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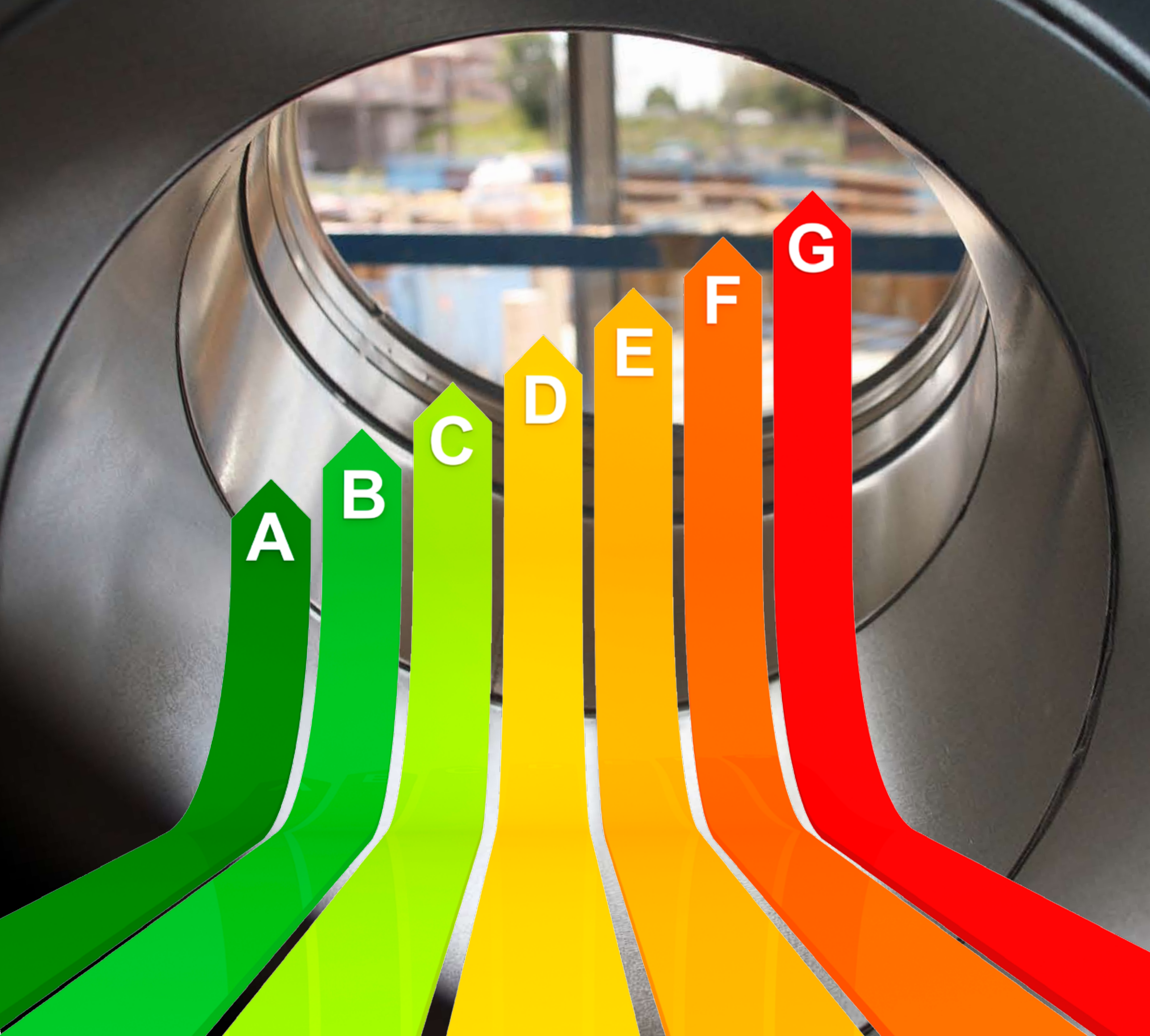
Focus on EPB standards



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Editor-in-Chief: Jaap Hogeling
jh@rehva.eu or j.hogeling@isso.nl

Associate Editor: Stefano Corgnati, Italy
stefano.corgnati@polito.it

General Executive: Süleyman Bulak

Editorial Assistant: Cynthia Despradel

ADVERTISEMENTS
Ms Cynthia Despradel
cd@rehva.eu

SUBSCRIPTIONS and CHANGES OF ADDRESSES
REHVA OFFICE:
Washington Street 40
1050 Brussels, Belgium
Tel: 32-2-5141171, Fax: 32-2-5129062
info@rehva.eu, www.rehva.eu

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A happy, healthy and successful year 2015 for all our REHVA Journal readers!

An enormous thank you for the former Editor-in-Chief: Professor **Olli Seppänen**. Professor Seppänen served REHVA for many years and made the REHVA Journal into a globally respected and successful journal. A great achievement that will be difficult to uphold, but with help of the REHVA community, the current and future authors and REHVA members it should be possible to uphold this standard and continue its success.

On behalf of REHVA board, staff and editorial board.

The 2nd generation EPB standards ready for enquiry

JAAP HOGELING
Editor-in-Chief

This CEN project was announced in the first REHVA Journal issue of 2011. Support of the EU-Commission under Mandate 480 made it possible to develop this coherent set of EPB standards. This development took place under the overall coordination of CENTC371 "Program Committee on EPBD" and the collective of the different team leaders (CTL) coordinating and working with the 5 other CEN/TC's involved. The CTL worked also in good coordination with the Liaison Committee of the EU Member States. The purpose of this close cooperation with the MS's is obvious. These CEN EPB standards are expected to be referenced by national legislation. This referencing will secure a proper implementation of the EPBD (Energy Performance Buildings Directive) on national level.

The overarching standard (OAS) FprEN15603:2014 'Energy Performance of Buildings – Overarching standard EPB' was the first to go on enquiry and formal vote. CENTC371 decided to publish this premature OAS to make it available as widely as possible but with the clear intention to revise it during 2015.

Due to a lot of non-responsive CEN members and understandable formal opposition from 3 CEN members it didn't pass the formal vote. CENTC371 decided as intended before, to update the OAS during 2015 but also to launch a new enquiry before a next formal vote. This procedure will allow CENTC371 to include all necessary changes based on the feedback of the enquiry of the total set of CEN and CEN-ISO EPB standards.

Ongoing discussions on how to facilitate the Voluntary Certification Scheme for Non-residential Buildings or issues raised by discussion on Primary Energy Factors may also influence the final content of the OAS.

This first issue of the REHVA Journal 2015 includes 7 articles about the current set of EPB standards published for enquiry. Where possible references are given to the draft Technical Reports connected to these prEN's. As these Technical Reports are not official published yet, they can only be accessed through the CEN livelink system. This means that the National Standards Bodies can assist you to receive these drafts. Those professionals aimed to use these EPB standards in practise are encouraged to react on the public enquiry of these EPB standards and by doing so make use of the TR's related to these standards. Most, not to say all, of the informative content of the EPB standards is included in the TR. This means that information regarding the background, justification of assumptions and verification by example calculation can only be found in these TR's. They are essential to consult if one wants to participate in the enquiry. Where standards include calculations, excel files have been developed to demonstrate that the given calculations work, these excel files can also be accessed via the CEN livelink system.

The enquiry period used to be 5 months but is recently restricted to 3 months. This makes action on the draft standards (prEN's) a more urgent matter. Some enquiries will close by the beginning of March 2015!

Access to the prEN's and other information can be granted by your national standard body. Where possible your REHVA contacts may assist you. ■

Subset of EPB standards on the energy use and the thermal performance of buildings and building elements




DICK VAN DIJK
TNO, Heat Transfer and Fluid Dynamics; team EPB
dick.vandijk@tno.nl

MARLEEN SPIEKMAN
TNO, Heat Transfer and Fluid Dynamics; team EPB
marleen.spiekman@tno.nl

DIRK VAN ORSHOVEN
Independent energy engineer
dirk.van.orshoven@skynet.be

WIM PLOKKER
VABI Software b.v.
w.plokker@vabi.nl

This paper introduces the subset of EPB standards dealing with the energy use and the thermal performance of building and building elements, with the focus on the standards which are new or significantly revised.

The European Commission asked CEN (mandate M480) to develop standards supporting the application of recast EPBD (Energy Performance of Buildings Directive) in the Member States: the so called set of Energy Performance of Buildings standards (EPB standards).

A comprehensive series of European (CEN) and international (CEN & ISO) standards are in preparation, aiming at international harmonization of the methodology for the assessment of the overall energy performance of buildings, called "set of EPB standards". This work is based on a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/480, [2]), to support essential requirements of EU Directive 2010/31/EC on the energy performance of buildings (EPBD) [1]. The main recommendations from the Intelligent Energy Europe CENSE project [3] were adopted in the Mandate.

