THE VALIDITY OF DAYLIGHT CALCULATIONS IN RIGHTS TO LIGHT

Peter S Defoe DipArb FRICS FCIArb MIQA
Ian Frame MSc, BA, Cert Ed, ILTM
Department of the Built Environment,
APU (Anglia Polytechnic University), Chelmsford Essex, CM1 1SQ
c.i.frame@apu.ac.uk; pdefoe@calfordseaden.co.uk

ABSTRACT: Rights of Light surveyors accept that the light from 0.2% of the skydome provides 1 Lumen of light and that this is sufficient for ordinary needs. This paper examines the validity of this by examining the original methods of calculation and comparing these with some more recent methodologies. It can be shown that there is a case for reassessing the methodologies currently accepted by the Courts and for proposing a new more accurate method.
Keywords – Daylight, Rights to Light, Skydome.

1. INTRODUCTION

This paper is drawn from work in progress towards a Professional Doctorate at APU. The research is based around my specialism within a multi-disciplinary practice and I wish to investigate the basis of the Court's acceptance of a standard of measurement of daylight which is outdated and probably wrong. The method of calculation of daylight sufficiency, which is accepted by the Court, is based upon research undertaken in the early 20th Century by P J and J M Waldram[1] (1923) and by A K Taylor (1931)[2] who used a "jury" of people to establish where in a room there was sufficient light from the sky for them to be able to work and then interpreted the results and plotted an average contour line on a plan of the room.

From this they determined that the level of light needed for ordinary use, equated to 1 Lumen and that this amount of light was available from 0.2% of the sky dome and the Courts have since interpreted that if this amount of light was available over 50% of the area of a room, then the room generally, would be adequately lit. This continues to be accepted by Rights to Light Surveyors when advising their clients whether a proposed development is likely to cause an actionable loss to an adjoining property.

The issue is that some are now questioning whether the established amount of light is in fact sufficient and argue that modern technology would allow us to use more sophisticated methods of assessment, if they can be justified to the satisfaction of the Courts.

2. THE ESTABLISHMENT OF THE RIGHT TO LIGHT

It is difficult to establish at what point daylight calculations were first undertaken but there is certainly evidence that people took the right to daylight seriously in the middle ages and that they relied upon the notion of 'time immemorial' when settling their right to the passage of light over another's land. The first year of the reign of King Richard I in 1189 was established by the Statute of Westminster in 1275 as being beyond the length of the oldest man's memory at the time and was thus deemed 'time immemorial' and anyone enjoying a right since that date will

have that right protected by the Courts This remains, in theory, one of the methods by which a Right to Light can be proven although it is unlikely that any new cases will arise.

More recently, but still over 170 years ago, the government of the time passed the Prescription Act 1832[3] which, in Section 3, states "*When the access and use of light to and for any dwelling house, workshop, or other building shall have been actually enjoyed therewith for the full period of twenty years without interruption, the right thereto shall be deemed absolute and indefeasible, any local usage or custom to the contrary notwithstanding, unless it shall appear that the same was enjoyed by some consent or agreement expressly made or given for that purpose by deed or writing*". It was not until 1904 that Lord Lindley clarified, in the case of *Colls v Home & Colonial Stores Ltd*[4], that *"….generally speaking an owner of ancient lights is entitled to sufficient light according to the ordinary notions of mankind for the comfortable use and enjoyment of his house as a dwelling house, if it is a dwelling house, or for the beneficial use and occupation of the house if it is a warehouse, as shop or other place of business. The expressions "the ordinary notions of mankind", "the comfortable use and enjoyment", and "the beneficial use and occupation" introduce elements of uncertainty; but similar uncertainty has always existed and exists still in all cases of nuisance, although the right to light has been regarded as a peculiar kind of easement"* and this was subsequently supported in *Cory v The City of London Real Property Co.*[5]

