ILLUMINATION LEVELS IN THE UNITED KINGDOM

R. A. Weale, Ph.D., Sc.D.

Dr. Weale: Mr. Chairman, let me say how pleased I am to be with you on this occasion. Some interesting problems have already come up and I should, of course, be very pleased to hear what other problems come up, even if the price that I have to pay is that I have to do some talking, too. And I realize that this symposium is supposed to be dealing with low levels of illumination; but, for the life of me, I do not know what you mean by "low." When I came in here this morning, I thought that this is intense illumination. I do not suppose that my physiology differs from that of anyone else who is present; it just depends on what you are used to. Then I noticed with horror that half the lights are cut off.

Well, I do not know whether measurement is the answer to everything, as I have just tried to indicate, because you get conditioned even to hell. Light, I think it is pretty obvious to remember, can be used for a number of purposes; survival, work, pleasure—all these have been mentioned; and, do not forget, it is also a commodity to be sold. And this is a problem which I think may affect the three other, what you all might almost call, physiological aspects of either work or pleasure. Work, of course, has tied in with it the question of prestige. The more important office worker has to be better lit, no matter whether the light is needed or not. And, at home, the Illuminating Engineering Society has just produced a new code—I shall tell you about that in a moment—and the code was produced, should I say, under the cloud of the energy crisis. And one or two economic questions have, of course, been asked. It does not follow that just because I mentioned those particular questions they were asked, but it will give you some idea of what you might call the atmosphere in which these questions were asked.

For example, who is going to benefit if it costs more to produce instruments to cut energy, than the energy you are going to save, especially if it is going to cost more in terms of energy to produce those instruments? And the other questions which arise are whether one ought to go hell for leather for outdoor lighting to be imitated indoors. Is daylight lighting a sine qua non, does it have to be produced under all conditions, does it have to be aimed for, is it the sort of thing that is a prize dangled by the gods in front of our eyes?

And the code which is now recommended is not based exclusively on the measurements obtained by either Dr. Blackwell or the late H. C. Weston or anyone else. It partly includes, very largely includes, results of answers obtained to a questionnaire; and, therefore, is based, in part, on user levels. The values which are recommended are certainly not, I repeat, not, minimum values; they are values which are in use in most cases. One asks oneself, of course, whether efficiency is more important than happiness; and, in a problem of this sort, one has to ask oneself whether one should rely entirely on the user. We are all familiar with the driver who feels never happier than if he has had some alcohol. It does not follow that his own response, his own subjective response, is necessarily the best from the point of view of society at large. But we must not forget that, with the exception of—I think I am right in saying—miner's nystagmus, there has been no demonstrable adverse ocular effect due to low illumination. But let me repeat, the sort of situation needed to produce a pathological condition involves illumination levels which are much lower than those you are likely to contemplate in what one can only refer to as reduced circumstances.

We are conscious that reports are coming

out that too much light may constitute a health hazard. Experiments have been done—and I am referring only to experiments done on vertebrate eyes—rats, pigeons and other species, chickens, I believe—which show conclusively that what we refer to as normal levels can be harmful. There is no doubt that this unrestricted introduction of daylight everywhere is hampering our enjoyment of, for example, art galleries, where it can be shown that it is quite wrong; but the trouble is that galleries are lit by lighting engineers and not by curators who ought to know better. And, if one takes this aesthetic problem and sets it aside—suffice it that I mention it—we have to ask ourselves to what extent biological mechanisms remember, that is, to what extent any harm that can be obtained, that can be experienced under intense conditions, may perhaps be subject to the reciprocity rule.

Well, these are the sort of questions which we have been asking ourselves; and now, to cut the cackle, let me produce some comparisons between the figures given in this document and the one which I have just mentioned as having been published in 1973. Almost without exception, you will find that the levels recommended in the U.K. are lower than those recommended in this country. And, before I specify this, I am reminded of an interesting comparison which we made some little time ago, for example, between the values recommended in Soviet Russia, in the United Kingdom and the United States. And we find that there is some correlation between the light recommended and the wealth of the country, if I may put it that way. And those of you who have traveled in the poorer parts of the European continent, perhaps in the Balkans, perhaps in some parts of Italy, will know what I mean; light is in some ways what you can afford. What that has to do with physiology, I really cannot see; but this may be due to the fact that I am used to less light.