This article introduces the subset of EPB standards dealing with the energy use and the thermal performance of building and building elements. These standards are developed or revised under the responsibility of the CEN technical committee, CEN/TC 89, *Thermal performance of buildings and building components*, in collaboration with ISO/TC 163, *Thermal performance and energy use in the built environment* or ISO/TC 163 subcommittee SC 02, *Calculation methods*. The focus in this article is on the standards which are new or significantly revised.

Set of EPB standards

EPB standard

An "EPB standard" is a standard that complies with the requirements given in the following three documents: CEN/TS 16628 [4], the basic principles for EPB standards, CEN/TS 16629 [5], the detailed technical rules of EPB standards and EN 15603 [6], the overarching EPB standard.

For many of these standards the revisions are mainly editorial plus changes to make the procedures unambiguous and software proof, to rationalize the choices and to ensure consistent interconnections.

However, some of the standards are new or completely revised and/or reorganised.

Modular structure

EN 15603 [6], the overarching EPB standard, provides a modular structure of the assessment of the overall energy performance of buildings. The structure identifies different modules, see **Table 1**.

Most EPB standards in the subseries of EPB standards under the responsibility of CEN/TC 89 in collaboration with ISO/TC 163 and/or ISO/TC 163/SC 2, are in module M2, see **Table 2**.

Unambiguous, but flexible

Although each EPB standard shall contain only unambiguous procedures, there is a need for flexibility, to take into account differences due to national or regional building traditions, building use and regulatory context. Therefore, in each EPB standard, a template is given in an Annex A, to specify in a transparent way the choices with regard to the methods and the required (default or fixed) input data or input data sources. A set of informative default choices (using the template of Annex A) is provided in Annex B of each EPB standard. In case the standard is used in the context of national or regional legal requirements, a mandatory set of choices may be given at national or regional level for those specific applications, in particular for the transposition of EU Directives such as the EPBD [1] into national legal requirements.

Accompanying technical report

The Detailed Technical Rules for the set of EPB standards [5] ask for a clear separation between normative and informative contents:

- to avoid flooding and confusing the actual normative part with informative content
- to reduce the page count of the actual standard
- to facilitate understanding of the package

Therefore, each EPB standard or group of EPB standards is accompanied by an informative Technical Report, containing the informative documentation and justification, including worked examples of the accompanied EPB standard.

Accompanying spreadsheet

Also according to The Detailed Technical Rules [5], and in agreement with the mandate M/480 [2], an accompanying spreadsheet to each EPB-standard shall be prepared to test and validate each EPB calculation procedure.

Table 1. Modules main areas, from [6].

Modules	Area
M1	Overarching standards
M2	Building (as such)
M3-M11	Technical Building Systems under EPB
M12-M13	Other systems or appliances (not under EPB)

Table 2. Submodules M2, from [6].

Sub	Sub area
1	General
2	Building Energy Needs
3	(Free) Indoor Conditions without Systems
4	Ways to Express Energy Performance
5	Heat Transfer by Transmission
6	Heat Transfer by Infiltration and Ventilation
7	Internal Heat Gains
8	Solar Heat Gains
9	Building Dynamics (thermal mass)
10	Measured Energy Performance
11	Inspection

The spreadsheet shall include a tabulated overview of all output quantities (with references to the EPB module where it is intended to be used as input), all input quantities (with references to the EPB module or other source from where the data are available) and fully worked example of the application (the calculation method between the set of input and output quantities) for validation and demonstration.

CEN and ISO

Several EPB standards are being prepared or revised as combined EN ISO standards under the so-called Vienna Agreement between CEN and ISO. This is in particular the case for the standards introduced in this article, as explained further on.

Some other CEN and ISO working groups have decided, for practical reasons, for the time being to work in parallel on separate CEN and ISO EPB standards, aiming to keep these as similar as possible, with the aim to merge these to EN ISO standards when the drafting has reached a more mature stage.

The intention is to come (eventually) to a complete and consistent set of ISO (EN ISO) standards on the Energy Performance of Buildings (EPB).

A unique Joint Working Group of ISO/TC 163 and ISO/TC 205, ISO/TC 163/WG 4 [7], [11] co-ordinates since 2009 the development of the set of EPB standards at the global (ISO) level, under the responsibility of the two ISO parent TC's.

Because the EPB standards under CEN/TC 89 are already EN ISO standards, they already need the (currently CEN only) overarching standard and the acceptance of the Basic Principles [4] and Detailed Technical Rules [5] for EPB standards not only at CEN, but also at ISO level.

Indeed, a new work item proposal is currently circulating in ISO to initiate the combined EN ISO development of the revision of FprEN 15603 [6].

The ISO 52000 series: consecutive numbering of all new ISO EPB standards

Recently, upon initiative of the ISO Joint Working Group, a series of consecutive ISO numbers has been reserved for the EPB standards, based on the modular numbering of items prepared in FprEN 15603 [6]. The numbers go from ISO 52000 until ISO 52150, with subseries for the successive modules.

This systematic set of consecutive ISO numbers may significantly boost the awareness on this EPB series. Gradually, all new or significantly revised ISO standards that are part of the set of EPB standards can receive the new number from this series.

The list covers both the standards and the corresponding technical reports. The rule is to always number a standards as an odd part number (part 1, part 3, etc.) and the corresponding Technical Report as an even part number (part 2, part 4, etc.).

For instance, the above mentioned EN ISO version of the EPB overarching standard will result in EN ISO 52000-1 and the accompanying technical report will become CEN ISO/TR 52000-2.

Subseries of EPB standards on energy use and thermal performance

There exists a long tradition of collaboration between CEN/TC 89 (*Thermal performance of buildings and building components*) and ISO/TC 163 (*Thermal performance and energy use in the built environment*) and its subcommittee SC 2 (*Calculation methods*).

Two of the "TC 89" standards are at the overarching level (M1), as shown further on. Also some of the other CEN/TC's are responsible for one or two specific overarching submodules, either by tradition or by strong affinity with other standards under their responsibility.

The other "TC 89"standards are under module M2 (building and building elements). These are prepared in collaboration between CEN and ISO either under ISO lead or under CEN lead, as shown further on.

Although all these standards and the accompanying technical reports are currently under preparation, we use in this article the stage indicators for the final published versions (e.g. EN ISO 52016-1) instead of the indicators for the current stage (e.g. prEN ISO/DIS 52016-1, draft standard for review). The (expected) period of enquiry of ach standard is mentioned in the list of references.

EPB standards on indicators, rating, requirements and certification; overall and building fabric

General considerations and overall energy performance

This concerns the new EN ISO 52003-1 [12] (plus the accompanying technical report CEN ISO/TR ISO 52003-2 [13], which provides more elaboration, explanation and justification). For the overarching module M1-4, Ways to Express Energy Performance. Lead: ISO/TC `63/WG 4 (JWG) [7].

These new texts will replace EN 15217:2007 and ISO 16343:2013, which are reworked and extended. The new standard and its technical report first provide general guidance on the intelligent use of the output of the EPB assessment methods, applicable to both overall EPB aspects and partial EPB features. Next, these principles are applied practically to the overall energy performance and its indicators, for which structured reporting formats are provided.

It is very important to realize:
if the level of sophistication of the ways to express the energy performance and the energy performance

requirements does not match the level of sophistication of the procedures to assess the energy performance, as laid down in the set of EPB standards, then these refined assessment procedures miss the target.

This is illustrated by the example in **Figure 1**.

Successively the following concepts are defined and discussed in the standard:

- Energy performance features
- Numerical EPB indicator(s)
- EPB rating
- EPB requirements
- EPB certificate

Each of these can refer to the overall energy performance and/ or (except the EPB certificate) to a specific energy feature (building element or group of elements, energy need, subsystem, etc.).

The texts give the rationale for the selection of an adequate mix of EPB requirements.

For setting sufficiently refined, tailored requirements that match the degree of sophistication of the EPB assessment methods, the specification of references requires detailed attention. In fact, proper references are tailored (project-specific), to reflect a fairly uniform technological-economic effort for each individual project over the entire and diverse range of possible building geometries. This is discussed in detail in the texts. In addition, a detailed description shows the equivalence of the formula and notional reference building approaches to determine the reference.

Structured tables are provided for reporting the chosen requirement mix and the selected numerical indicators.

Illustration

A practical example is given in **Figure 1**, which illustrates on the basis of some 200 real dwelling shapes how for a given set of technical measures the numeric value of an EPB indicator can strongly vary from one project to another.

If the reference value that is used for rating and/or to set a requirement is a fixed value (in casu: requirement expressed as maximum value in kWh/m² floor area disregarding building shape or size), then buildings with a relatively large envelope area would need a large technological-economic effort to meet the requirement, while on the other hand buildings with a relatively small envelope area would need only a small technological-economic effort to meet the same requirement. A more appropriate reference for the rating and/or requirement would take into account this variation.

Building fabric

This concerns the new standard EN ISO 52018-1 [19] (with the accompanying technical report EN ISO/TR 52018-2 [20]), for module M2-4, Ways to Express Energy Performance. Lead: ISO/TC 163/SC 02/WG 15 [9].