P J and J M Waldram[6] published their paper entitled "Window design and the measurement and predetermination of daylight illumination" in The Illuminating Engineer, in 1923, and this incorporated several methods of calculating the daylight factor including what became a widely used diagram system. By 1927, in *Horton's Estate Ltd v James Beattie Ltd*[7], it was stated that *"The human eye requires as much light for comfortable reading or sewing in Darlington Street, Wolverhampton as in Mayfair."* Then, in 1928, Percy Waldram[8], who was by then a "well know light expert" gave an address to the Surveyors Institution, now the Royal Institution of Chartered Surveyors (RICS) gave a paper entitled "The Estimation of Damage in Ancient Lights Disputes, followed in September 1928[9], with a paper entitled 'Daylight and Public Health' to the Commission Internationale de L'Eclairage and in which he summed up by stating that:

a) *the positions from which no sky at all is visible at table height are inadequately lit for ordinary purposes, such as continued clerical work, and*
b) *it is undesirable that rooms should be constructed, or used for habitancy (sic), or for clerical or other ordinary work over long periods, unless they have at least some sky visible from table height over some reasonable portion of their area.'*

He further advised the members of that forum that 'whitened obstructions, light walls and ceilings and other expedients for mitigating gloom were no longer beneficial once the surfaces became dirty and especially on dull days. Prior to this he had also stated that the human eye could not be trusted when dealing with light levels and gave an example where the light in an ordinary room lit by windows on one side only, fell away very quickly indeed as the distance from the window increased as the amount of visible sky decreased rapidly but the human eye was not necessarily aware of this. He concluded by stating, amongst other things, that the light must be direct from the sky, and not from artificial light or from reflected surfaces.

3. THE WALDRAM METHOD

Percy Waldram was fairly prolific in his writings and gave expert evidence in Court supported by the papers which he and others had published. One such paper was given to the Department of

Scientific and Industrial Research (technical paper 12) entitled "The Daylight Illumination required in offices" by A K Taylor[10] (1931), and this was also referred to in the CIE Proceedings in 1931 at Appendix I[11]. In this he referred to work by the Illumination Research Committee and concluded that his paper supported the previously adopted figures with particular reference to the work by PJ and JM Waldram in the Illuminating Engineer of 1923[12], where it was stated that over a wide range of illumination values, the adequacy or inadequacy of the lighting at a point was closely correlated with the daylight factor at that point The paper went on to describe how he had established the levels of light necessary by engaging a 'jury' to visit several offices and establish where in the rooms they each thought that there was sufficient light. Since Waldram had previously stated that the human eye could not be trusted when dealing with light levels, the validity of this jury approach should be brought into question. He then took these results and produced them in graphical and tabular form and gave the answer which he said best suited the results and replicated the methodology suggested in the 1923 paper.

Traditionally, Rights to Light surveyors prepared Waldram diagrams, such as the much simplified example shown at Figure 1, on which the windows in a room have been plotted from a single point within the room. In this example there are three windows which might provide light within the room and the window shapes ignore the effect of the window frames and glazing bars. To assess the area of sky visible from each point, the chart is overlaid with a grid of squares, each square representing 0.1% of the skydome and therefore two squares or their equivalent, are needed to achieve 0.2% and thus sufficient light according to the law as it stands.

Figure 2 shows the same windows with external obstructions plotted in and the small area which continues to receive light from the sky represents 0.2% of the sky dome. As can be seen, this is extremely small and a few Rights to Light surveyors such as Michael Pitts[13] (2000), have started to question whether this is still an appropriate way to continue to measure adequacy of light.

