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ABSTRACT

Despite popular myth, it is almost always economical to switch fluorescent lights off when they are not needed. Some of the practical results of a larger study on lighting economics are summarized here.

RÉSUMÉ

Contrairement à l'opinion populaire, il en coûte presque toujours moins cher d'éteindre les lumières fluorescentes quand on ne s'en sert pas. Ce document expose quelques-uns des résultats pratiques d'une étude approfondie sur l'économie de l'éclairage.

SWITCH THE LIGHTS OFF!

M.S. REA

Background

The lighting program at National Research Council of Canada started in the late 70s when energy savings were being employed. Energy management rather than energy savings alone quickly became the key objective for our laboratory, reflecting the view that all costs, not simply energy costs, were important. We began to concentrate on what we termed "wasted lighting energy," that is, electrical energy consumed by the lights when no one was in a space. Among other objectives, we began to look at techniques for coordinating light operation and occupancy. Most of these saved energy; some were too expensive, however, to be practical. Other, less expensive methods of saving energy were considered but they almost always entailed increased frequency of switching lamps 'on' and 'off.' Our concern with costs naturally led us to consider the economics of switching.

We discovered very quickly that there are myths about switching for both incandescent and fluorescent lamps. The popular press tended to argue for leaving lights 'on' to avoid a "surge of electricity" when switching. When we conducted a survey of approximately 50 office workers in the Toronto area, only 40 percent believed that turning lights 'off' for 15 minutes would conserve energy.[1] A study commissioned by the US Navy six years ago showed that this "surge" was insignificant.[2] Strictly from an energy saving point of view, the lights would have to be switched 'off' for only 0.04 seconds to save the added energy created by the surge. Despite evidence to the contrary, then, many people believe energy is wasted by switching.

More sophisticated individuals accept the view that energy can be saved by frequent switching but still argue for *not* switching fluorescent lamps because more frequent switching reduces lamp life. Although this is true, lamp life is not the real issue in determining whether it is a good idea to switch or not. Rather, it is important to determine whether the costs associated with reduced lamp life are offset by savings in operational costs and, importantly, by delaying the costs associated with relamping. This point is not well understood by most people and is the subject of this summary.

