“Towards Energy Conservation with High Productivity: Recommendations for Indoor Environmental Requirements in Workplace during the Summer Season”

April 24, 2014

We, at the Thermal Environment Committee of the Society of Heating, Air-Conditioning, and Sanitary Engineers of Japan (SAHSE), have compiled recommendations regarding the indoor environment when cooling offices in summer, the results of which are presented here.

These recommendations state that energy conservation measures should not lead to decreased workplace productivity, which is the original objective of an office. Instead, it should be possible to achieve an energy-conserving office without compromising on comfort.

Our objectives are to:
1) achieve an indoor environment that does not decrease the health, comfort, and productivity of workers, and
2) achieve energy conservation by selecting and operating appropriate air conditioning equipment.

In the future, we continue to conduct academic research and plan to create proposals on methods to conserve energy without compromising comfort.

Please visit our website for a report on the recommendations.

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Towards Energy Conservation with High Productivity -
Recommendations for Indoor Environmental Requirements in Workplace during the Summer Season

In modern society, great emphasis is placed on the intellectual creativity, and many companies and research institutes work with an aim to achieve this. Therefore, there is a need for workplace where productivity is kept constant. In commercial buildings, setting an indoor temperature of 28 °C is recommended as an energy conservation measure by the Japanese government. However, while mitigating indoor temperature without any strategies would reduce the amount of energy consumption, it may force workers to compromise on their comfort. This would result in decreased productivity of the workers, defying the original objective of the office. Furthermore, there may be times when the anticipated energy reduction effects may not be achieved. The Society of Heating, Air-Conditioning, and Sanitary Engineers of Japan (SHASE) recognizes this as a major problem. Therefore, the Society has set out the following objectives and recommendations:

1) to achieve an indoor environment that does not decrease the health, comfort, and productivity of workers, and
2) to achieve energy conservation by selecting and operating appropriate air conditioning equipment.

■Problems with an office set at 28 °C

The value of “28 °C” has become widespread as a result of energy conservation efforts, such as the Cool Biz campaign. However, raising the cooling setpoint temperature may result in discomfort of the workers, which may, in turn, decrease working efficiency. Field measurements in an office set at 28 °C showed that the actual indoor temperature could exceed 28 °C, in which cases, the percentage of dissatisfied workers was as high as 80%. Additionally, field studies in call centers showed that when the air temperature was raised from 25 °C to 28 °C, working efficiency decreased by approximately 6%. Because personnel costs

are approximately 100–200 times that of energy costs, decreased productivity stemming from indoor environment deterioration can lead to large economic losses. With this in mind, it is important to achieve an indoor environment that not only conserves energy but also does not decrease the health, comfort, and productivity of workers.

■What is the basis for recommending 28 °C?

The Cool Biz campaign suggested a temperature setpoint of 28 °C considering the upper limit of the management standard temperature in the 1970 Act on Maintenance of Sanitation in Buildings (henceforth, Building Sanitation Act). This Act sets a temperature range between 17–28 °C as an environmental sanitation management standard. It should also be noted that this 28 °C was not a setpoint value for air conditioning but was the temperature of the occupied zone. Variations between the setpoint temperature and the actual indoor temperature can differ due to thermostat positions, control methods, and internal loads. Therefore, a setpoint temperature of 28 °C and an indoor temperature of 28 °C are not always the same. The Research Grant for Health and Science, "Research on Environmental Health Standards for Buildings," on which the Building Sanitation Act was enacted, indicated that the reason behind the value 28 °C was that it was neither a target value nor the recommended value. Instead, it was the upper limit of the allowable temperature range. In other words, it is incorrect to use 28 °C as a recommended value. Instead, the recommended value for air conditioning given in this report is between 22–24 °C.

■What is a comfortable thermal environment?

The temperature that people feel is not the air conditioning setpoint temperature. Even if this were the case, there are situations when this can feel uncomfortable. For example, when the thermal insulation performance of walls, ceilings, or windows are poor, their inner surface temperatures are greatly affected by the outdoor environmental conditions. Surface temperatures are likely to become higher than indoor temperatures especially when there is solar radiation. As a result, the perceived temperature could be higher than the actual indoor temperature. Thermal comfort is affected by a combination of six factors: air temperature, radiant temperature (surrounding surface temperature), air velocity, humidity, metabolic rate (activity), and clothing. With this in mind, a temperature of 26 °C is recommended as a setpoint temperature for a typical office. Even for an office that underwent Cool Biz initiatives, a temperature of 27 °C would be the upper limit.

Under thermally neutral conditions, a relative humidity range of 30–70% may not have a great effect on thermal sensation. As such, it is often the case that lowering the indoor temperature is more effective for energy conservation than insufficient dehumidification. In contrast, offices with advanced air conditioning systems could lower the temperature sensed by the body and maintain the workers' comfort, even when the air temperature is 28 °C by maintaining a low radiant temperature for the ceilings, floors, and walls, and appropriately implementing dehumidification. Finally, a thermal environment controlled by other people tends to be uncomfortable. Instead, increasing the degree of individual environmental control, such as through use of personal air conditioning, can psychologically improve comfort.

■Energy conservation awareness and changes in the office environment due to the Great East Japan Earthquake

Following the Great East Japan Earthquake in the summer of 2011, many electricity conservation measures were conducted in offices. However, indoor temperature mitigation, which was one of the primary electricity conservation measures, greatly decreased the comfort and intellectual productivity of workers. By contrast, energy conservation measures based around decreased lighting did not have a large effect on workers. Based on this, excessive indoor temperature mitigation has now been improved, and the setpoint temperature has been restored to 26–27 °C. Further, design illuminance of 750 lx in Japan, which was relatively higher than that of other countries prior to the earthquake, was changed to less than 500 lx. Reduced internal loads greatly contributed to air conditioning load reductions.

■Energy conservation effects of indoor temperature mitigation

Methods for reducing energy consumption of air conditioning equipment while maintaining indoor environmental quality are detailed in the SHASE document, “Precautions for electricity conservation measures in commercial buildings and residences in the summer: (1) Electricity conservation menu in commercial buildings.” It has been reported in some packaged air conditioning systems that the anticipated energy conservation effect may not be obtained due to increased partial load and resulting decrease in coefficient of performance (COP). To avoid the instinctual concept that “compromise = energy conservation,” efforts should be made to advance measures that utilize Building Energy Management Systems (BEMS) while quantitatively determining its effects. The energy conservation effects of dehumidification and changes in radiant temperature can vary greatly depending on the air conditioning system adopted.

■Pioneering cases

The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan (SHASE) has recognized examples of advanced buildings which conserve energy without compromising comfort or productivity; standout buildings among these have been given Society awards. These buildings will serve as models for the future.

The academic basis of these recommendations has been summarized as a report.

April 2014

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Thermal Environment Committee (Priority Research)

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