is backed by a number of case studies, some of which are reviewed by Aizlewood and Littlefair (ref 2). These give savings around the upper end of this range.

TABLE 1. CASE STUDIES OF DAYLIGHT LINKED LIGHTING CONTROLS (FROM REF 2)

Case Study	Type	Savings %
Chase Manhattan	Office	64
GEC Turbines	Office	30-50
Gwent CC	Office	85
Jacobs Well, Bradford	Office	36
Lloyds Bank	Office	32
Portsmouth CC	Office	40
Racal Decca	Office	75
S Yorks Police	Office	60
BR Ilford	Railway Shed	33
Brooke Bond Foods	Warehouse	56
British Telecom	Warehouse	47

These results are backed by calculations using the LT method (ref 3). The LT method suggests lighting energy savings of between 30-60% (depending on orientation and indoor illuminance) for a building with 20% of its window wall glazed, compared to an identical unglazed building. However these savings apply only to a zone within 6m of the windows. For rooflit buildings, 10% glazing (percentage of floor area) gives 40-60% savings in lighting use. Importantly, the savings result in an overall drop in building energy consumption (of around 15-30%) once the extra heating requirement is factored in. Reference 4 gives further details. Overall then, energy savings alone would suggest a correction factor of 0.6-0.8 could be justified in daylit spaces.

For infrequently occupied spaces less data are available. In principle, percentage savings due to absence detection for a particular switching zone should be close to the percentage of time the zone is unoccupied. However, savings will be reduced because occupancy sensors always incorporate a time delay to prevent nuisance switching off. The size of this effect will depend on how often the space is entered.

For example, lower savings could be expected in a toilet which is regularly visited for a short while, compared to a computer room where operators may enter less often but spend longer time on each visit.

In some types of space this effect can be counteracted by the requirement for a manual switch on following absence detection. In daylit spaces, in particular, people may decide they do not need to switch on the lighting when entering the space. This can give extra savings, because the additional switch off has forced the occupant to review the need for lighting.

Large energy savings have been reported in practice, for example, savings of 85% were reported in a Unipart warehouse (ref 5) due to the introduction of occupancy sensing.

If we define a rarely visited space as being occupied less than half the time, then a correction factor as low as 0.5-0.6 could be justified on energy saving grounds.

FLEXIBILITY

The above analysis suggests that a reduced requirement for lamp/luminaire efficacy could, in daylit and rarely visited spaces, be compensated by savings from lighting control. But are there any benefits from such a reduction?

In the draft Part L the basic requirement is for a luminaire efficacy of 40 lm/W or more. This is based on efficient tubular fluorescent or high intensity discharge lamps, with efficacies of 65 lm/W or above, housed in efficient luminaires (light output ratio 0.62 or better). This type of requirement has been widely advocated within the lighting industry. A 65 lm/W limit already forms part of the good practice guidance in the CIBSE code for interior lighting (ref 6). However there are problems with it. Nearly all forms of compact fluorescent lighting have a circuit luminous efficacy between 50 and 65 lm/W. Unless these are used bare, they will not meet the 40 lm/W luminaire efficacy.

Important flexibility for the designer could be introduced if compact fluorescent lighting were allowed in daylit and rarely visited spaces with appropriate controls. This could be done by adopting correction factors less than 1 for these spaces, which would then allow lamps of lower efficacy (light output to power consumption ratio). For a 50 lm/W lamp with a particularly efficient luminaire (LOR 0.64), a lighting control correction factor of 0.8 would be appropriate. A correction factor of 0.75 would allow a slightly less efficient luminaire of LOR 0.6.

Thus introducing correction factors of 0.75 to 0.8 would offer designers a much wider range of lamp types, while restricting them to energy efficient options. Reducing the correction factors further is of little extra benefit; designers would tend to opt for less efficient luminaires or more tungsten lighting.

SUMMARY OF RECOMMENDATION

A correction factor of 0.8 to the luminaire efficacy in offices, factories and warehouses is recommended in either:

(a) daylit spaces with daylight linked lighting control, either photoelectric or flexible manual; or
(b) infrequently occupied spaces with absence detection, where a sensor switches off the lighting in the absence of occupants, but switching on is done manually.

A correction factor of 0.75 is suggested where both (a) and (b) apply.

REFERENCES

1. VHC Crisp, PJ Littlefair, I Cooper and G McKennan, ‘Daylighting as a passive solar energy option: an assessment of its potential in non-domestic buildings’ BRE Report BR129, Garston, CRC, 1988.
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