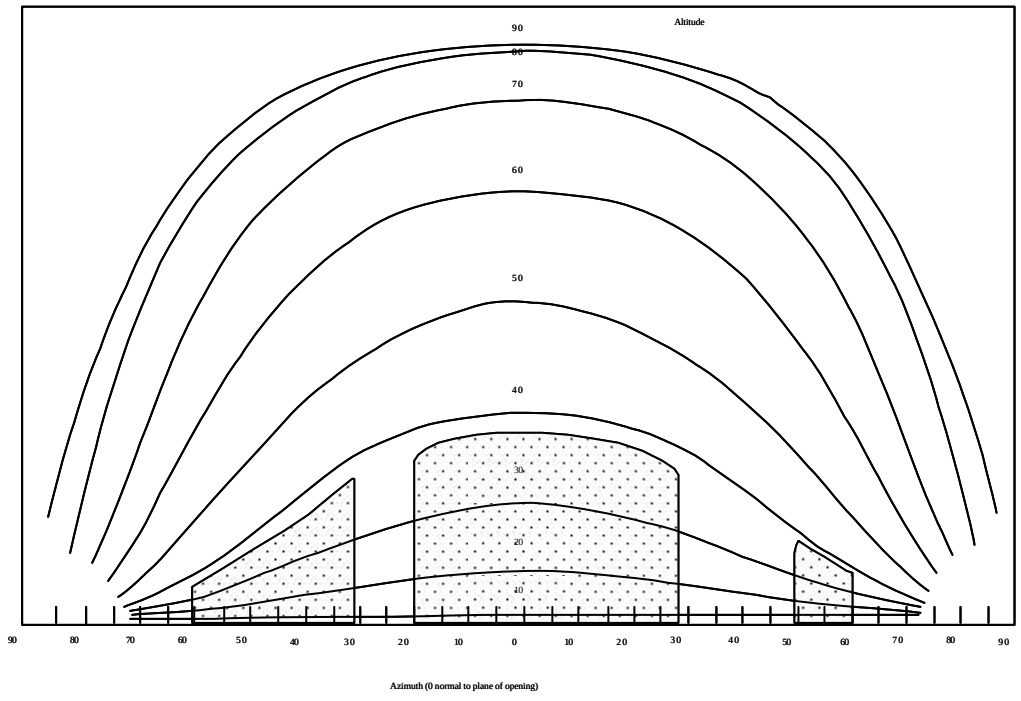

Figure 1. Simplified Waldram diagram showing window outlines

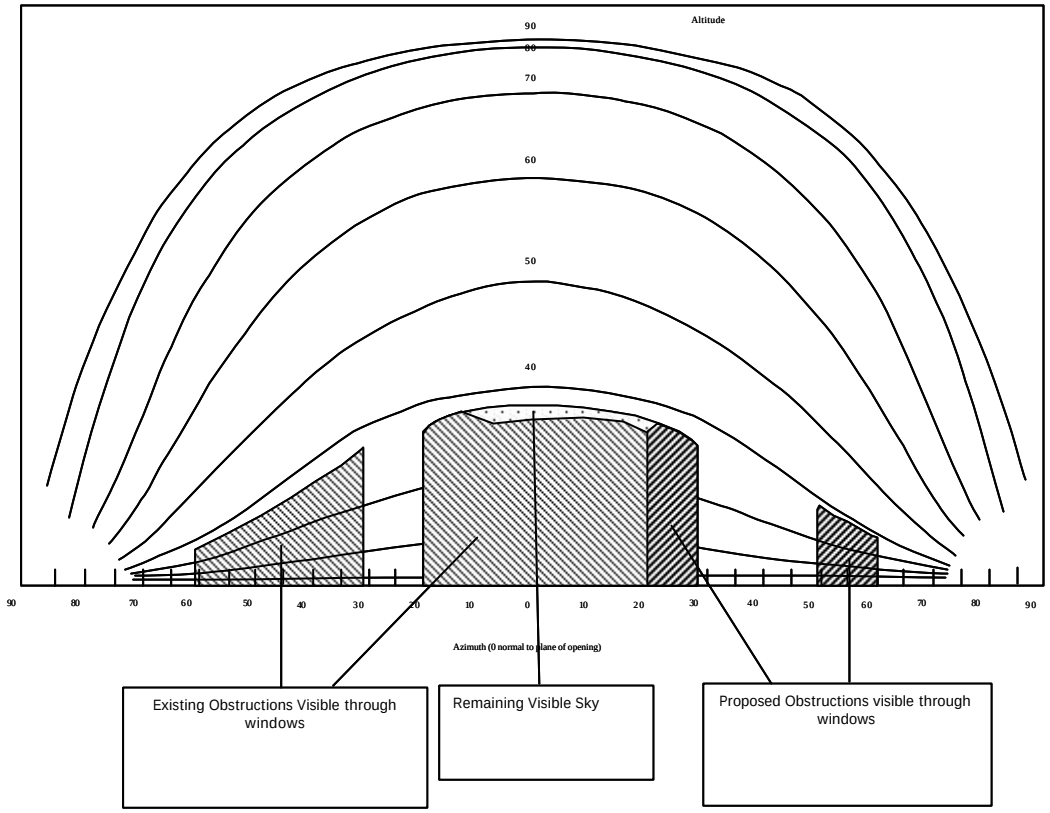

Figure 2. Waldram Diagram with External Obstruction plotted into window openings

The degree of accuracy or inaccuracy will depend upon the size of the chart and the user's ability to draw the obstructions and count squares. The other possible inaccuracy is the basis of the chart itself and this is one of the fundamental matters that require research.

Figure 3 shows a basic room plan with a single window with one metre grid marked on it. Using traditional methods, the smaller the grid the more Waldram diagrams that have to be produced and the more time consuming the process