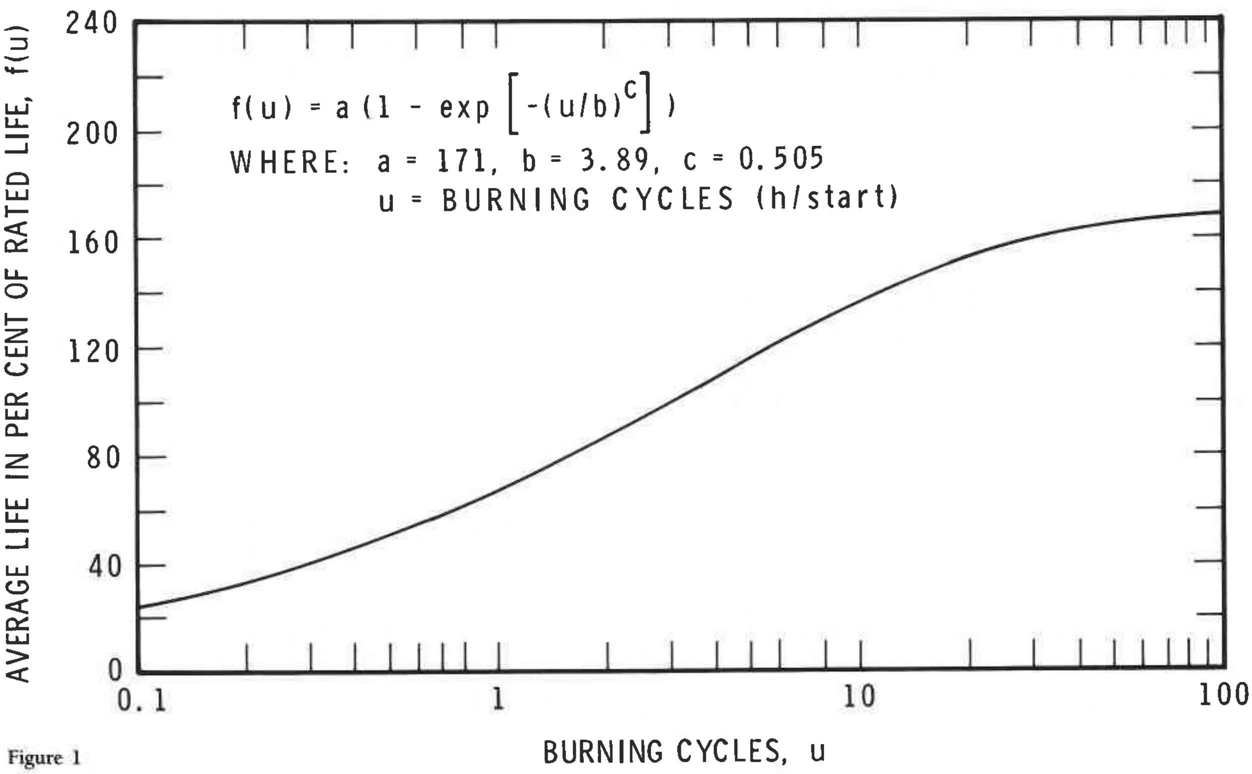

Figure 1

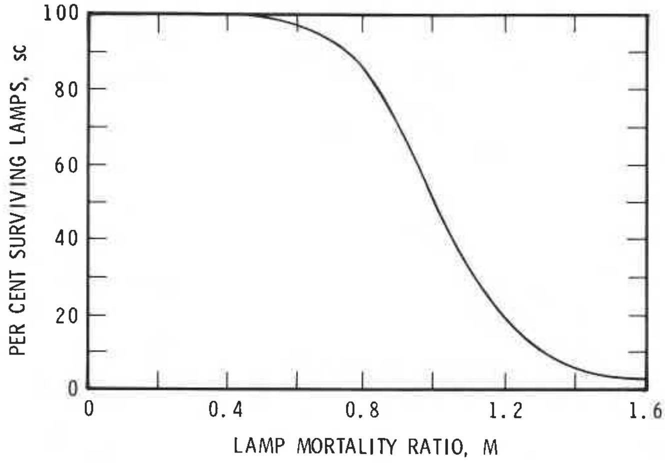

Figure 2

Factors important to switching economics

A larger, more detailed report[3] documents the factors important to the economics of switching and dimming fluorescent lamps. The findings are summarized here, but the actual equations and assumptions as well as a sensitivity analysis and a determination of break-even periods are presented in the original report.

Briefly, the costs important to the economics of switching fluorescent lamps are electricity rates and lamp and ballast replacement costs. The important parameters are the hours of light usage, the number of switching operations, the average burning cycle [1], and the mortality criterion [2] used for relamping (*i.e.*, the statistical basis for relamping).

The equations developed for the report were used to evaluate two cases; one was biased in favor of switching and the other against switching. Case I, which was favorable for switching, assumed high electricity rates, high ballast prices, and low lamp prices. Case II assumed low electricity rates, low ballast prices, and high lamp prices. Five realistic switching scenarios ranging from continuous operation to switching ten times a day (whenever one leaves the space) were evaluated. In both cases, and for all switching scenarios examined, it was economical to switch (or dim) fluorescent lamps. Although these examples probably span the range of realistic conditions encountered in most commercial settings, the equations are general enough to be applied to any situation.

Some interesting points emerged from these cost analyses:

First, we know very little about the aperiodic switching of fluorescent lamps likely to be encountered in a realistic environment. All manufacturers' lamp mortality tests are based upon n hours 'on' (usually $n = 3$ hours) and 20 minutes 'off' cycling schedules. In [1] we can see how the rated lamp life changes with different periodic burning cycles. But since switch operations are not independent, it may not be possible to use such data to describe realistic switching conditions accurately. Nevertheless, these are the only data currently available.

Second, ballast costs are normally ignored in economic evaluations of switching, but they *are* important. Although ballast life is not affected by switching, ballast operation and replacement costs can be more important than lamp costs.

Third, whether a building owner/operator uses spot relamping or group relamping is not as important as has been supposed. Costs associated with relamping do *not* depend solely upon the total costs of relamping but rather upon the ratio of the relamping costs to the mortality criterion [2] chosen for relamping. With spot relamping, the criterion is usually extended to the point at which the lamp burns out, but the criterion for group relamping must be more frequent. The real cost of the less expensive group relamping schedule divided by a smaller mortality criterion may be very close to that for the more expensive spot relamping procedure divided by the longer mortality criterion.

Fourth, relamping schedules, spot or group, can be delayed for a longer period of time than is usually believed. Conventional wisdom puts relamping at about three years. The shortest lamp life is associated with continuously burning lamps, but these are expected to last almost the three years. With switching lights 'off' during unneeded periods, relamping may be delayed for as long as eight years.

Fifth, and perhaps most important, it is very difficult to make frequent switching under realistic conditions uneconomical. Of course some unrealistic scenarios might be devised to make switching uneconomical, but under normal conditions switching lights 'off' when they are not needed is always a savings. Strategies to encourage switching should be explored more aggressively by building owners and operators.

Summary

We believe that the original report[3] is the most comprehensive discussion of the economics of switching fluorescent lamps that has been published to date. The computational procedure that we developed can be used in a variety of ways, from the economic assessment of various lighting designs or retrofits to the evaluation of maintenance and relamping schemes and are general enough to incorporate more accurate data on existing lamps or new ones as they are developed. We will use these equations to extend our efforts to evaluate the economics of lighting and to coordinate light operation and occupancy.

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