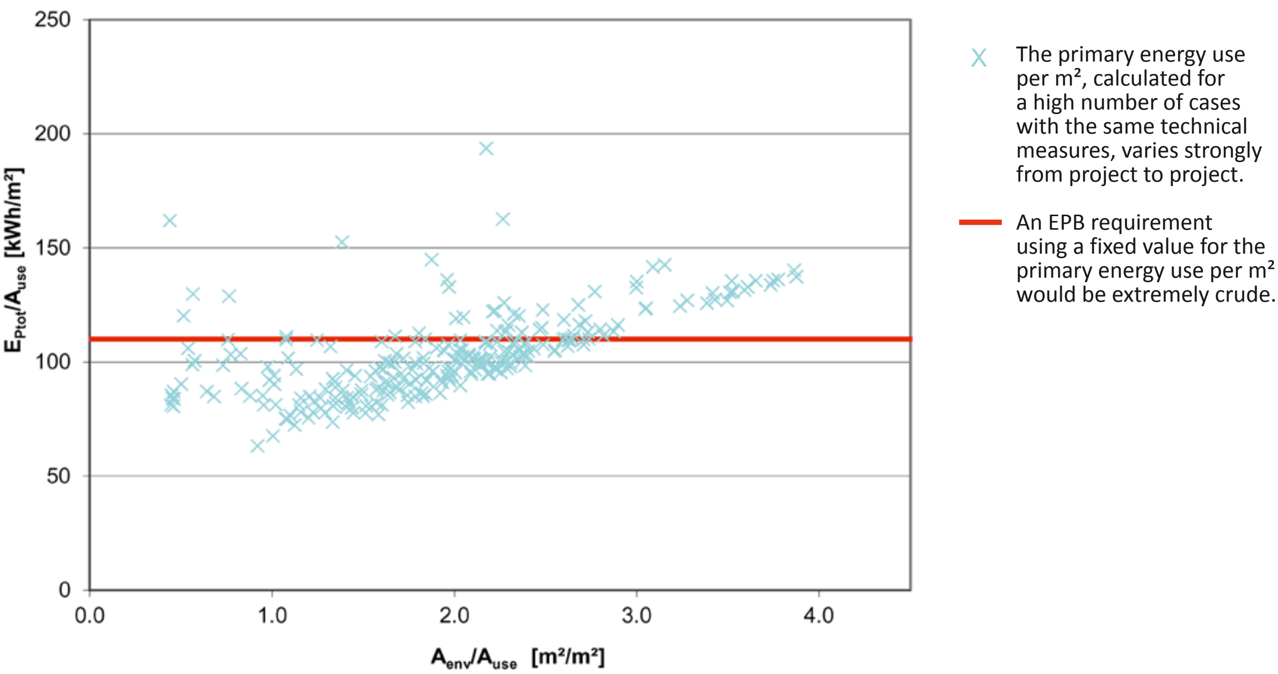


Figure 1. Example how the impact of a sophisticated energy performance assessment misses its target if the corresponding energy performance requirements are less refined.

These new texts discuss in detail the many possible EPB features and their respective numeric indicators that can be used for setting requirements related to the energy efficiency of the fabric and to the heating and cooling energy needs. Here too, structured reporting formats for these aspects are provided. In the technical report, the following aspects are discussed for each of the features: possible motivations for setting a requirement, possible numeric indicators, comparable economic strictness of the requirements, practical points of attention, testing aspects when applicable, new construction and renovation issues and exceptions. This information helps public and private actors to set in well-informed manner EPB requirements with a view of achieving the objectives that are pursued.

Overarching EPB standard on external environment conditions

This concerns a new standard, EN ISO 52010-1 [14] (plus the accompanying technical report CEN ISO/TR ISO 52010-2 [15]), for the overarching module M1-13, External Environment Conditions. Lead: ISO/TC 163/SC 02/WG 15 [9].

This International Standard provides the common standard climatic data that shall be used for the all relevant EPB modules.

The standard gives procedures to calculate the distribution of solar irradiation on a non-horizontal plane based on measured hourly solar radiation data on a horizontal surface, obtained from EN ISO 15927 (part 1, 2 and 4) [21]. The procedures include assumptions to assess the impact of surrounding obstacles on the irradiation (shading). A simple method for conversion of solar irradiance to illuminance is also provided. The solar irradiance and illuminance on an arbitrary surface are needed as input for energy and daylighting calculations.

The standard also contains procedures for the use of (other) output from EN ISO 15927 (part 1, 2, and 4) as input for the EPB assessment.

Calculation of the distribution of solar irradiation on a non-horizontal plane

The model is named after Mr Perez. Several improvements were made in the course of time. The calculation procedure described in this standard is based on the "simplified Perez model" proposed in the early 90's. The explanation and justification is given in CEN ISO/TR 52010-2 [15]. Essentially, the model is composed of three different components:

1) a geometric representation of the sky dome;

2) a parametric representation of the insolation conditions, and;

3) a statistic component linking both components mentioned before.

It is a model of anisotropic sky, where the sky dome is geometrically divided into three areas, each of them showing a constant radiance, different from the other two.

These three areas are:

- Isotropic diffuse (for the sky hemisphere);
- Circumsolar radiation;
- Horizon brightness.

For the purposes of this International Standard the following is added:

- Isotropic ground reflected radiation

The diffuse (sky) radiation for the surface uses as input hourly values of diffuse horizontal and direct beam solar radiation. Other inputs to the model include the sun's incident angle to the surface, the surface tilt angle from the horizontal, and the sun's zenith angle.

Calculation of illuminance

For the luminance distribution of the sky and ground the irradiation is converted into illuminance by multiplication with the global luminous efficacy (Lm/W).

Calculation of shading by external objects

Shading by distant objects is taken into account through a shading correction coefficient for the direct radiation. Shading of diffuse radiation and reflection by distant objects is not taken into account, as explained below. Shading by fins and overhangs is calculated in EN ISO 52016-1.

Objects in the environment may block part of the solar irradiation on a plane (e.g. hills, trees, other buildings). The same or other objects may also reflect solar radiation and consequently lead to a higher irradiation. For example, , a highly reflecting surface (e.g. glazed adjacent building) in front of the (on the Northern hemisphere) North facing façade of the assessed building.

In order to avoid that for those objects specific solar reflectivity data have to be gathered, it is, as simplification, assumed that:

a) The direct radiation (including circumsolar irradiation) is partially blocked, if the object is in the path between sun and plane;

b) the diffuse irradiation (including irradiation from ground reflectance) remains unaffected.

This is physically equal to the situation where the radiation reflected (and/or transmitted) by the objects in the environment is equal to the diffuse radiation blocked by these objects.

This approach is chosen for simplicity. The effects on the accuracy of the calculated solar radiation have to be determined. An alternative method is to take diffuse shading into account. In order to do this sky view factors have to be calculated. This can be simplified by dividing the skyline in different segments and calculate the sky view factors for each segment separately assuming an equal skyline height over the segment.

Other climatic data

The standard also contains procedures for the use of (other) output from EN ISO 15927 (part 1, 2, and 4) [21] as input for the EPB assessment, such as:

- air temperature;
- atmospheric humidity;
- wind speed;
- precipitation;
- solar radiation;
- longwave radiation.

The reason for passing these data via this standard is to have one single and consistent source for all EPB standards and to enable any conversion or other treatment if needed for specific application.

EPB standards on calculation of the energy needs for heating and cooling, internal temperatures and heating and cooling load in a building or building zone

This concerns the new standards EN ISO 52016-1 [16], EN ISO 52017-1 [17](plus accompanying technical report CEN ISO/TR ISO 52016-2 [18]), for the modules M2-2, Building Energy Needs, M2-3, (Free) Indoor Conditions without Systems, but also for M4-3, Maximum Cooling Load. Lead: ISO/TC 163/SC 02/WG 15 [9].

Reorganization

Current set:

Currently, there are several strongly related international standards available in which an hourly calculation method is described. These standards all have a different purpose, but there is a large overlap between them, in input data, boundary conditions, assumptions, calculation procedures and validation procedures. This concern:

- EN ISO 13790:2008, Energy performance of buildings – Calculation of energy use for space heating and cooling
- EN 15265:2007, Thermal performance of buildings – Calculation of energy use for space heating and cooling – General criteria and validation procedures
- EN ISO 13791:2012, Thermal performance of buildings – Calculation of internal temperatures of a room in summer without mechanical cooling – General criteria and validation procedures
- EN ISO 13792:2012, Thermal performance of buildings – Calculation of internal temperatures of a room in summer without mechanical cooling – Simplified methods
- EN 15255:2007, Thermal performance of buildings - Sensible room cooling load calculation - General criteria and validation procedures

Therefore a restructuring of these standards was proposed and agreed in ISO/TC 163/SC 2 and CEN/TC 89.

New set:

These standards are replaced by EN ISO 52017-1, EN ISO 52016-1 and the accompanying technical report CEN ISO/TR 52016-2.