Now, I have not worked out all the comparisons, partly because ours are given in lux and yours in good old British footcandles, but, by way of comparison, let me pick on a handful of them. For example, in airplane repair service areas, you ask for 100 footcandles and we think that 45 are sufficient. Art galleries: on statues, you would recommend 100 footcandles whereas we think that 28 are ample. In assemblies: rough, easy seeing, 50 as compared with 29; medium seeing problems, 100 in the U.S. as compared with 46. For fine work, you recommend 500 as compared with our 93; and, for extra fine, you recommend 1000 as compared with our 140. Book binding, folding, assembling, pasting, and so on: your 70 against our 46. Cutting, punching, and stitching: just to show that I can be fair, 70 against 70.

I have marked one or two where I am afraid you are being absolutely mean with light. In the printing industries, the font assembly, sorting, you recommend 50 as compared with our 70. And, ladies and gentlemen, in hospital toilets, you recommend 10 as compared to our 14.

Library reading rooms: for the study of notes, 70 as compared with our 46; stacks, 30 in the U.S. as compared to our 14. Now, when it comes to book repair and binding we are neck and neck, 40 versus 46; cataloging 70 versus 46; check-in and check-out desks, 70 versus 46. Machine shops: rough bench and machine work, 50 to 28; fine bench and machine work, fine automatic machines and so on, 500 as against 93.

There are some which we find unmentionable. You recommend 1,000 for a dental chair and we just mark it SL, special lighting. In obstetric work, on the delivery table, you recommend 2,500, we recommend SL. And this applies to a number of cases where your recommendations are in four figures and brings me to the point which I really should have made earlier on. I discussed these and kindred problems with Dr. Hopkinson, who very much regrets that he cannot be here, but since we see eye to eye, I can, in a way, speak for him, and he thinks that this sort of comparison, if it is valid, points to what I think Dr. Riegel referred to as task-operated lighting. Dr. Hopkinson reminded me that he has reminded you and your colleagues that the increase in light has gone far enough and that it might, perhaps, be conveniently reversed, but this should not be at the expense of seeing. It is, as you might guess, at the expense of not seeing, of illuminating areas where nobody does any seeing and that, perhaps, local illumination on the task has a lot to recommend it. Thank you.

DISCUSSION

Mr. Nelson: Are the recommended illumination levels of your society those of a consensus group and on what basis were they formulated?

Dr. Weale: Yes, they represent a consensus group and were based partly on measurement and partly on a questionnaire. Obviously it was a complicated thing, the sort of exercise which you have been recommending, even at the best of times. The subject satisfaction is obviously something that ought to be considered. I am reminded of a symposium which was held in Heidelberg nine years ago on the employment of older workers where one of the speakers pointed out that—I believe in the post, that is right, postal workers had been dissatisfied with the light that was used, and, when these were raised to fifty footcandles, everybody was happy.

Mr. Lee (NIOSH): Dr. Weale, you made the statement that you knew of no adverse affects that have been associated with low levels of illumination. Were you referring solely to pathological findings, or do you include in your definition of "adverse effects" subjective symptomatology, such as, headache and eyestrain?

Dr. Weale: I intended to say pathological effects, permanent damage, and so on. If I did not, I am awfully sorry. Things that you can detect, organic changes.

Mr. Lee: The reason, I bring it up is that this group should confront the issue of what is an "acceptable" physiological effect. We are confronting it all the time in the setting of other occupational health standards. In the setting of such standards, we consider not only pathological, nonreversible effects, but subjective and reversible symptomatology as well. Should we not have an illumination standard which prevents eyestrain and headache?

