

## TREND IN HEAT GAINS FROM OFFICE EQUIPMENT

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### ABSTRACT

The paper is focused on the trend in heat gains from PCs and monitors as widely used IT equipment. The study included literature review and measurements carried out by the authors of the paper. Updated set of recommended values for PCs and monitors is proposed to replace the ASHRAE recommendations based on the measurements carried out in 1990s. The updated values of typical heat gains are determined from the maximum heat gains measured with three-minute interval. The typical heat gains should be used with respect to the design purpose.

### INTRODUCTION

Personal computers and information systems (IT) are widely applied in most of the buildings today. Internal heat gains from the office equipment represent a major portion of cooling load.

The paper is focused on the trend changes in heat gains from PCs and monitors as widely used IT equipment. The study included literature review and measurements carried out by authors of the paper.

A lot of problems have been solved in previous studies: nominal to actual power consumption ratio, measurement of radiant and convective gains (Jones at al. 1998), impact of room conditions on heat gains (Hosni at al. 1998), and the diversity factors of equipment. Also a problem is a determination of the total (radiant plus convective) heat gain from equipment. The estimation was usually based on the nameplate power consumption.

It was found that the ratio of peak heat gain to nameplate power consumption typically ranged from 25 % to 50 % for general office equipment with the nameplate power consumption of less than 1000 W but from 7 % to 32 % for PCs and from 15 % to 32 % for monitors (Hosni at al. 1999). A similar result (20 % to 30 %) was presented for a desktop computer workstation (PC and monitor together). If the equipment is considered separately

the ratio varies from 12 % to 64 % for PCs and from 29 % to 46 % for monitors (Wilkins at al. 1991). The heat gains were measured as power consumption.

This ratio illustrates the dramatic difference that exists between the nameplate and the measured peak consumption. Thus, air-conditioning system design on the nameplate data may result in extra initial costs and extra life cycle operating expenses of the building.

Presented results of the ratio endorse conclusion drawn by Wilkins and Hosni (2000): All research completed to date, suggests that it is not possible to find a standard value of the ratio which could be applied to all nameplate data to obtain a useful estimation of the actual heat gain. The measurement of power consumption should be used instead.

The diversity factor of equipment (defined as the ratio of measured actual heat gains of all equipment to the sum of the peak gain from all equipment) quantifies changes of actual gains (Wilkins and McGaffin 1994). The diversity factor depends on occupants, type of their work, type of used equipment and it may range from 37 % to 78 % as found by the study in five office buildings. Wilkins, McGaffin and other researchers presented that computers and monitors do not reduce consumption at idle mode, with the exception of computers with Pentium processors and some monitors measured by Hosni at al. (1999). The reduction in consumption at idle mode is, however, significant for printers and copying machines.

ASHRAE published recommended values of heat gains from office equipment (ASHRAE Fundamentals 2005). The heat gain from a PC is defined as an average value 55 W, conservative value 65 W and highly conservative value 75 W. Monitor heat gain is prescribed for a small monitor (13-15") 55 W, medium monitor (16-18") 70 W and large monitor (19-20") 80 W. The values are valid for CRT monitors. The recommendations are based on the research published from 1991 to 1999 (Hosni at al. 1999, Wilkins and McGaffin 1994 and Wilkins at al. 1991).