becomes. Whilst it is thought that the smaller grid increases the accuracy, the probability is that errors creep in to eliminate this expected benefit. Since this process must be repeated both before and after the new obstructions, the production of an accurate result becomes very time consuming.

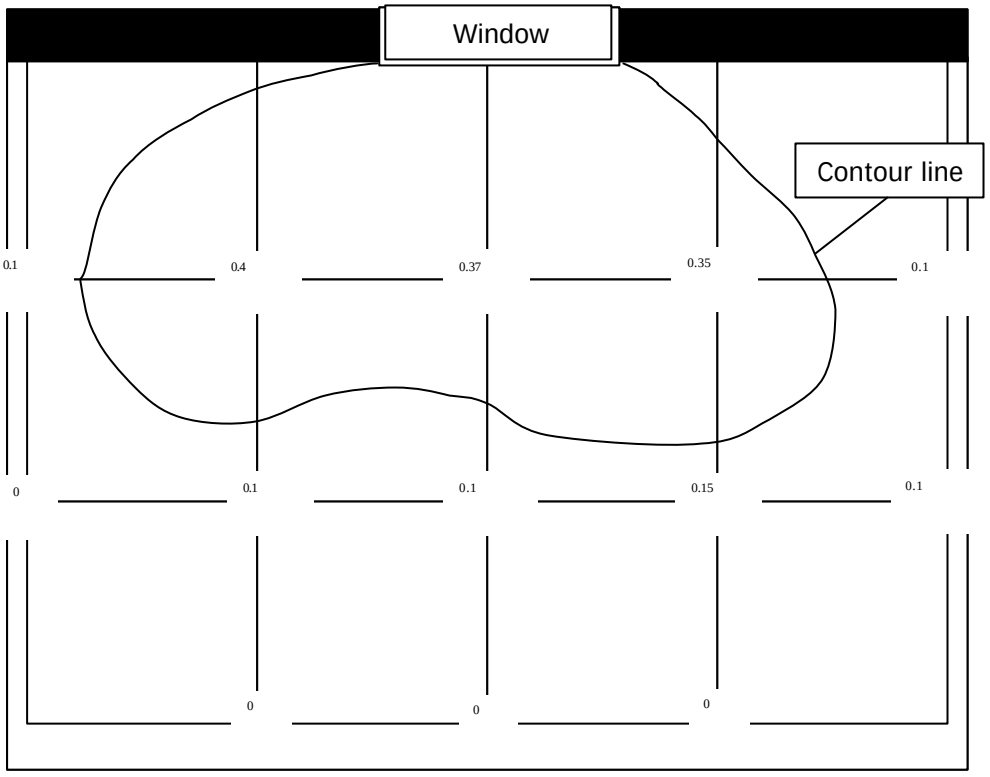

Figure 3. Room Plan with Contour Line

When each grid point value has been established, it is necessary to calculate roughly where on the grid the 0.2% value is achieved and join the dots to form a contour line using experience to judge the curve of the line. Having done this, the area inside or outside the contour is measured for 'before' and 'after' any obstruction externally.

