

THE GENERAL SERVICES ADMINISTRATION'S APPROACH TO ENERGY CONSERVATION IN LIGHTING

Harold Nelson

Mr. Nelson: The General Services Administration, as the basic building construction and operating agency of the Federal Government, has both extensive experience and a wide range of responsibilities. It has always tried to balance employee comfort and efficiency with the judicial expenditure of Federal funds. While meeting the safety and health needs has always been an important part of the GSA objectives, GSA has recently emphasized and amplified its commitment to safety in new policy statements and statements and actions of its top officials. We also are just as firmly committed to a policy of not only positive action in conserving energy but also to a position of conserving the Nation's energy resources. Our actions have already demonstrated that sizeable energy conservation is achievable. We are determined to be successful in making additional significant reductions in energy utilization in Federal buildings. We recognize that what we do may well become models for others. We are convinced that energy conservation is necessary, practical, and compatible with the overall objectives of GSA and of the Nation, including safety and health. Such a totally balanced goal is possible only if reasonable men work together and determine or develop the valid data in useable form that will permit sound judgments based on the best facts and measurements possible. Any case, where hard questions have been sidestepped by conservation overdesign at the cost of energy, must be attacked. In the forthcoming arena of competition for limited energy, energy using needs, such as illumination, are going to be pressed to justify their case. It is important that meetings such as this take the problem head on. Since the relationship of illumination to energy is quite direct while the connection between safety and health and illumination is difficult

to specifically quantify, safety will be the loser unless these needs can be well defined and supported.

BACKGROUND

In the 1930's, lighting in Federal Buildings was provided by incandescent lamps in the 15 footcandles range. Additional task lighting needs were provided by exterior lighting through windows and desk lamps. In the 1940's, the fluorescent lamp was introduced and lighting levels were increased to about the 30 footcandles range. As late as 1967, GSA design standards called for 35 footcandles for general office lighting and 50 footcandles for prolonged close work and difficult seeing tasks.

In the early 1960's, the modular design concept was adopted where entire floors of buildings were designed to have the same lighting level (50 footcandles). This uniformity provided maximum furniture placement flexibility without regard to ceiling fixtures. While our standards provided for 2 levels of light, most designers provided fixtures in all space capable of lighting to the higher, rather than the lower level.

In 1967, GSA adopted higher levels for general office and difficult seeing tasks when it raised levels to 75 footcandles. A level of 30 footcandles was specified for ordinary and intermittent seeing tasks. In effect, this raised all lighting levels in new buildings to 75 footcandles as lighting was designed for maximum tenant flexibility. Thus, people became accustomed to working in the higher intensity lighting levels. In an effort to simplify instructions to Contract Architects and Engineers, GSA published a condensed handbook for design of new buildings. The handbook accepted

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the Illuminating Engineering Society standards as a basis for design in December 1972. In January 1973, Integrated Ceiling Standards were issued by GSA for modular design at 60 footcandles for general office lighting on the task.

While our new construction design standard prior to the energy crisis was 75 footcandles, our guidelines for existing building remodeling allows for 50 footcandles of lighting. It is interesting to note that although we have numerous buildings where the predominant lighting level was in the 50 footcandles range prior to the energy crisis, we have no record of visual problems at these locations. It is understandable that employees accustomed to brightly lighted offices will psychologically react to the lower lighting levels and question the wisdom of the GSA's action.

In May 1972, GSA cosponsored with the National Bureau of Standards an Energy Roundtable of outstanding designers, and executive and Government officials with responsibilities in all phases of building construction, design and management. On Standard Levels of Illumination the report stated:

The lighting standards used in new buildings should be carefully reviewed. In many cases, we may be lighting work areas at levels five or six times what is actually necessary. Reductions can be made without jeopardizing hygienically and psychologically adequate illumination levels, while realizing considerable savings. By halving an illumination level, the energy requirement is cut by significantly more than 50 percent. For example, when artificial illumination is reduced from 150 to 50 footcandles, the energy required drops by over 90 percent.

In recognition of the roundtable evaluation, GSA initiated a comprehensive lighting study by the engineering firm of Ross and Baruzzini in January of 1973. In the view of the critical energy situation and the need for the Federal Government to take a leading role in the conservation program, the General Services Administration, in coordination with the Federal Energy Administration, established regulations for lighting intensities in Government-owned and -leased buildings which were published in the Federal Management Circular, FMC 74-1, January 21, 1974, addressed to the Heads of Executive Departments and Establishments. The regulations provide for lighting intensities

of 50 footcandles at work stations, 30 footcandles in work areas, and 10 footcandles in nonworking areas during working hours. A safety minimum of 1 footcandle was set for the inevitable shadowed areas in corridors and walk ways.