## **METHODS**

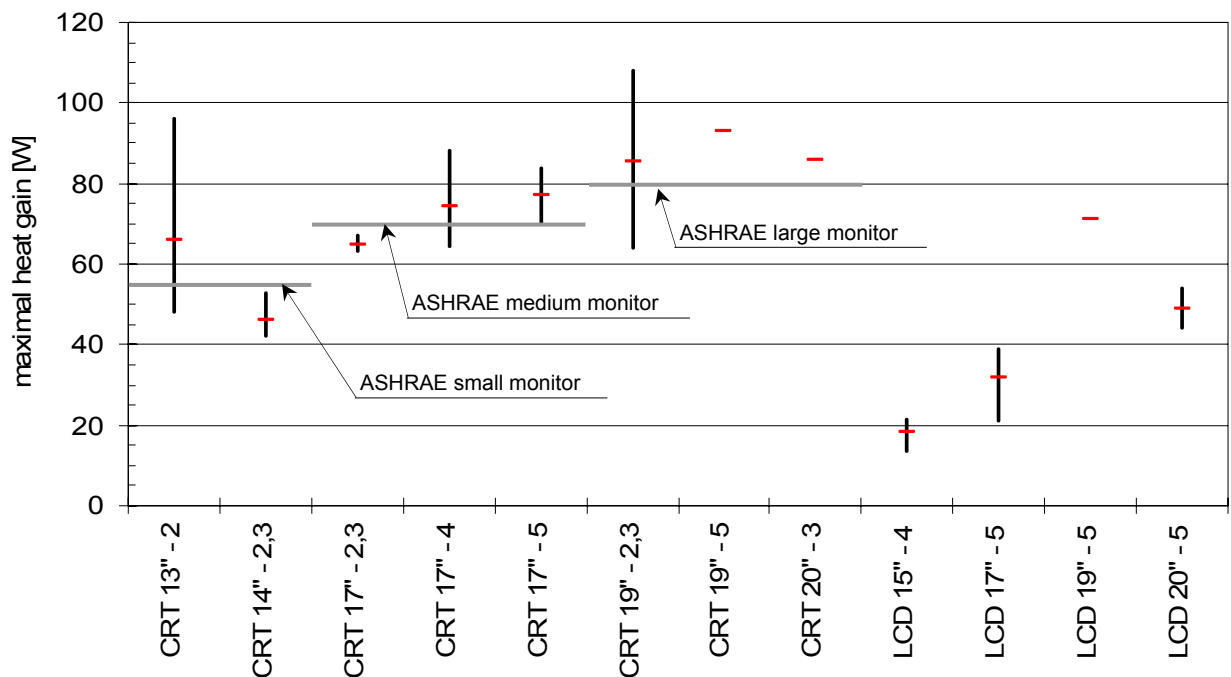
Evaluation of the trend in heat gains is based on the studies of Hosni at al. (1999), Wilkins and McGaffin (1994) and Wilkins at al. (1991). Moreover, the current study comprehends two measurements performed recently by Duška (2004) and Lukeš (2007). Wilkins at al. (1991) tested five PCs but only one was recognized as 386 grade. Data from this study will be labeled as 1. Wilkins and McGaffin (1994) measured twelve PCs. Two of them can be identified as 486 grade and two 386 grade (labeled as 2). Hosni at al. (1999) tested four PCs, three of them were Pentium (CPU - central processing unit 200 MHz and 400 MHz) and one was 486 grade (labeled as 3). Only the PCs with known type of CPU

were used for evaluation. Heat gains of monitors were adopted from Hosni at al. 1999, Wilkins and McGaffin 1994.

Our first measurement was carried out in the Skoda AUTO office building, Mlada Boleslav, Czech Republic, from August to December 2004 (Duska 2004). Data from the measurement will be labeled as 4. The second measurement was carried out in LINET Company, Zeleznice, Czech Republic from February to May 2007 (Lukes 2007) (labeled as 5). In both measurements almost 200 PCs and monitors were measured for at least one week.

The heat gains from equipment were measured as power consumption. An integrative constant of the measurement was set to be three minutes. This interval was found to be optimal to determine the maximum heat gain (Hosni at al. 1999). The maximum heat gain was evaluated for every PC and monitor from the recorded week data. Equipment was divided into groups characterized by the main technical parameter. It was the screen size for a monitor and the type and frequency of CPU for a PC.