Dr. Weale: Well, it is not up to me to make this decision. Let me remind you that we suffer stress when we drive and the stress passes; it does not stop us from driving. It seems to me that limited reversible changes have to be accepted in modern life. One would not be responsible for damaging a body permanently, even temporarily, but it seems to me that a little bit of headache will happen to you if you get caught in a traffic jam. Are you going to stop driving? You are going to stop driving if it is going to harm you permanently.

Chairman Heins: Dr. Weale, do you believe people in your country who work under the levels which you just described suffer from eye fatigue, headaches and other symptoms of "eyestrain", as a rule, from working under these levels?

Dr. Weale: I am astonished, Mr. Chairman, that these levels are referred to or implied as being low. No, there is no report of anyone, as far as I know—I mean I have not spoken to fifty million people. There is no complaint anywhere. Much more than this country, we are trade-union ridden; and, it seems to me that if there were any complaint, if any money were to be gotten from working under low-level illuminating conditions we would know about it.

Mr. Caplan (NIOSH): Dr. Weale, you alluded to the fact that in the Soviet Union, or perhaps in the eastern European countries, they had a different set of standards on the average. In the field of toxicology, or particularly the field of industrial toxicology, the levels which are considered to be hazardous or causing certain effects are usually lower in the eastern European countries than they are in western Europe or the United States. And I wonder, in the field of illumination, do they have the same general philosophy, that any behavioral changes are considered to be toxic, at least in the industrial environment? You did not mention what the levels were in general in the Soviet Union. Are they lower, or higher or what?

Dr. Weale: They are lower; but I am afraid I cannot accept the premise made by the last speaker. To give one example, the safety levels for microwave radiation are much lower in the Soviet Union than, for example, they are in this country, and we are not prepared to accept that, just because it is the Soviet Union, it follows that they are less concerned about the safety of their people.

Mr. Caplan: I meant they are more conservative. Their standards of allowable exposure to carbon monoxide, for example, or acetone, are lower, more restricted than those we use in the United States.

Dr. Weale: In lighting, it is the other way around. They think that people can manage with less light than the U.K. or the U.S.A.

believe necessary, at any rate, in some respects.

Dr. Blackwell: Dr. Weale has made the point that it seems as if the amount of light used depends upon the economy. I think we can bring out, when we finally get to it this afternoon, that light is a variable which has a return. One can relate the two—lord knows it is not linear. If you have the right kind of specification of light in terms of CIE units, equivalent luminants or illuminations, raw ones, then there is a progressive increase. It is not linear, lord knows, far from it. Now, if that is true, that if you specify light in the right terms, the more of it you have the better you can perform the visual systems, then is it not perfectly reasonable that rich countries would go higher, figuratively, than poor ones? That does not necessarily mean it is some kind of ridiculousness. It is indeed an interesting statement that this country can afford lower—has been able to afford, in the past, to afford cooler temperatures for air conditioning, let us say, more light, et cetera. This does not mean it is folly. It just means that this is, indeed, a continuous variable with no cutoffs, which it is. If one knows the tradeoff relationship, then one can make a decision. We can afford more light. That day may be past; and, if past, then let us see what the tradeoff curve looks like. We can see what happens if we start moving back down. I do not find that that proves it is a folly. It seems to me that is a reasonable thing in the variable which gives a continuous reward going up monotonically, but slowly, in my opinion.

Dr. Weale: I do not think anyone said that it was folly. I just pointed it out as a fact.

Dr. Halldane: I think I can respond to some other questions I have here in terms of other physiological responses. There was some work done on hyperbilirubinemia, particularly in infants in hospitals, that light was necessary for the development of the blood. The development of bilirubin within the blood is dependent on irradiation of the body. Now, this is a very specific case of infants, and perhaps to hospitals. Years ago the mother was informed to get the baby outside as much as possible and it would develop healthy. Now, I think that this is an important thing, that light is important for that physiological process. So that is one response that you could identify with your concern.