It can be seen, just from this limited example, that there is further scope for inaccuracy.

1. The measurements of angles to the obstructions can be wrong.
2. The guess at the curve could be wrong
3. The measurement of areas could be wrong

In addition, this method is very time consuming and hence computer programmes have been written, based on this process, which shorten the time quite dramatically.

4. OTHER CURRENT METHODS

Modern methods of calculating Daylight, as opposed to the methods used for Rights to Light calculation, include those which have been set out in BRE Digests 309 and 310 in 1986[14] and then in BS 8206:Part2[15] and The BRE digest by Littlefair (1998)[16] but these methods are used only for Planning purposes and are not considered to be valid in Rights to Light cases. In fact there are several differences worthy of consideration. Firstly, right to light calculations are based on the sky component of light from a uniform sky whereas daylight calculations are based on a CIE sky which is not uniform, and secondly, after measuring the vertical sky component, the calculation of the average daylight factor takes into account the internal reflectance as well as the reduction in light through glazing and the effect of the window frame and glazing bars.

In these alternative methodologies, the quality and quantity of natural light in an interior is recognised to be dependant upon two main factors. The design of the interior environment is important, including such things as the size of windows, the depth and shape of rooms and the colour of internal surfaces but the design of the external environment plays the major role, particularly whether obstructing buildings are so tall that they make adequate daylighting impossible, or whether they block sunlight for much of the year.

4.1 Vertical Sky Component

The starting point for general daylight calculations is at the face of the window rather than internally within a room and is usually measured from the centre of affected windows and projected outwards at an angle of 25 degrees in the vertical plane. The guidance Littlefair[17] states that any window within four metres horizontally of a point which gains a Vertical Sky Component (VSC) reading of 27%, which equates to all obstructions being below the 25 degree line, will probably provide sufficient light without further tests.

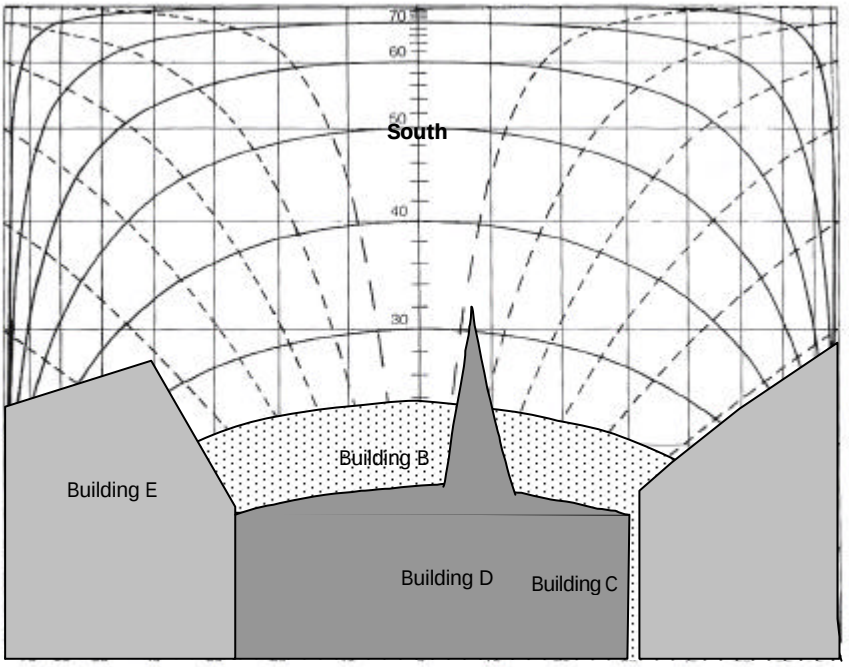

Figure 4. Typical Waldram Diagram for VSC calculations

In Figure 4, Building B would leave a VSC of 27% or Buildings C, D and E in combination would leave a VSC of 27%. The amount of light incident on the outside face of the window being considered is quite clearly well in excess of the 0.2% being considered under rights to light calculations but it is impossible to assess, from this diagram, the effect once the light has passed through the window opening and indeed a small window, or a window set in one corner of a room may produce undesirable results.