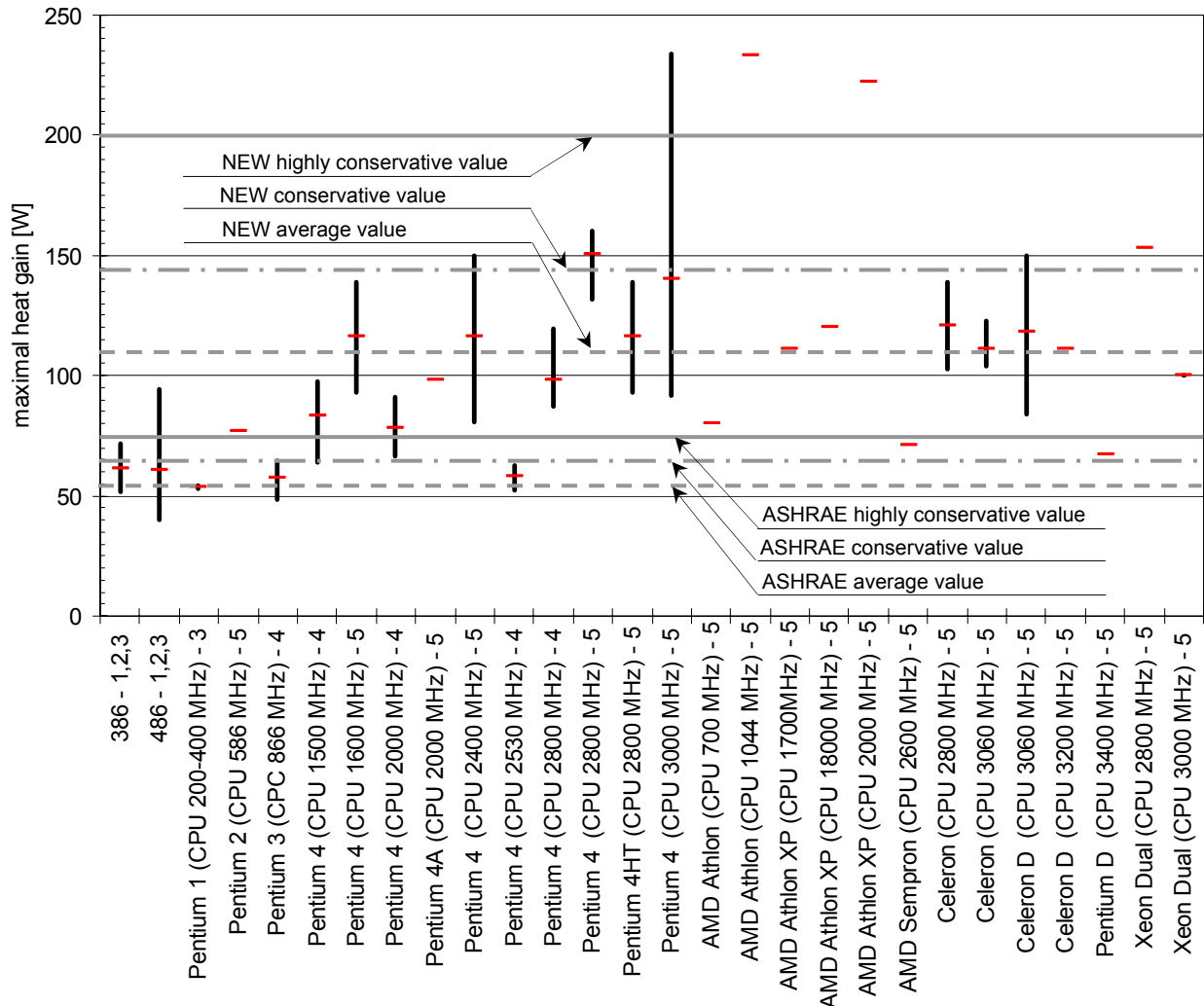
## RESULTS



**Figure 1:** Maximum heat gains from CRT and LCD monitors

The measured heat gains from monitors are presented in Figure 1, PCs' results are shown in Figure 2. The groups are represented by the maximum, minimum and mean value of the measured data. The charts illustrate how the heat gains from equipment have

changed over the past 15 years. The recommended values used for the design of air-conditioning systems are presented for comparison.



**Figure 2:** Maximum heat gains from PCs

## DISCUSSION

First of all the attention will be paid to the monitor. The results of CRT monitors are comparable to the results obtained in the previous studies. However, a little correction of recommended values for medium and large monitors could be done by increasing them by about 5 W and 10 W, respectively. A major change in monitors' heat gains have been caused by wider installation of LCD monitors in offices. A new set of recommended values is proposed in Table 1.

**Table 1: Updated typical (peak) heat gains from a monitor**

Monitor Size	CRT [W]	LCD [W]
Small Monitor (13" to 15")	55	20
Medium Monitor (16" to 18")	75	35
Large Monitor (19" to 20")	90	50

The heat gains from PCs have been going through even more dramatic development comparing to monitors. The ASHRAE recommended values are completely below the heat gains from PCs today. A new set of recommendations for PCs is proposed in Table 2.

**Table 2: Updated typical (peak) heat gains from a PC (without monitor)**

	[W]
Average Value	110
Conservative Value	145
Highly Conservative Value	200

The updated typical heat gains from office equipment are based on the maximum heat gains measured in three-minute interval. It represents extreme heat gains without considering the heat gain reduction by diversity factor or variation of a single piece of equipment. The typical heat gains should be used with respect to the design purpose.

## CONCLUSION

The paper deals with the trend in heat gains from PCs and monitors based on literature review and measurements performed by the authors of the paper. Updated set of recommended values for PCs and monitors is proposed to replace the ASHRAE's recommendations based on the measurements carried out in 1990s. The updated values of typical heat gains are determined from the maximum heat gains measured in three-minute interval. The typical heat gain values should be used with respect to the design purpose, e.g. according to the procedure involving the peak gains and diversity factors as described in ASHRAE Fundamentals 2005. For advanced calculation methods or simulations the typical heat gains are not suitable and heat gain profiles based on measurements are recommended.

## ACKNOWLEDGMENTS

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