In the new set, there is a clear separation between a generic calculation method, and specific applications of this calculation method with specific assumptions, simplifications and specific input data, depending on the application:

EN ISO 52017-1 contains a generic (reference) method to calculate the hourly thermal balance in a building (zone). This method is based on and replaces EN ISO 13791. This standard contains no specific assumptions, boundary conditions, specific simplifications or input data that are not needed to apply the generic calculation method. This standard also includes validation cases (as in EN ISO 13791). Specific assumptions and input data are given that only apply to these validation cases. In this way the generic method and validation cases are clearly distinguished.

EN ISO 52016-1 cancels and replaces EN ISO 13790:2008, which was developed during the first EPBD mandate (M/343). It contains a (new) simplified hourly calculation method and a monthly calculation method. The hourly calculation method is a specific application of the generic method provided in EN ISO 52017-1. This standard further contains specific boundary conditions, specific simplifications and input data for different applications (energy needs for heating and cooling, internal temperatures, heating or cooling load).

Moreover, the hourly and the monthly method in EN ISO 52016-1 are closely linked: they use as much as possible the same input data and assumptions. And the hourly method produces as additional output the key monthly quantities needed to generate parameters for the monthly calculation method. This means that a number of (nationally) representative cases can be run with the hourly method and from the key monthly quantities the monthly correlation factors can be derived.

Reference hourly method in EN ISO 52017-1

EN ISO 52017-1 provides a generic hourly calculation procedure, with only a minimum number of assumptions needed to define the energy balance equations, with no specific application, no specific solution technique and no specific input data. Specific assumptions and input data are only given for a set of test cases to validate the procedures.

The generic reference hourly calculation method to calculate the thermal balance in a building or building zone produces as main output the hourly indoor air, mean radiant and operative temperature.

The content of EN ISO 13791:2012 has been re-used without major changes, except:

- The heating or cooling needs are added, but just as a term in the thermal balance. The control of heating and cooling, involving temperature set points and control types, is left to the specific application standard(s) such as EN ISO 52016-1.
- Specific boundary conditions that are not relevant for the reference method have been moved to EN ISO 52106-1 and/or to the validation cases.

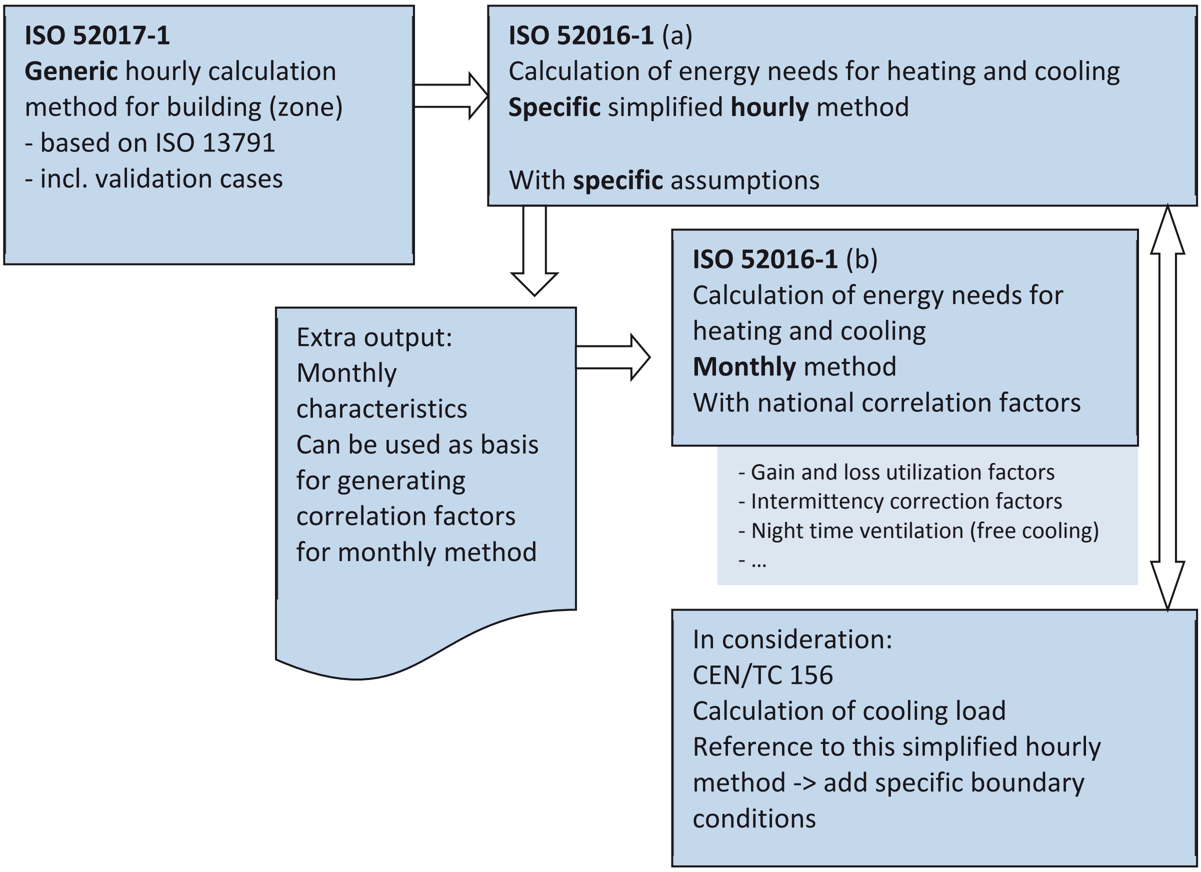


Figure 2. The relation between EN ISO 52016-1 and EN ISO 52017-1.

- The moisture balance equation from (informative) Annex K of EN ISO 13791 has been added to EN ISO 52017-1, also in the form of (normative) generic equations. The control of latent heat flow, involving humidity set points and control types, is left to the specific application standard(s) such as EN ISO 52016-1.

So EN ISO 5207-1 focuses on the reference hourly calculation procedures and associated validation cases and criteria.

Application in EN ISO 52016-1

Introduction

This International Standard presents a coherent set of methods at different levels of detail, for the calculation of the energy needs for space heating and cooling and/or calculation of the internal temperatures and/or calculation of the heating and/or cooling loads of a building or building zone, including the influence from technical buildings systems, control aspects and boundary conditions where relevant for the calculation. More in detail:

Simplified hourly method in EN ISO 52016-1

The hourly calculation procedure in this International Standard has been derived from the reference calculation procedure as given in EN ISO 52017-1.

EN ISO 52016-1 contains a specific (simplified) hourly method to calculate the hourly energy needs for heating and cooling and/or the hourly indoor temperature (air, mean radiant and operative) and latent energy needs (humidification and dehumidification).

The simplified hourly method in EN ISO 52016-1 is more advanced than the simplified hourly method given in EN ISO 13790:2008. The main difference is that the building elements are not aggregated to a few lumped parameters, but kept separate in the model. This makes the method more transparent and more widely usable, e.g. because:

- there is no worry about how to combine e.g. the heat flow through the roof and through the ground floor, with their very different environment conditions (ground temperature and ground inertia, solar radiation on the roof);
- the thermal mass of the building or building zone can be specified per building element and there is no need for an arbitrary lumping into one overall thermal capacity for the building or building zone;
- the mean indoor surface temperature (mean radiant temperature) can be clearly identified.

At the same time, the input data to be supplied by the user are (still) the same as for the monthly method.

Only the standard writers will have to introduce extra data: hourly operation schedules and weather data. On the other hand, the standard writers don't need to prepare tables with pre-calculated factors (on operation of blinds, effect of solar shading, etc.).

The drawback is that due to the much higher number of nodes a robust numerical solution method is required (software).

EN ISO 52016-1 is an application of the method provided in EN ISO 52017-1. In function of the application, specific assumptions, simplifications, solution techniques and input data restrictions are provided in the standard. See CEN ISO/TR 52016-2 for extensive explanation and justification.

With the hourly calculation method the thermal balance of the building or building zone is made up at an hourly time interval.

The main goal of the hourly calculation method compared to the monthly method is to be able to take into account the influence of hourly and daily variations in weather, operation (solar blinds, thermostats, heating and cooling needs, occupation, heat accumulation, etc.) and their dynamic interactions for heating and cooling. This limited goal enables to keep the extra input for the user compared to the monthly calculation method to a minimum.

The hourly climatic data are given in EN ISO 52010-1 and the hourly and daily patterns of the conditions of use (operating schedules) are given in the relevant other EPB standards. The hourly method produces also key monthly data that are essential for a quick understanding of the main processes involved and as a means to derive correction and adjustment factors for the monthly method.

Monthly method in EN ISO 52016-1

EN ISO 52016-1 contains also a specific monthly method to calculate the (monthly) energy needs for heating and cooling.

