# “Air-conditioning” an out-dated term for the current practise for the cooling of buildings?

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## Introduction

The two tasks cooling of buildings and ventilation for buildings are often mentioned and treated in combination, although they serve completely different purposes: Good room air quality is provided by ventilation systems, whereas the surplus heat in the building has to be removed by some cooling system in order to maintain an acceptable thermal comfort. The reason for the combined consideration is that traditionally the systems providing the two tasks are air based “air-conditioning systems”, developed decades ago in the USA. They are still the main technology in many countries, and therefore the thinking mentioned above is still well established.

However, there are more recent technological developments like chilled ceilings and building component embedded systems (TABS, thermally active building component systems), which are clearly independent of the ventilation purpose and bearing a considerable energy efficiency potential. It is a well-known fact that air is a bad energy carrier and energy can be transported much more efficiently by liquids (essentially water) – a fact which is important in respect of the EPBD requirements. Also, the considerably higher temperature levels of surface based systems increase the potential for the use of natural sources (ground, outside air) for cooling – again bearing an efficiency potential in regards of the EPBD requirements.

In some countries, water based systems have replaced air-condition systems. In Switzerland e.g., the majority of new office buildings are equipped with TABS, and chilled ceilings are used in cases with higher internal heat gains.

The calculation methods in the standards have to reflect this development and to provide the possibility to show the potential of the different technologies in respect of energy efficiency.

## The CEN-EPBD standards related to cooling

There is a group of standards in the CEN-EPBD package which deals with cooling aspects:

- EN ISO 13790: Calculation of energy use for space heating and cooling
- EN 15255: Sensible room cooling load calculation – General criteria and validation procedures
- EN 15265: Calculation of energy use for space heating and cooling – General criteria and validation procedures
- EN 15243: Calculation of room temperatures and of load and energy for buildings with room conditioning systems

EN ISO 13790 provides calculation methods for the heating and cooling energy demand of buildings. It is discussed in the article from Dick van Dijk [1].

EN 15255 and 15265 are validation standards for room based calculation methods. They have a close relation to each other, using the same room model for the validation cases. EN 15265 is referenced by EN ISO 13790. EN 15255, dealing with load calculations, gives a classification of cooling load calculation methods and the related validation cases. It is referenced by EN 15243. This latter standard is discussed in more detail below.

## EN 15243 “Calculation of room temperatures and of load and energy for buildings with room conditioning systems”

The EN 15243 is the EPBD standard dealing with the calculation of the system aspects of cooling. The standard is also described in [2]. This standard covers system related aspects for buildings having

cooling, humidification or dehumidification needs. For the ventilation part it refers to EN 15241 and 15242 (these two ventilation related standards are not discussed in this article).

The system energy use calculations are based on building related thermal energy needs from EN ISO 13790 calculations. It also covers the heating and cooling part for buildings which need room conditioning systems .According to this standard it is possible to use any calculation method, including hourly simulations, as long as the general requirements are fulfilled. The main reason for this is that the variety of systems in the HVAC domain is very large, and no general method is able to cover all types of systems. The standard includes the definition of the procedure for the load calculations with reference to EN 15255. This is because the sizing of HVAC components is often of significant importance for the energy calculation through their part load behaviour. The method for the room load and energy calculation can be the same, with different boundary conditions given in EN 15243.

## Classification of methods

The possible methods are classified according to **table 1**, especially showing the relationship between building and system calculations. Typical applications for the different combinations are given.

**Table1.** Calculation method classification

| | | System | Calculation |
|---|---|---|---|
| | | Hourly | Monthly, seasonal, annual |
| Building | Hourly | BhSh | BhSm |
| Calculation | Monthly, seasonal | BmSh | BmSm |

## Principal requirements

### *General structure*

A general structure, to be followed by any calculation method, is defined similar to EN 15316-1 for heating systems: for each sub system, the heat losses with their recoverable and non recoverable parts, the heat amount or the delivered energy to be supplied from the preceding sub system and the auxiliary energy needed shall be calculated. The structure is given in **figure 1**.