These regulations were based upon performance engineering considerations and were used in space utilized for general office type activities. Provisions for exceptions to the standards for higher levels of lighting for specialized tasks are included in the Circular. These regulations reflect the recommendations of the engineering study.

Some of our occupants, through representatives of their employee organizations, have expressed concern that these levels of lighting may cause eye fatigue, eye damage, headaches, etc. Most, if not all of these fears, are based on the reduction from the higher lighting levels recommended by the Illuminating Engineering Society (IES), and have been followed for a number of years by both private and Government agencies. The IES recommended levels were based on a 99 percent accuracy of performance developed during periods of energy abundance. We believe, however, that during the current situation, we must be able to distinguish between that which is desirable and that which is required.

FUTURE

The future designer will no longer be able to design on the basis of total space lighting at levels sufficient for the most difficult tasks and for most poorly sighted workers. He is going to have to execute an energy conserving system with the minimum of energy expended on nonwork areas, and the specifically needed illumination at the actual work place. He is going to be subjected to simultaneous demands for sufficiency and conservation. To do his job, he is going to need more and better data on the effect of illumination and other vision affecting factors on the total man.

CONCLUSIONS

In order to move forward with conservation in consort with safety and health, and, with measured regard for comfort and efficiency, it is urgently requested that this meeting either

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develop or start in motion the action that will lead to the development of all the parameters governing the impact of illumination on safety and health. We not only need to know the parameters, but also the degree or extent of impact resulting from various graduated changes in the related variables. We must go beyond standardized go/no-go criteria and progress to evaluate the impact. We doubt that we have recognized specific needs that demand attention now. These include the physiological effects of low levels of illumination at the work place; the levels of illumination required by both normal and impaired vision persons to see physical hazards in the work areas or passages; and, the impact of surroundings, color, or contrast on health or safety. We also need to know how to specify, if other than footcandles, in a manner compatible for convenient measurement. We need

to know the adequacy of measurement equipment as it relates to the physical characteristics of the eyes. If current data is not adequate, we need to have identified areas of further research.

Note: The following material was provided to each participant by FEA and GSA:

1. Lighting Systems Study, Ross and Baruzzini, March 1974.
2. Federal Management Circular 74-1: Federal Energy Conservation and supplement.
3. Energy Roundtable Report on Energy Conservation in Public Buildings.
4. Memorandum dated March 29, 1974, from the Assistant Commissioner for Buildings Management, General Services Administration to all Regional Commissioners, PBS on Safety and Energy Conservation.

DISCUSSION

Dr. Halldane: I would like to respond to one thing you brought up very quickly—the problem of instrumentation. Later on, I will bring out the business that the light meter is not the only instrument we have to deal with; and that, fundamentally, most of the visual responses will be responding to such things as measurements with a telephotometer, which is a much more expensive instrument and relates more to the visual response than does the illuminance measured by an incident photometer that we are going to deal with. And we have also got to come to grips with calibration, which tends in some cases to be more expensive than just buying the instrument itself, particularly when you get to telephotometers and other standard sources. Your point is very valid. You will have to consider the economics of instrumentation, of monitoring whatever comes up, and I would like to address this later on this afternoon.

Mr. Nelson: I have found in my work that there are three levels of sophistication, and most of you are in top-level sophistication. I find, in fire phenomenology, and I believe it is the same here, that the Ph.D., and I suppose the M.D. level, work in complex functions, or, in the doctor's relationship, in long words which carry large meanings and are very erudite and specific and can, shall we say,

make flat lines engineeringwise out of some very wriggled curves. But the next move down is the engineer, the B.S. graduate. The most complex function he normally handles is a Reynolds number, because he spent half of his hydraulic engineering course in learning what a Reynolds number is. He is much more tuned to physical phenomena which he can measure with an instrument or a device—mass, speed, weight, heat, illumination. The final level is the technician. He is not incompetent, but he does not know $F = MA$, he does not know $E = IR$. He knows that this instrument and this table go together and he knows that you had better wire black to black, which the Ph.D. may not, or you will blow the damn thing.

Dr. Halldane: I think we have to accept that if you are going to use a light meter, to be of any significance, it has to be photopically corrected and cosine-corrected, too.