Because the physical processes are highly nonlinear (because at one moment there is a heating or cooling need and at other moments there is not; because of the inertia of the building; because of the dynamic interactions with the systems and users), there are many dynamic effects, which cannot be explicitly accounted for by taking monthly mean values. These are approximated by simplified equations using correlation factors or simple correction factors. For instance for the utilization of the momentary gains and losses, for intermittent heating and cooling, for free cooling by ventilation, et cetera.

These correlation and correction factors can be developed on the basis of the results from series of calculations on a variety of cases using the hourly calculation procedures, as shown in **Figure 2**. E.g. at national or regional level, to produce national or regional correction and adjustment factors replacing the informative default values from Annex B if needed.

The calculation method is basically the same method as in EN ISO 13790:2008.

For intermittent heating and cooling new straightforward formulae were developed (see explanation in CEN ISO/TR 52016-2), because the equations from EN ISO 13790:2008 appeared to lead to unintended results. The challenge was to develop a simple method that provides a rough approximation of the mean internal temperature over the intermittency period. A refined approximation would not be justified, because there are many inevitable simplifications anyway. The monthly method is not capable to deal accurately with the dynamics in the heat balance, for instance:

- no distinction in ventilation rate, operation of solar blinds, internal heat gains (incl. lighting) during occupancy periods (e.g. office hours) and during the periods with reduced heating or cooling set-point temperature (e.g. for offices: nights and weekends): the monthly method can only deal with monthly mean values;
- no distinction between operational and air temperature;
- no possibility to take into account a boost mode, with –optionally- a maximum heating or cooling power during the boost period;
- no distinction between periods (e.g. days or hours) in heating or cooling mode: the monthly method calculates for each month both the heating need *and* the cooling need as two completely separate calculations, without interaction, each with the specific assumptions, e.g. on the use of solar blinds, ventilation, etc., for the heating and the cooling mode respectively. In reality there will be days in heating mode and days, alternating, in cooling mode.

Because of the dynamic character of the moisture balance in a thermal zone, the calculation of the latent heat for (de-)humidification is not foreseen in the monthly method.

The monthly method uses monthly climatic data and monthly mean conditions of use and occupancy patterns.

Specific assumptions per application in EN ISO 52016-1

- Although aim and outcome of the hourly calculation of the internal temperature, the energy need for heating and cooling and the calculation of the heating and cooling load are different, the calculation method is the same and they use the same inputs as far as possible. However, specific assumptions of the calculations may differ. This is foreseen in the standard.
- As much as possible the monthly and hourly calculation of the energy need for heating and cooling use the same assumptions and boundary conditions. Also the same inputs are used as far as possible, although for the monthly method averaged on monthly basis and where relevant corrected to approximate the impact of dynamic effects and dynamic interactions (e.g. recoverable heat or cold from the technical building systems, control actions) that are not covered by the monthly time step.

Removal of overarching elements from EN ISO 52016-1

Several parts of EN ISO 13790:2008, preceding or following the actual calculation of the energy needs for heating and cooling, are now covered at overarching level and should therefore be removed from the standard on the energy needs for heating and cooling:

- assessment boundaries (moved to overarching standard, M1-5);
- general zoning rules (moved to overarching standard, M1-8);
- assessment of conditioned floor area (moved to overarching standard, M1-5);
- conditions of use (moved to overarching level, EN 16798-1, M1-6).

Consequently these elements are not taken over in EN ISO 52016-1 from EN ISO 13790:2008.

Relation EN ISO 52016-1 with other EPB standards

For the input-output relations with the other EN and EN ISO standards in the set of EPB standards, only EN ISO 52016-1 (and not EN ISO 52017-1) is relevant.

There are many inputs from and many interactions with many other EPB standards. More details are given in the technical report [18].

EPB standards on hygrothermal performance of building components and building elements

This concerns the revision of a suite of standards mainly under module M2-5: EN ISO 6946, EN ISO 10211, EN ISO 13370, EN ISO 13786, EN ISO 13789 and EN ISO 14683, plus the preparation of one accompanying technical report on this cluster, CEN ISO/TR 52019-2. Lead: ISO/TC 163/SC 2/WG 9 [8].

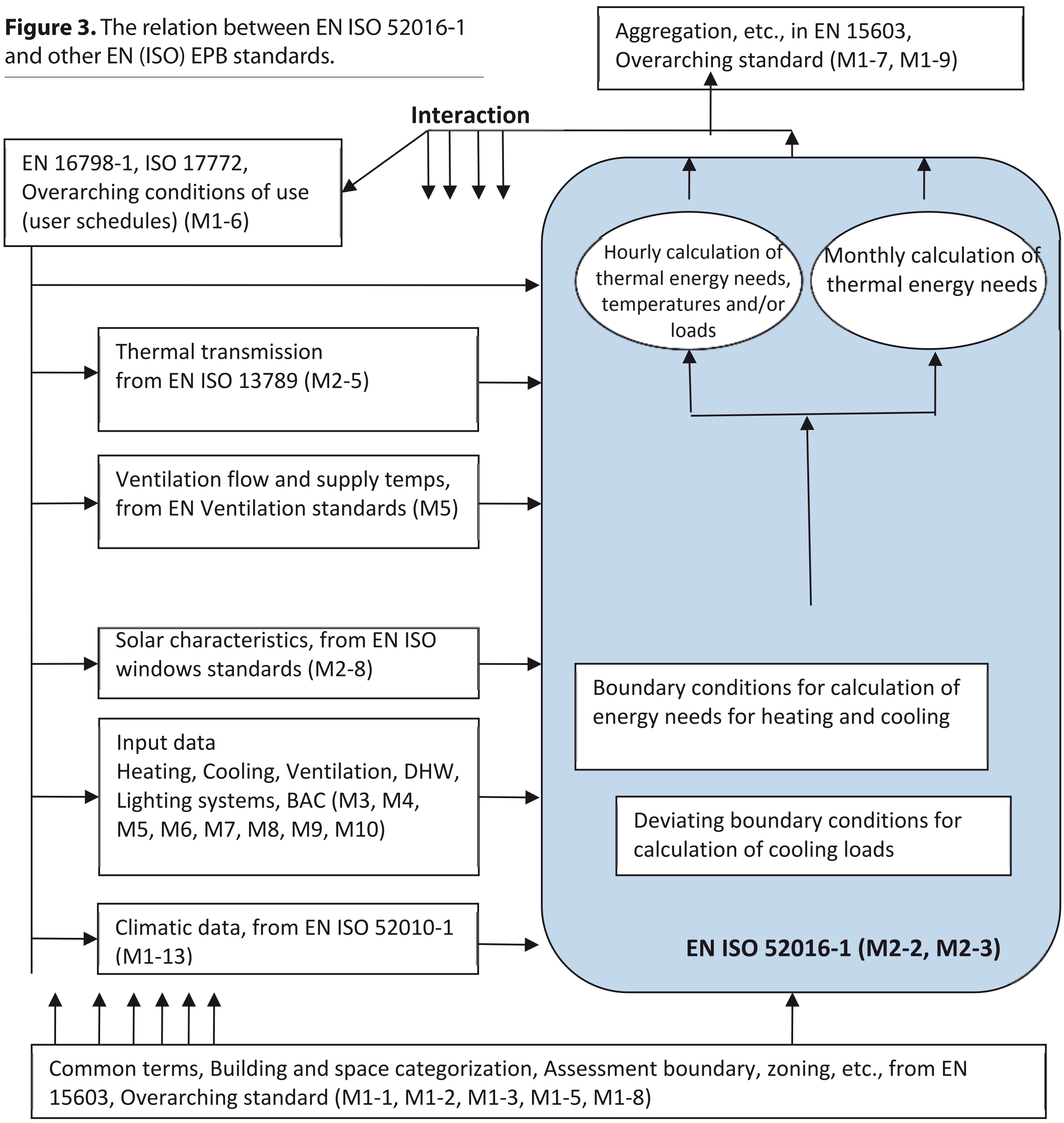
For these standards the revisions are mainly editorial, plus changes to make the procedures unambiguous and software proof, to rationalize the choices and to ensure consistent interconnections, in particular with all the other standards in the "CEN/TC 89" family of EPB standards.

EPB standards on thermal, solar and daylight properties of windows and facades

This also concerns the revision of a suite of standards under module M2-5 and M2-8: EN ISO 10077-1, EN ISO 10077-2 and EN ISO 12631 as well as EN 13363-1 (new number: ISO 52022-1) and EN 13363-2 (new number: ISO 52022-3), plus the preparation of one accompanying technical report on this cluster, CEN ISO/TR 52022-2. Lead: CEN/TC 89/WG 7 [10], in collaboration with ISO/TC 163/SC 2/WG 9 [8].

Also for these standards the revisions are mainly editorial, plus changes to make the procedures unambiguous and software proof, to rationalize the choices and to ensure consistent interconnections, in particular with the other standards in the "CEN/TC 89" family of EPB standards and with the (CEN) product standards in this field.

Figure 3. The relation between EN ISO 52016-1 and other EN (ISO) EPB standards.