### *Required functionality*

Simplified and detailed calculation methods are distinguished in the standard. For both simplified and detailed methods, an overview of required functionality of calculation methods is given. For this, a system overview is included in form of a large table.

For all system types included in the overview, important technical features that affect the energy consumption are shown in another table.

Energy calculation methods should address all the mechanisms that are relevant to the system types being considered. The documentation accom panying each calculation method shall report how each mechanism is represented. Different degrees of calculation complexity will be appropriate for different applications.

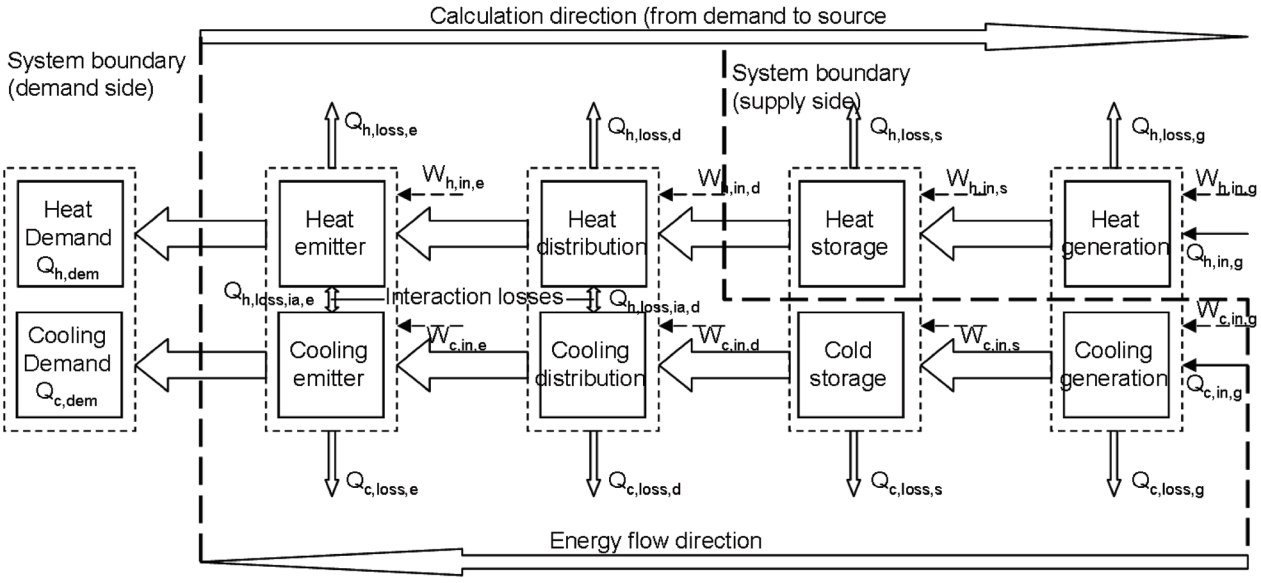


***Figure 1.*** *General calculation structure*

### *Verification*

Instead of a particular calculation method, a verification procedure for the calculation methods is proposed, using a two step approach as follows:

Step 1: Required Characteristics : Define the required characteristics according to the system table and check that the method appears to provide them.

Step 2: Verification of calculation accuracy

### *Informative annexes*

A large part of the document is in informative annexes. Example methods are given for many specific aspects. They all stem from national standards. This must be considered as a first step towards harmonisation, since for many countries it was not possible to change their methods due to the fact that their regulations refer to their national standards. Therefore a full harmonisation to a common method will require one or two more revision generations.

## Current status

EN 15243 is a published EN. However, a resolution has been accepted for a preliminary work item in ISO TC 205 for a standard on "Combined calculation procedure for heating and cooling load (including latent) and related energy use for systems" with EN 15243 as a basis. This is intended to be the next revision of EN 15243.