Where the windows are not considered to be of sufficient size or are not in the most ideal location to provide light to the room inside we look at what is known as the "no sky" line within the room. In almost the same way that we undertake Rights of Light analyses, we look for the contour within the room where no sky is visible rather than the notional 0.2% which is used for Rights of Light. This measurement is taken at desk top height (which, for the purposes of this exercise, may be taken to be anywhere from 0.75 to 0.85 metres above floor level) and it is possible to do this physically on site with existing buildings by moving around the room and marking on a plan the points where the sky is no longer visible. Where the buildings do not yet exist or there are several rooms to do, the process is speeded up by using computer software but the ability to model the complexities of real buildings is essential for the daylighting software to be accurate. (Ubbelohde M S 2004)[18]

4.2 The Average Daylight Factor (ADF)

The average daylight factor is expressed as a percentage of average illuminance within a room divided by the unobstructed illuminance outside the room and takes account of how clear the glass is; the net area of the window (omitting glazing bars for example); the total area of room surfaces including is all of the walls, floors and ceilings. This area is then factored by giving it an average reflectance value. (As many clients have realised, magnolia is quite good for reflectance values). The amount of light is then adjusted by taking account of the previously calculated VSC and converting this into a "visible angle" to produce an end result.

It is easiest to visualise the "visible angle" as the conversion of a complex skyline into a single line such as Building B in Figure 4. In other words, where the VSC equals 27%, the angle of obstruction will be the equivalent of 25 degrees and the value used in the daylight factor calculation is what remains of the 90 degrees i.e. in this case the visible angle 65 degrees. It is possible, however, to achieve acceptable average daylight factors with a room like a tunnel (that is where the window is at the end of a long room such that only the half of the room nearest the window benefits from any daylight) so it is also important to check that a room receives enough light for the majority of its depth.

The recommended ADF, for a generally daylit appearance, is 5% but it is accepted that most rooms are lit with electric bulbs and here the recommended level can be reduced to 2% but the minimum levels for Living Rooms and Bedrooms is lower (1.5% and 1% respectively) and we find that Planning Authorities are accepting anything above the minimum. It is still not possible to relate this back to the 0.2% used in rights to light cases but there is no doubting that this method of measurement has its own validity and should be considered when reassessing the existing basis of rights to light calculations.

4.3 Computerised Systems

A few practices now have computerised calculation systems for calculating Rights to Light areas, which no longer use the Waldram diagram as their basis. The modern method relies upon rays shot through the window at the skydome and then counting the number which pass unobstructed. The ultimately the result still depends upon the assumption that the light from the sky is uniform and is measured in terms of 0.2% of the skydome being visible. The potential for inaccuracy here is similar to the original method in that the source measurements used for the model could

be wrong but the calculation is usually to 3 decimal places whereas the original will have been to one place at best.

More problematic is that until two practices run identical calculations (unless they have the same software); no-one knows if the software has been written correctly. In fact it is perfectly possible to replicate one set of results but not a second set owing to software differences and only by regularly comparing the results with those produced traditionally is it possible to have confidence in the software.

4.4 Other Influences

In the past, the Building Regulations[19] stipulated the area of glazed window required for a habitable room as a percentage of floor area but they did not deal with sky visibility or daylight factors. More recently, the Building Regulations[20] have been amended but make no reference to size of windows for daylight. They do however deal with heat loss and the net result has been to reduce window sizes.