In addition, a new work item proposal on dynamic facades was proposed. For the time being this subject is adopted as Annex G in EN ISO 52016-1. This annex provides a framework for the energy, load and internal temperature calculations in case of dynamic transparent building elements. Dynamic transparent building elements are elements with thermal and/or solar and/or visual properties that vary with boundary conditions, either passively or due to an active control.

Conclusion

In this paper the subset of EPB standards dealing with the energy use and the thermal performance of building and building elements were introduced, with the focus on the standards which are new or significantly revised. All these standards are being prepared as EN ISO standards, continuing the tradition of successful collaboration between CEN/TC 89, *Thermal performance of buildings and building components* and ISO/TC 163, *Thermal performance and energy use in the built environment*.

These standards cover a wide ranging chain, from building components and elements, and climatic data, to hourly and monthly calculation of the energy needs for heating and cooling and indoor temperatures, to energy performance indicators and expressions for energy performance rating and requirements. The main goal is to make these standards credible and useable, unambiguous but flexible and consistent. ■

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[13] CEN ISO/TR 52003-2, Energy performance of buildings – Indicators, requirements and certification – Part 2: Explanation and justification of ISO 52003-1 (in preparation).

[14] EN ISO/DIS 52010-1, Energy performance of buildings – Overarching assessment procedures for external environment conditions – Part 1: Conversion of measured hourly weather data to input for energy calculations (in preparation; expected to be out for 3 months enquiry starting at Dec. 31, 2014).

[15] CEN ISO/TR 52010-2, Energy performance of buildings – Overarching Assessment Procedures. External environment conditions – Part 2: Explanation and justification of ISO 52010-1 (in preparation).

[16] EN ISO 52016-1, Energy performance of buildings – Building and Building Elements – Calculation of the Energy Needs for Heating and Cooling, Internal Temperatures and Heating and Cooling Load in a Building or Building Zone – Part 1: Calculation procedures (in preparation; expected to be out for 3 months enquiry starting at Dec. 31, 2014).

[17] EN ISO 52017-1, Energy performance of buildings – Building and Building Elements – Calculation of the Dynamic Thermal Balance in a Building or Building Zone – Part 1: Detailed procedures (in preparation; expected to be out for 3 months enquiry starting at Dec. 31, 2014).

[18] CEN ISO/TR 52016-2, Energy performance of buildings – Calculation of the energy needs for heating and cooling, internal temperatures and heating and cooling load in a building or building zone – Part 2: Explanation and justification of ISO 52016-1 and ISO 52017-1.

[19] EN ISO 52018-1, Energy performance of buildings – Ways to express the energy performance and energy performance requirements of the building fabric – Part 1: Procedures (in preparation; expected to be out for 3 months enquiry starting in January 2015).

[20] CEN ISO/TR 52018-2, Energy performance of buildings – Ways to express the energy performance and energy performance requirements of the building fabric – Part 2: Explanation and justification of ISO 52018-1 (CD Aug. 2014; DIS under preparation at the time of the preparation of the present draft version of TR 52003-2).

[21] EN ISO 15927-1 to 6, Hygrothermal performance of buildings – Calculation and presentation of climatic data – Parts 1 to 6.

Indoor environmental input parameters for the design and assessment of energy performance of buildings

The first international standard that dealt with all indoor environmental parameters (thermal comfort, air quality, lighting and acoustic) was published in 2007 as EN15251. This standard prescribed input parameters for design and assessment of energy performance of buildings and was a part of the set of standards developed to support the implementation of the Energy Performance of Buildings Directive in Europe. The standard has now been revised and issued for public comments with a new number: prEN16798-1.

BJARNE W. OLESEN
Ph.D. Fellow REHVA and ASHRAE, Professor
International Centre for Indoor Environment and Energy,
Department of Civil Engineering,
Technical University of Denmark
bwo@byg.dtu.dk

Besides the standard, a Technical Report 16798-2 is also being developed to support and explain the standard in more details. The standard is now written in normative language and should be clearer as all the informative text will be included in the technical report. The standard does include default criteria in 3-4 categories (**Table 1**) for the indoor environmental parameters, as described in this paper. It is however in a series of tables in an informative annex B. Individual countries can decide if they want to use these default values, only use one category, or use quite different values, which will be included in a normative national annex A with similar structure as annex B.

It is important to emphasis that the requirements and default criteria are based on the influence on the occupants and the standard do not set direct criteria depending on the type of system (mechanical or non-mechanical) used for conditioning the space.

Table 1. Description of the applicability of the categories used.

Category	Explanation
I	High level of expectation and also recommended for spaces occupied by very sensitive and fragile persons with special requirements like some disabilities, sick, very young children and elderly persons, to increase accessibility.
II	Normal level of expectation
III	An acceptable, moderate level of expectation
IV	Low level of expectation. This category should only be accepted for a limited part of the year

The draft technical report TR16798-2 will include guidance to the standard in similar sections as the standard. The TR includes also some additional sections and annexes with more voluntary concepts and methods as described in this paper.

In parallel two similar documents ISO-CD17772 and ISO-DTR17772 are being developed as almost identical documents. At a later stage it may be possible to combine these standards to one EN-ISO standard. The entire mentioned document will be available for comments during the first couple of months in 2015.

In the following section some of the highlights and especially what is new will be described.

Thermal Environment

The sections for thermal environment are almost identical to the existing standard. Criteria for both mechanical and non-mechanical heated, cooled and ventilated buildings are included. An addition is the criteria for local thermal discomfort based on EN ISO 7730 including draught, vertical air temperature differences, and radiant thermal asymmetry and floor surface temperatures. These criteria do not influence the calculation of energy performance; but will influence the design of the building and heating, cooling, and ventilation systems.

In the standard personalized systems have been introduced as a new part; but without any default criteria. However an annex in the TR gives some examples on how criteria for personalized systems could be expressed (see **Table 2**).

Table 2. Example criteria for personalized systems.

Aspect	Requirement
'Temperature' control winter	At workstation level, the (operative/equivalent) temperature is adjustable with a response speed of at least 0,5 K / minute within a range of 5 K, from 18 to 23 °C.
'Temperature' control summer	At workstation level, the (equivalent) temperature is adjustable (with a response speed of at least 0,5 K / minute within a range of 5 K, from 22 to 27 °C.
Fresh air supply control	Local fresh air supply (per workstation) is adjustable from around 0 to at least 7 l/s.
Delivered air quality	For requirements related to air cleaning technology: see Annex K.
Installation noise	Noise level - with the personalized system in the highest setting - should not be higher than 35 dB(A).

Air Quality

The standard does include some new aspects related to indoor air quality. Like in the existing standard the requirements to indoor air quality is mainly expressed as a required minimum ventilation rate. The general requirements for the designer regarding the indoor air quality is the same for residential and non-residential buildings.

Design parameters for indoor air quality shall be derived using one or more of the following methods:

- Method based on perceived air quality
- Method using criteria for pollutant concentration
- Method based on pre-defined ventilation air flow rates

Within each method, the designer shall choose between different categories of indoor air quality and define which building category is to be used. The method used shall be documented and it must be explained why the selected method is appropriate.

Method based on perceived air quality

The total ventilation rate for the breathing zone is found by combining the ventilation for people and building calculated from the following formula.

$$q_{tot} = n \cdot q_p + A_R \cdot q_B \qquad \text{Eq (1)}$$

Where

q_{tot} = total ventilation rate for the breathing zone, l/s
n = design value for the number of the persons in the room, –
q_p = ventilation rate for occupancy per person, l/s·per person
A_R = floor area, m²
q_B = ventilation rate for emissions from building, l/s per m²

The basic tables with default values are **Table 3** and **Table 4**. The perceived air quality levels are set for non-adapted persons. If in special cases the design will include adapted persons see TR16798-2. A new criteria is that the total ventilation rate must never be lower than 4 l/s per person.

A building is by default a low-polluting building unless prior activity has resulted in pollution of the building (e.g. smoking). In this case, the building shall be regarded as non-low polluting. The category very low-polluting

Table 3. Design ventilation rates for non-adapted persons for diluting emissions (bioeffluents) from people for different categories.

Category	Expected Percentage Dissatisfied %	Airflow per non-adapted person l/s per person
I	15	10
II	20	7
III	30	4
IV	40	2,5*

* Category IV is intended for the evaluation of IAQ in existing buildings where the space for installations are limited.

Table 4. Design ventilation rates for diluting emissions from different type of buildings.

Category	Very low polluting building l/s per m²	Low polluting building l/s per m²	Non low-polluting building l/s per m²
I	0,5	1,0	2,0
II	0,35	0,7	1,4
III	0,2	0,4	0,8
IV	0,15	0,3	0,6
Minimum total ventilation rate for health	4 l/s per person	4 l/s per person	4 l/s per person

requires that the majority of building materials used for finishing the interior surfaces meet the national or international criteria of very low-polluting materials. An example of how to define very low-polluting building materials is given in Annex B3 of the standard.