The other is the ultraviolet component and the control of bacteria, in that there are some responses here, mainly control of bacteria. A certain amount is necessary certainly not for visual reasons; but I would like to hear others for that.

Now, in terms of Dr. Weale's comments, I originally come from New Zealand and I have been two and a half years in Australia. Of course, when I was designing, I was going by the Australian Standard, which is a compromise between the British and the American. The Australian Standard was influenced by the increases in American illumination over time, but not completely. It has been gradually rising. We must remember that lighting has increased by the advent of certain technologies. First of all, we had the gas light, then incandescent, and then, the real crucial point was the development of fluorescent lighting where you get twice the light output for the equivalent number of watts. So there is your technological and economic development, which were the crucial points in the changes. Now, we are not going to have that advantage from the intense energy sources, like the sodium vapors, inside buildings, because, you have to diffuse it over a wider area. You are not going to get those developed within buildings. But, the more intense sources will become a more economical means for exterior lighting. So it is very clear that we will have to differentiate in terms of technology of exterior, large-distance types of illumination sources where you can develop the economy in terms of your light sources; but you are not going to develop much more efficient types of luminaires material-wise.

What we can concentrate on is a better distribution of luminaires for the interior situation and developing light for specific behavioral responses, such as, specific tasks and specific responses which I hope to identify more this afternoon. I hope this will support your contention. There certainly have not been complaints over time in terms of people unable to work and that lighting levels have increased because of poorer performance. This has never been the argument in terms of the increase in lighting levels, because people worked satisfactorily in gas light. Indeed, I have developed standards for mine lighting in this country and you are dealing with a pretty black environment there. And, for this reason, I developed a

standard based on luminance and not illumination, which I will go into later on and the assumptions behind us and where we should be going in the type of specification in the future. But it will support the comments of Dr. Weale that other countries have gone through this and supports his arguments and questionnaires. The development of lighting has not been in terms of any degradation in performance.

Dr. Mead (IERI): I am reminded of a little anecdote that we are probably all familiar with in the classical Hawthorne experiments where the relay room girls were subjected to changes in illumination. Sometimes the illumination went up, sometimes, down; unbeknownst to them. They merely saw people manipulate the bulbs and, in some instances, a special case, the illumination went down to the level of moonlight with no reduction in the assembly of relays and no complaints on the part of the workers.

Dr. Ross (Ross & Baruzzini Contract): Just one further distinction on Dr. Weale's comments about the disparity between the United States and British standards. British standards, as I understand it, are average, neither maximum nor minimum, but good common practice; whereas the United States' standards are minimum standards.

Mr. Crouch: I wish to correct that. The recommendations are called "minimum on the task at any time." And this has been interpreted as being minimum levels. It merely means a maintenance of the level on the details of the task for visual purposes at all times with maintenance factors included. So it was not intended—that statement was not—in fact, if you will look you will find "current good practice" is the heading. And then the level is specified where you measure it at minimum on the task at any time, which allows for maintenance factors, that is all. It was not intended that you should go much higher—the light-for-heat advocates began to use this very expression to indicate that IES was recommending minimums; and, therefore, it was better to go much higher. In the Chicago area, they added one hundred to one hundred fifty footcandles and this heated the entire building without the use of any other energy. Now, the IES protested any visual basis for this (even though it might be economically feasible and even critical fuel wise) and issued a public statement—a published statement—saying that the recommendations of the Illuminating Engineering Society were based on currently known psychophysical data and relationships. It was the best available information at the time, and it was not to be construed that much higher levels would be much better. We did not know. We did not have the facts.

Dr. Riegel: I just wanted to ask Mr. Crouch if he concurs with the view that these levels, although they were not specified as minimum levels, have become so in practice.

Mr. Crouch: Yes and no. While IES issued a public statement and published it in its journal and advocated that all its members follow these recommendations, in every community there is a range of values used by engineers and architects, some of whom go below the standards and some above the standards, but IES has adhered to its recommendations.