Mr. Nelson: All I am trying to say is I would like to have a direct train between the three levels. And one of our problems is that sometimes we do it sophisticatedly at the research level and we do not try to connect it to the man at the bottom. He is going to make measurements somehow.

Mr. Talty (NIOSH): You mentioned something in your circular about heat-of-light technology.

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Is that synonymous with the energy budget approach?

Mr. Nelson: In a way, it is probably multi-purpose and vague because its answer is vague. Basically, it is the fact that we are getting quite a number of buildings in which there is no heating equipment, and in which we are depending upon the overheat from the ballasts to maintain the winter temperatures. And some of these buildings, of course, in freezing weather, you have to keep the lights on or you have to do something else. Sometimes reheat coils are used. We get all sorts of things. This, again, was a typical sort of thing for a builder to build when the leaseholder was going to pay the electric bill.

Mr. Talty: That leads me to another question. Dr. Riegel, from the FEA mentioned that the energy budget approach had been considered and dropped because there were too many unknowns. I am wondering, if that is an adequate basis for dropping it?

Mr. Nelson: Well, the GSA is doing a kind of energy budgeting and I am going to digress now into total energy. We in the federal government can serve as a model. Also, because we are code-exempt, uninsured and responsible, we can do certain types of modeling for the rest of the world to look at. The Manchester, New Hampshire Building, which is just now going under contract for the GSA, is specifically an energy-budgeted building balance. We have also started including energy direction in our contracts with architects and engineers. We have always given them a space requirement, a real property requirement and a financial budget, plus all the other safety mandates and the other things; but basically those three budgets. We are now giving them an energy budget. I do not know exactly how it is expressed, BTU per square foot, or something like that. We are giving him an energy budget and, frankly, challenging him against the energy budget for his design. This is another model to try. If it works, and it seems to be working in some areas, fine. The question is: What does he sell short to do it?

Mr. Caplan (NIOSH): Is that a variable energy budget?

Mr. Nelson: Oh, obviously it has to be. It has to be related against degree days on both sides of the picture and the designer has to have some sort of balance. I am not completely familiar, but the energy budget, I believe, is

established for the architect in a negotiation consultation with considerations of the atmospheric conditions. It will probably be subject to change, because we all know that any weather bureau map shows you geographic norms and can leave you way out for some particular snow belt, wind path or something like that. All you have to do is go up to the Federal Building in Cleveland to see a building in a wind tunnel. This can happen.

Dr. Blackwell: To show that there is communication possible between the different sides of the table, let me say that I, as a vision researcher, feel that we have the know-how to assist you very much in setting criteria in energy terms for different kinds of human performance. I feel, also, that the work we have done, as spun off in the CIE report, makes it possible to evaluate the extent to which different environments, physically produced in different ways, provide levels of visual benefit which can be used as criteria. In short, I believe the basis exists for a reasonable technology now. There is no reason to wait. And I think if we can get on to a discussion of some of these things, this can begin to become apparent. I, myself, do not fight at all the idea of an energy budget. I think it would be very interesting to relate it to human activity. Then, let us see what engineering can do to provide this most efficiently. I do not agree with the notion that, because different light sources are different in efficiency, one should go away from that. All the more reason, if someone can produce a good visual environment with a sufficient light source, why not reward him for it? That is the American way. So let us get visual criteria, and not forget those the rest of today and tomorrow.

Dr. Riegel: I think I agree with everything Mr. Nelson said. I think it is possible we were talking about two slightly different situations. The problem facing the FEA, and the one that I was talking about a few minutes ago, was one of doing something last winter to achieve energy savings in lighting. It was our feeling at that time that it was not a good approach to think of going into existing buildings to use the energy budget approach. I feel that it is a very fruitful area to continue to explore, especially for new buildings.

Dr. Yonemura: I think we should distinguish between energy and power budget. Mr. Nelson used BTU per square feet, and this is a power

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budget. This is the power required. He also used total energy. I think we should agree, because Dr. Blackwell made the comment about how he can help in the energy budget. I think he meant power budget, because energy very strongly brings in individual behavior, for example, how often he turns the light off and on. This would be the total energy used in a year, rather than the power required, and we should very clearly keep the distinction in mind.

Dr. Halldane: There is a lot of confusion, particularly with the FEA, if you are talking about barrels per day, watts per this and joules per that; and I think everybody here is somewhat confused because most of you have not come through the physical sciences. I have a physical science background, and I am a little more sensitive to this. Now, I think our savior in the future will be through metrication, because this will force us to consider everything in uni-

form quantities and units. And, when we talk about energy, everything should be talked about and converted into joules. Let us have no mistake about it, it should be, and, then, we will be able to start to communicate with our overseas friends as well as ourselves. I think this is a very significant point. The distinction between power and energy is that power is energy per unit time. Now we know what we are talking about. That has a separate unit, the watt, and it is universal. And the most convenient thing in terms of the watt is of course in electricity. We have various energy and power measures to convert to joules and watts respectively.