The technical report will show tables with default values based on the two tables above and an assumed density of occupants. An example is given here in **Table 5**.

As mentioned above the technical report is also discussing a possible design for adapted persons i.e. persons that have occupied the space for more than 15 minutes and then adapted to the odour level of bioeffluent from the occupants. This may be relevant for spaces like conference rooms and auditorium, where people enter at the same time. The odour level will increase (perceived air quality decrease); but at the same time the occupants adapt to the odour level in the space and the lower ventilation and level of perceived air quality acceptable. This is as example the basis for the minimum ventilation rates given in ASHRAE standard 62.1. In the present standard prEN16798-1 the criteria of a total ventilation of minimum 4 l/s person must be fulfilled. It can be seen in **Table 5** that only in a few cases the criteria of 4 l/s person will be used and only for category 4. On the other hand if the ventilation rate is designed for adapted occupants the criteria of minimum 4 l/s person is used in all cases except for Category I. The values in italics indicate situations where the calculated ventilation rate is lower than the minimum value of 4 l/s per person required for health.

Method using criteria for pollutant concentration

The ventilation rate required to dilute a pollutant shall be calculated by this equation:

$$Q_h = \frac{G_h}{C_{h,i} - C_{h,o}} \cdot \frac{1}{\varepsilon_v} \qquad \text{Eq (2)}$$

Where:

Q_h = the ventilation rate required for dilution, in litre per second;

G_h = the pollution load of a pollutant, in micrograms per second;

$C_{h,i}$ = the guideline value of a pollutant, see Annex B6 , in micrograms per m³;

$C_{h,o}$ = the supply concentration of pollutants at the air intake, in micrograms per m³;

ε_v = the ventilation effectiveness

NOTE. $C_{h,i}$ and $C_{h,o}$ may also be expressed in ppm (vol/vol). In this case the pollution load G_h has to be expressed in l/s.

To calculate the design ventilation air flow rate from Eq. (2), the most critical or relevant pollutant (or groups of pollutant) shall be identified and the pollution load in the space shall be estimated. When this method is used it is required that CO_2 representing the pollutant emission from people (bio effluents) shall be used as one of the gases. Values depending on the category of indoor

Table 5. Non-adapted persons. Examples of recommended ventilation rates for non-residential buildings with default occupant density for three categories of pollution from the building.

Type of building or space	Cate-gory	Floor area m² per person	q_p	q_p	q_B	q_{tot}		q_B	q_{tot}		q_B	q_{tot}	
			minimum ventilation rate										
			l/s per m²	l/s per person	l/s per m²	l/s per m²	l/s per person	l/s per m²	l/s per m²	l/s per person	l/s per m²	l/s per m²	l/s per person
			for occupancy only		for very low-polluted building			for low-polluted building			for non-low polluted building		
Single office	I	10	1	10	0,5	1,5	15	1	2,0	20,0	2	3,0	30
	II	10	0,7	7	0,35	1,1	11	0,7	1,4	14,0	1,4	2,1	21
	III	10	0,4	4	0,2	0,6	6	0,4	0,8	8,0	0,8	1,2	12
	IV	10	0,25	2,5	0,15	0,4	4	0,3	0,6	5,5	0,6	0,9	9
Land-scaped office	I	15	0,7	10	0,5	1,2	18	1	1,7	25,0	2	2,7	40
	II	15	0,5	7	0,35	0,8	12	0,7	1,2	17,5	1,4	1,9	28
	III	15	0,3	4	0,2	0,5	7	0,4	0,7	10,0	0,8	1,1	16
	IV	15	0,2	2,5	0,15	0,3	5	0,3	0,5	7,0	0,6	0,8	12
Confe-rence room	I	2	5	10	0,5	5,5	11	1	6,0	12,0	2	7,0	14
	II	2	3,5	7	0,35	3,9	8	0,7	4,2	8,4	1,4	4,9	10
	III	2	2	4	0,2	2,2	4	0,4	2,4	4,8	0,8	2,8	6
	IV	2	1,25	2,5	0,15	(1,4) 1,8	(3) 4	0,3	(1,6) 2	(3,1) 4	0,6	1,9	4
Audito-rium	I	0,75	13,3	10	0,5	13,8	10	1	14,3	10,8	2	15,3	12
	II	0,75	9,3	7	0,35	9,7	7	0,7	10,0	7,5	1,4	10,7	8
	III	0,75	5,3	4	0,2	5,5	4	0,4	5,7	4,3	0,8	6,1	5
	IV	0,75	3,3	2,5	0,15	(3,5) 4.7	(3) 4	0,3	(3,6) 5,3	(2,7) 4	0,6	(3,9) 4,7	(3) 4

Table 6. Adapted persons. Examples of recommended ventilation rates for non-residential buildings with default occupant density for three categories of pollution from building itself.

Type of building or space	Cate-gory	Floor area m² per person	q_p		q_B	q_{tot}		q_B	q_{tot}		q_B	q_{tot}	
			Adapted q_p according to table B1										
			l/s per m²	l/s per person	l/s per m²	l/s per m²	l/s per person	l/s per m²	l/s per m²	l/s per person	l/s per m²	l/s per m²	l/s per person
			for occu-pancy		for very low-polluted building			for low-polluted building			for non-low polluted building		
Confe-rence room	I	2	1,75	3,5	0,5	2,25	4,5	1	2,75	5,5	2	3,75	7,5
	II	2	1,25	2,5	0,35	1,60	(3,2)4	0,7	1,95	(3,9)4	1,4	2,65	5,3
	III	2	0,75	1,5	0,3	1,05	(2,1)4	0,4	1,15	(2,3)4	0,8	1,55	(3,1)4
	IV	2	0,50	1	0,25	0,75	(1,5)4	0,3	0,80	(1,6)4	0,6	1,10	(2,2)4
Audito-rium	I	0,75	4,67	3,5	0,5	5,17	(3,9)4	1	5,67	4,3	2	6,67	5,0
	II	0,75	3,33	2,5	0,35	3,68	(2,8)4	0,7	4,03	(3,0)4	1,4	4,73	(3,6)4
	III	0,75	2,00	1,5	0,3	2,30	(1,7)4	0,4	2,40	(1,8)4	0,8	2,80	(2,1)4
	IV	0,75	1,33	1	0,25	1,58	(1,2)4	0,3	1,63	(1,2)4	0,6	1,93	(1,5)4

air are defined for CO_2 in Annex B2 of the standard. Threshold values, based on WHO, for other sources are listed in Annex B6. Emission rates and outdoor concentrations for the gases considered shall be defined based on material testing or certification (see Annex B3 of the standard) and local ambient air quality values.

Method based on pre-defined ventilation air flow rates

This is a method to determine certain pre-defined minimum ventilation air flow rate estimated to meet requirement for both perceived air quality and health in the occupied zone.

The pre-defined ventilation air flow rates shall be expressed by one or more of the following parameters:

- total design ventilation for people and building components (q_{tot});
- design ventilation per unit floor area (q_{m^2}); design ventilation per person (q_p);
- design air change rates (ach); design opening areas (A_{tot}).

Default values are presented in Annex B2 of the standard.

Design ventilation rates in residential buildings

Pre-defined ventilation air flow rates can be given on national level based on one or more of the following criteria: total air change rate for the dwelling, supply air flows for specific rooms, exhaust air flows from specific rooms. In Annex B2 of the standard the default values for the three criteria is shown (see **Table 7**). It is assumed that air is supplied in living rooms and extracted from wet rooms. Both the total air flow rate for the entire dwelling and the exhaust air flow rate from wet rooms shall be calculated. The higher of the two shall be used. In the technical report several examples on default ventilation rates in residential buildings are presented.

The standard is also describing concepts for natural ventilated building, where the criteria based on CO_2 could be used. In annex B2 a methodology for defining default design opening areas for natural ventilation systems in dwelling is presented (see **Table 8**). The opening areas must be provided as supply/extract grilles, stack ducts, window grilles, or similar system.

Table 7. Default criteria based on pre-defined ventilation air flow rates: Total ventilation (1), Supply air flow (2) and (3) supplemented by exhaust air flow.

Category	Total ventilation including air infiltration		Supply air flow per. person	Supply air flow based on perceived IAQ for adapted persons		Supply air flow for bedrooms	Exhaust air flow Peak or boost flow for high demand l/s		
	(1)		(2)	(3)		(4)			
	l/s per m²	ach	l/s per person	q_p l/s per person	q_B l/s per m²	l/s per person	Kitchen (3a)	Bath-rooms (3b)	Toilets (3c)
I	0,49	0,7	10	3,5	0,25	10	28	20	14
II	0,42	0,6	7	2,5	0,15	8	20	15	10
III	0,35	0,5	4	1,5	0,1	4	14	10	7
IV*	0,23	0,4				2,5*	10	6	4

Column 3 and 4: The ventilation air flow rates must be available when the rooms are occupied. The design can take into account that not all bedrooms are occupied at the same time, e.g. during daytime. The number of persons in bedroom depends on the size according to design criteria and building regulations.