### Outcome of the EU CENSE Project in respect of EN 15243

Conclusions and recommendations for the standard on room conditioning systems EN 15243 are:

- Development of methods to determine cold distribution efficiency: the standard does not provide concrete calculation methods for annual cold distribution efficiency. This is due to the variety of systems, the complex nature of interaction between heat and cold distribution and the lack of (national) methods on this subject.
- Asses the Eurovent guidelines on their usefulness to determine cold generation efficiency: the standard does not provide concrete calculation methods for annual cold generation efficiency. This is due to the variety of generators and systems and the lack of (international) standards on testing cooling machines and systems. However in recent years Eurovent has published test guidelines for several systems.

### Calculation of cold generation efficiency based on product related standards

For the certification of liquid chilling packages, there has been a EUROVENT standard 3 defining the test conditions and the procedure to calculate the seasonal energy efficiency ratio (SEER). This is based on four operation points, under which the units shall be tested. The SEER is calculated by a weighted average of the efficiencies of the four test values. The procedures given in this EUROVENT standard have been included in the revised EN 14825, which has passed the UAP recently.

In the frame of the development of the Swiss standard for the energy requirements for buildings with room conditioning systems 4, which has just been finished on the basis on the simplified hourly calculation method of EN 13790 and on EN 15243, a simplified model for the calculation of the chiller performance was developed. The goal was to have a model for hourly calculations, which correctly represents the dependency on temperature boundaries and part load ratios of the chiller COP, using only the input available from standard based test results available, like those from [3]. As shown

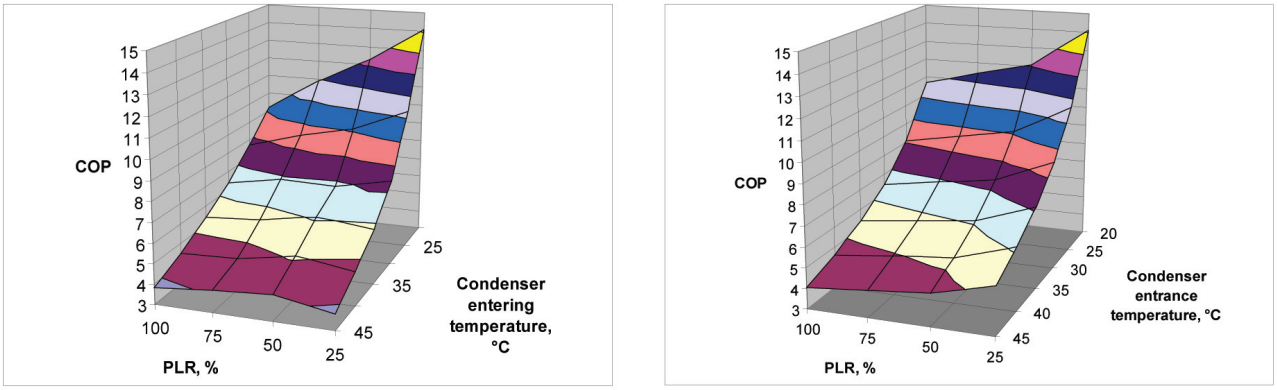


***Figure 2.*** *Original performance map (left) and generated with the model (right) for a specific chiller type*

in [5], this goal could not completely be reached. The model shows a very good behaviour for different chiller types, as the examples in **figure2** and **table2** show.

However, the four rating points are not sufficient to support the generation of a full performance map. For the model shown here, a fifth point is necessary. This is partly due to the arrangement of the rating points. They are arranged too much on a diagonal of the performance map. Knowing that this is not the main purpose of these rating points, it would nevertheless be of great help if there could be a development in the direction of a better support for this in future.

**Table 2.** Comparison of seasonal performance factors calculated with original performance data, the developed model and according to ARI and EUROVENT rating standards for 2 different chiller types

| | Original | Model | ESEER |
|---|---|---|---|
| Type 1 | 12.5 | 12.7 | 10.3 |
| Type 2 | 5.8 | 6.2 | 7.3 |

## References


1. *Dick von Dijk: Building energy performance, Article in Rehva journal, January 2011*
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3. *Eurovent Standard 6-C003-2008: Rating Standard for Liquid Chilling Packages; EUROVENT CERTIFICATION, F-75003 PARIS*
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