I hope to reiterate on this a little more this afternoon; but, as was said in the discussion before, there is a lot of confusion that is developing at this stage. Let us preserve a unification of units and measures and consolidate this as part of our program today.

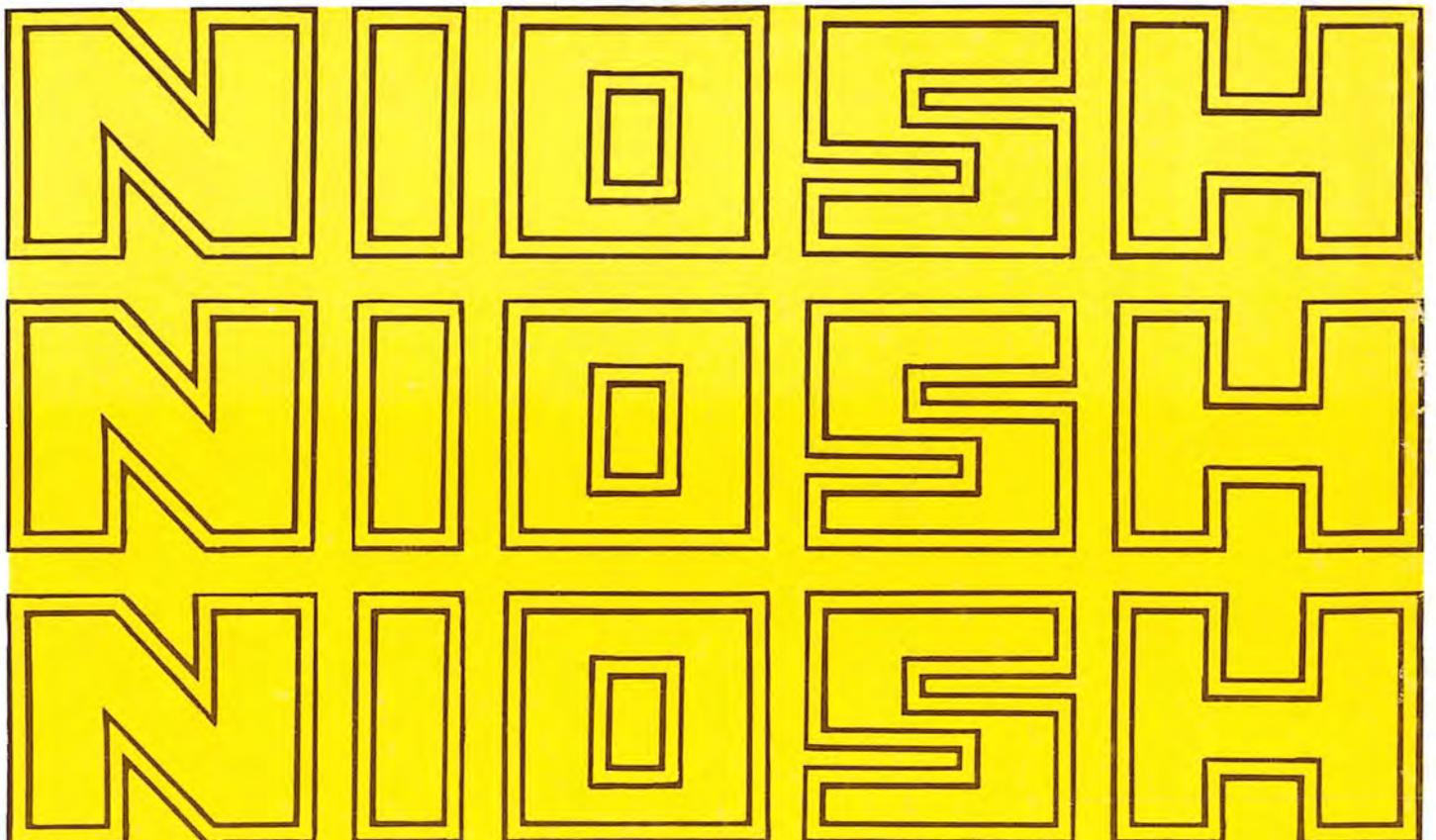
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