Dr. Halldane: The Australian Standard states it is the minimum service value of illumination which gets around the problem of maintenance. We have to get some international terminology and update the IES handbook.

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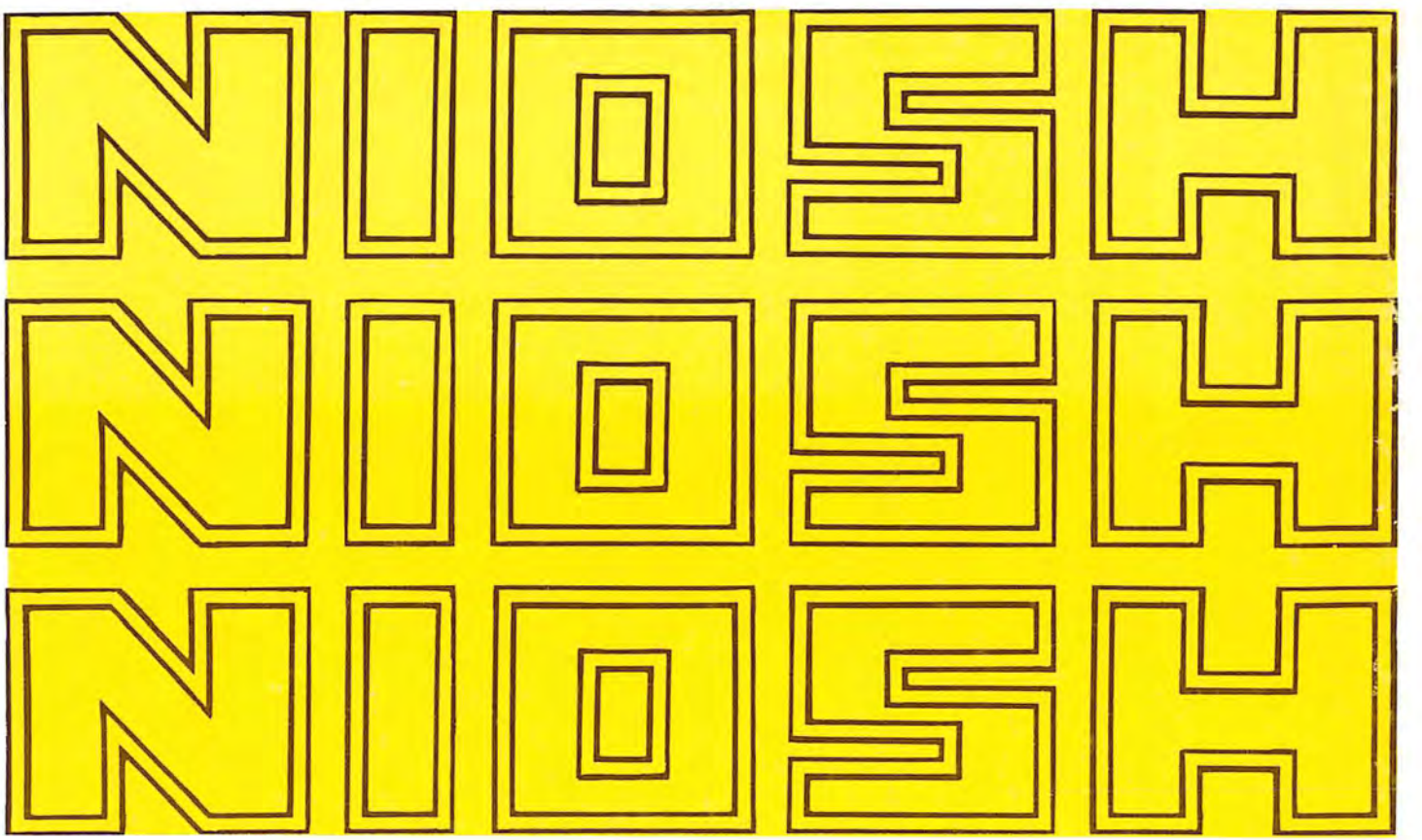

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