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OBSERVATIONS ON INFRARED RADIATION AT THE WORKPLACE

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ABSTRACT

A discussion of the use of radiant heating in sedentary workplaces is presented. The advantages of the approach with respect to energy conservation are emphasized along with accompanying effects on worker comfort and performance. The results of a study which investigated infrared heating effectiveness for secretarial workers are briefly presented.

INTRODUCTION

Reducing energy consumption is a major priority due to the dwindling supply of natural energy sources. Great sums of money are currently being spent to investigate alternative energy systems. These include solar, wind-power, geothermal and nuclear in addition to the more conventional sources. Along with the evaluation of various forms of energy production, alternative means of energy utilization are also under study. One area in which large amounts of energy are expended is in ensuring human thermal comfort, i.e. heating and cooling. Whether at home or in the workplace, it is important for people to be comfortable.

Maintaining the comfort standards that people became accustomed to during times of abundant fuel supplies is a challenging problem. A modification of public attitudes along with a complete reevaluation of conventional methods of heating and cooling is required. This process has already begun in various offices and manufacturing plants. A recent federal regulation places certain upper and lower limits on thermostat settings for different seasons of the year. This regulation applies to all public buildings. Although recommended changes in attire can improve thermal comfort, the bulkiness of additional clothing in the winter months can lead to other comfort problems and safety hazards. Also, certain tasks requiring manual dexterity can not be performed if the amount of clothing is increased.

An alternative approach is to modify current methods of heating in both existing and newly designed buildings. A new method which is currently being employed in a very limited number of workplaces is infrared radiant heating. In contrast to conventional forced air methods of heating, radiant heaters are aimed at a relatively small surface area rather than the larger environment surrounding the worker. In terms of energy efficiency, there is a tradeoff between the reduced ambient temperature and the increased radiant heating. Since radiant heating is effective within a certain temperature range, it should be considered as a supplementary rather than a primary heat source.

The use of radiant heating is not an entirely new idea. Its use is widespread, primarily in industrial applications such as food preparation, paint and glue drying, moisture removal and limited personnel heating. One application that has not been thoroughly investigated is that of supplemental heating for sedentary workers.

BACKGROUND

The majority of research on radiant heating has been concerned with subject comfort rather than performance. Rohles (1978) reported on a study which examined the effectiveness of small 200 watt heaters attached to the modesty panels of desks. He found that the subjects had an increased sensation of thermal comfort with the heaters, particularly if they were informed of their presence.

Other studies on radiant heating have been performed to determine the optimum level of radiation and placement of heaters for maximum human comfort. In general, 1 to 1.5 watts per square foot are required to yield a one degree F increase in the comfort level (Boyd, 1962). For example, 65° F with no radiant heating is equivalent to 40° F with 25 to 38 watts per square foot of radiant heating.

One of the major considerations concerning the placement of heaters is a symmetrical arrangement. Since radiant

heating affects primarily the exposed surface area of the body, it is essential that the body be heated uniformly from all sides to prevent uneven heating (McNall and Biddison, 1979), Most arrangements that have been investigated thus far have consisted of overhead placement of the heat sources at a distance of 2 to 2.5 meters and at an angle of 45° with respect to the subject.

Additional studies have been performed on the combined comfort effects of clothing and radiant energy levels. The addition of clothing essentially lowers the overall level of operative temperatures for comfort by an average of 8° F (Gagge, Hardy, and Rapp, 1965). It imposes a dampening effect on sudden changes in skin temperature and magnifies the effect of slight activity or restlessness in providing the additional warmth necessary for thermal equilibrium and comfort.

Studies on the effects of radiant heating on performance have concentrated on temperature extremes (Lockhart and Keiss, 1971). However, even at very low temperatures, radiant heating improves performance on most tasks. Thus, this heating approach appears feasible and promising.

EXPERIMENT

A study was performed to evaluate the effectiveness of radiant heating for secretarial workers in cool environments. Six female subjects proficient in secretarial skills were exposed to various levels of dry-bulb temperature ranging from 45 to 65° F. They were provided with overhead radiant heating panels supplemented by additional radiators for the lower torso and allowed to adjust the level of radiant heating to maintain their comfort. During their exposure, they performed typical clerical tasks (typing, filing, etc.) and filled out comfort questionnaires to determine their satisfaction with the thermal environment. Two measures of performance were obtained, the amount of work accomplished and the number of mistakes committed.

CONCLUSIONS

Analyses were performed on the comfort information from the questionnaires along with the performance date. Four basic conclusions were drawn from the results of the study.

(1) Radiant heating could be used effectively to maintain an individual's comfort at temperatures down to 45° F and possibly lower. The addition of radiation provided a feeling of increased warmth compared with the control condition of 65° F.

(2) The required amount of radiation increased with decreasing ambient temperature.

(3) The quantity of work decreased slightly but the change had no practical significance.

(4) The quality of work did not change.

In summary, the study shows that supplementary radiant heating can be effectively utilized at lower ambient temperatures. This is true in terms of both comfort and performance. To determine economic feasibility, a separate analysis must be performed for each application. Important considerations include the size and arrangement of the work space, the design of the radiant heater, the ambient temperature range and external climate conditions. Additional sites for use include assembly line operations, inspection stations and other places where employees remain in the same general area throughout the work day.

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