A discussion paper has been issued by Littlefair (1999), through the ODPM[21], in connection with the future updating of Building Regulations relating to natural daylight. This illustrates the current conflict between heat loss through windows and the benefits of natural daylight and it is possible that this will result in some guidance on the levels of light considered to be desirable but, in the interim, properties can be built I such a way that the rooms do not receive adequate daylight even by the low standard recognised by the Prescription Act and, after 20 years, when someone wishes to obstruct part of the small amount of daylight which the property does have, the loss will be automatically actionable.

A recent international standard BS ISO 895:2002[22] considers daylighting and sets a minimum daylight factor of 1% on the working plane 3 metres from the window wall and 1 metre from side walls and this may provide a useful benchmark. The amount of light from the sky will vary for time of day and year and for the angle of elevation of the visible portion and this will need to be taken into account using information from the Commission Internationale de l'Eclairage (CIE) to provide an acceptable average. In addition, research undertaken by the International Energy Agency (IEA) has looked at monitoring procedures for assessment of daylight performance of buildings, and in a report dated February 2001, Velds M and Christoffersen J[23] described how "daylighting design is both an art and a science. Qualitative information and visual feedback on a given daylighting concept are usually as important as the quantitative figures that reflect the engineering aspect of daylighting design".

The Chartered Institute of Building Services Engineers (CIBSE) advise that the only legal requirements are that daylighting should be "sufficient and suitable" but in their guide, Volume A Design Data (1988), Table A1.6[24], they set out levels of illuminance for various activities which could be used in assessing what level of lighting should be provided naturally. The Health and Safety Executive, (HSE)guidance documents suggest good practice only and are not mandatory but may still be used in the same way as the CIBSE guide.

5. OBJECTIVES

M Pitts (2000)[25] proposed a series of discussion points including the question of whether we should adopt the CIE sky rather than the uniform overcast sky used by Waldram; whether 0.2%

of the skydome is sufficient or should some other percentage be adopted; whether reflected light should be considered; whether 50% of a room having enough light is sufficient.

The first objective will be to determine, by research, what amount of light is sufficient for general needs without requiring artificial light and also to review the research and methods of calculation used by Waldram others with particular emphasis on the scientific approach of using average sky values and the effects of variables such as internal and external reflectance. The intension is to compare the Waldram method with other forms of measurement, including those methods contained in guidance issued by the Building Research Establishment (BRE) and assess whether any of the available methods provides a sufficiently accurate method of measurement or whether we should consider any alternative method of measurement including the use of the "no sky" line.

6. RESEARCH METHODOLOGIES

Waldram recognised that the human eye is remarkably adaptable and, for this reason, it would not be appropriate to replicate the original research unless the variables can be identified and measured. What the eye can tolerate for a short period of time may not be acceptable over the longer period and it is probable that existing research by ophthalmologists and by lighting engineers will prove to be sources of information. The law in respect of rights to light, disregards special purposes and so the stated standards of light requirements for use with computer screens for example, will be ignored however there is a need therefore to establish what constitutes general needs. Levels established historically have to be reviewed in context and what was acceptable or necessary in the late Nineteenth and early Twentieth centuries may no longer be relevant.

The first step will be therefore to compare previous research by CIBSE, IEA, HSE and Ophthalmologists to ascertain whether there is common ground amongst these and any other relevant disciplines upon how much day light is in fact sufficient for general needs, without resorting to artificial light. Once the required level or levels have been established, the study will compare the various existing methodologies to assess whether the results are significantly different and, by using current technologies and databases, how this amount of light may be received from the sky dome and thus how measurement may be undertaken. An artificial skydomes will be used to directly compare the effect of uniform and non uniform skies.

7. CONCLUSIONS

A considerable amount of research has been undertaken into daylighting generally but very little into the application in respect of rights to light. This paper has provided the background to some of the issues and concerns about the current methods of calculating light in right to light cases. This research project, currently undertaken as part of a Professional Doctorate at APU, seeks to establish whether the present methods of calculation are valid and reliable and whether the level of lighting needed will be different from that which has previously been accepted. It is the intension to demonstrate that other more stringent methods of measurement should be considered.

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