* Category IV is intended for the evaluation of IAQ in existing buildings where the space for installations are limited.

Supply air flow for method 3 is based on eq (1).

Table 8. Default design opening areas for dwellings. Values for bedrooms and living rooms may be given per m² floor area or as fixed values per room.

	Extract Kitchen, bathrooms and toilets (cm²)	**Supply** Bedrooms and living rooms (cm²)
Default design opening area	100 per room	60 per room

Filtration and air cleaning

The standard is also setting up some requirements regarding the use of filtration and air cleaning. The influence of position of outdoor air intakes, filtration and air cleaning shall be considered according to prEN 16798-3 (revised EN13779) and the draft technical report TR 16798-2. If filtration and air cleaning is used the following points shall be considered:

- Reducing the amount of airborne pollutants (pollens, molds, spores, particles, dust) from the outdoor air intake by circulating the air through a filter.
- Circulating secondary air through a filter or other air cleaning technology to reduce the amount of pollutants in the air
- Reduce the concentration of odours and gaseous contaminants by circulating the secondary air or recirculating the return air (gas phase air cleaning)

Design guidelines on air cleaning and filtration are given in prEN16798-3 and ISO DIS 16814. How to partially substitute outside air by air cleaning is described in draft TR16798-2.

Lighting

To enable people to perform visual tasks efficiently and accurately, appropriate lighting shall be provided. The degree of visibility and comfort is wide ranging governed by activity type and duration of required lighting criteria for work places as specified in EN12464-1 and for sports lighting in EN 12193. For some visual tasks in buildings and spaces the required lighting default criteria are presented in Annex B4 to the standard. The design illuminance levels shall be obtained by means of daylight, electric light or a combination of both. For reasons of comfort and energy in most cases the use of daylight is preferred. This depends on factors like standard occupancy hours, autonomy (portion of occupancy time during which there is enough daylight), location of the building (latitude), amount of daylight hours during summer and winter, etcetera.

A new thing is the inclusion of a table with default values for daylighting as shown in **Table 9**.

Noise

Guidance for evaluation of noise at the design stage is found in EN 12354-part 5. The noise from building service systems may disturb the occupants and prevent the intended use of the space or building. The noise in a space shall be evaluated using A-weighted equivalent sound pressure level, normalized with respect to reverberation time to take into account the sound absorption of the room. Default values for three categories are then listed in the informative annex to the standard.

Occupant schedules for energy calculations

For energy calculations the result will depend very much on how the occupant schedules will be assumed. In this way it may be very difficult to compare same type of building if different occupant schedules have been used. Therefore the standard prEN16798-1 list several recommended occupant schedules for different type of spaces like residential, offices, schools, restaurant, meeting room, department store, etc. The schedules include criteria for the indoor environment based on the default values, time and level of occupancy and internal loads from other equipment. The criteria used for room temperatures, ventilation, and humidity are based on Category II and very low-polluted building. The internal loads from appliances are based on recent values from a study by REHVA.

Table 9. Daylight availability classification as a function of the daylight factor DCa,j of the raw building envelop opening and DSNA EN15193.

Vertical Facades Daylight factor DCa,j	Roof lights Daylight factor DSNA	Classification of daylight availability
DCa,j ≥ 6%	7% < DSNAa	Strong
6% > DCa,j ≥ 4%	7% > DSNA ≥ 4%	Medium
4% > DCa,j ≥ 2%	4% > DSNA ≥ 2%	Low
DCa,j < 2%	2% > DSNA ≥ 0%	None

a Values of DSNA > 10% should be avoided due to danger of overheating

Additional sections in the technical report

The following sections from the existing standard have all been moved to the technical report with only a few changes.

- Evaluation of the indoor environment and long term indicators
- Inspections and measurement of the indoor environment in existing buildings
- Classification and certification of the indoor environment.

Conclusions

With this revision a more concise standard will be available together with guidance in a technical report.

All criteria listed given as categories in an informative annex are default values. Individual countries may select other values or one category following the concept of the way the default values are expressed.

The inclusion of default occupant schedules will make the calculated energy performance more comparative between buildings. ■

References

[1] CEN/TC156/WG19/N84: prEN16798-1 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.

[2] CEN/TC156/WG19/N89: draft prCEN/TR 16798-2 WD :Guideline for using indoor environmental input parameters for the design and assessment of energy performance of buildings.

[3] prEN16798-3: Energy performance of buildings - Part 3: Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems; see also article Claus Händel.

Articles

Ventilation for non-residential buildings

– *Performance requirements for ventilation and room-conditioning system*

CLAUS HÄNDEL
Convenor CEN/TC 156 WG20: Revision of EN 13779,
European Ventilation Industry Association (EVIA),
Fachverband Gebäude-Klima e.V. (FGK)
haendel@fgk.de

Over almost 10 years, EN 13779 ventilation for nonresidential buildings – performance requirements for ventilation and room-conditioning systems is used as a basic standard for the design of ventilation systems within Europe (draft in 2003 and EN in 2007). The standard specifies a common understanding of ventilation systems in Europe and provides a classification system for key performance data.

Main changes in EN 13779 / EN 16798-3

Within EPBD-Mandate M480, EN 13779 was identified as a key standard used in the building regulations of many EU member states. The current revision reflects the needs to update some aspects and to clarify some borderlines with other standards. There have been made some editorial changes. First the standard was renumbered to EN 16798-3, which is little helpful, because this standard is one of the most used in ventilation segment and second, the standard was split into a normative part and an supporting Technical Report CEN/TR 16798-4, containing all informative annexes of former EN 13779 (**Figure 1**). As in all revised EPBD standards, the normative EN 16798-3 offers the possibility of a national annex to clarify the national needs.

All indoor air quality aspects in EN 16798-3 (IDA classes etc.) have been deleted or shifted to EN 16798-1. The main focus of the current standard is on the performance of the technical system and its impact on energy efficiency and supply air quality.

- Design and definition aspects will mainly be kept and updated
  - o Agreement of design criteria
  - o Specifications of air

- All aspects of indoor air quality and indoor environment will be handled in EN 16798-1
  - o Based on the needs of human beings and buildings
  - o Ventilation rate (based on fully mixed airflows)
  - o Temperature, humidity, draft risk, etc. CO_2

- All aspects of the system of non-residential ventilation will be kept in EN 16798-3
  - o Outdoor Air Quality
  - o Supply Air Quality
  - o System performance
  - o System design

Ecodesign Directive

In November 2014 the "EU COMMISSION REGULATION (EU) No 1253/2014 of 7 July 2014 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for ventilation units" was published, specifying minimum performance requirements for ventilation units. The key performance requirements are:

- **Internal specific fan power** of ventilation components (SFP_{int}) is the ratio between the internal pressure drop of ventilation components and the fan efficiency, determined for the reference configuration

- **Thermal efficiency of a non-residential heat recovery** (η_{t_nrvu}) means the ratio between supply air temperature gain and the exhaust air temperature loss, both relative to the outdoor temperature, measured under dry reference conditions, with balanced mass flow, an indoor-outdoor air temperature difference of 20 K, excluding thermal heat gain from fan motors and from **internal leakages**

EN 16798-3 was updated to specify calculation procedures and a link between EPBD and ErP.

Basic System Types and Configurations

Air-conditioning and room conditioning systems may or may not be combined with ventilation systems. **Table 1** shows a definition of principle ventilation systems based on the air volume flow.

Based on ventilation and thermal functions, ventilation or air-conditioning system can be specified by functions as shown in **Table 2**. Systems may also be combined to provide more functions.

Outdoor Air, Supply Air

In the process of system design, consideration needs to be given to the quality of the outdoor air (ODA) around the building or proposed location of the building. The classification was updated to the current guidelines (WHO 2005) and regulations.

Table 1. Basic system types of ventilation systems.

Description	Name of the system type
Ventilation system with a fan assisted air volume flow in only one direction (either supply or exhaust) which is balanced by air transfer devices in the building envelope.	Unidirectional ventilation system
Ventilation system with a fan assisted air volume flow in both direction (supply and exhaust)	Bidirectional ventilation system
Ventilation relying on utilisation of natural driving forces (further guidance in CEN/TR 16798-4)	Natural ventilation system
Ventilation relying to both natural and mechanical ventilation in the same part of a building, subject to control selecting the ventilation principle appropriate for the given situation (either natural or mechanical driving forces or a combination thereof).	Hybrid ventilation

As a starting point for ODA classification, EN 16798-3 proposes the following procedure:

- ODA 1 applies where the WHO (2005) guidelines and any National air quality standards or regulations for outdoor air are fulfilled.
- ODA 2 applies where pollutant concentrations exceed the WHO guidelines or any National air quality standards or regulations for outdoor air by a factor of up to 1,5.
- ODA 3 applies where pollutant concentrations exceed the WHO guidelines or any National air quality standards or regulations for outdoor air by a factor greater than 1,5.

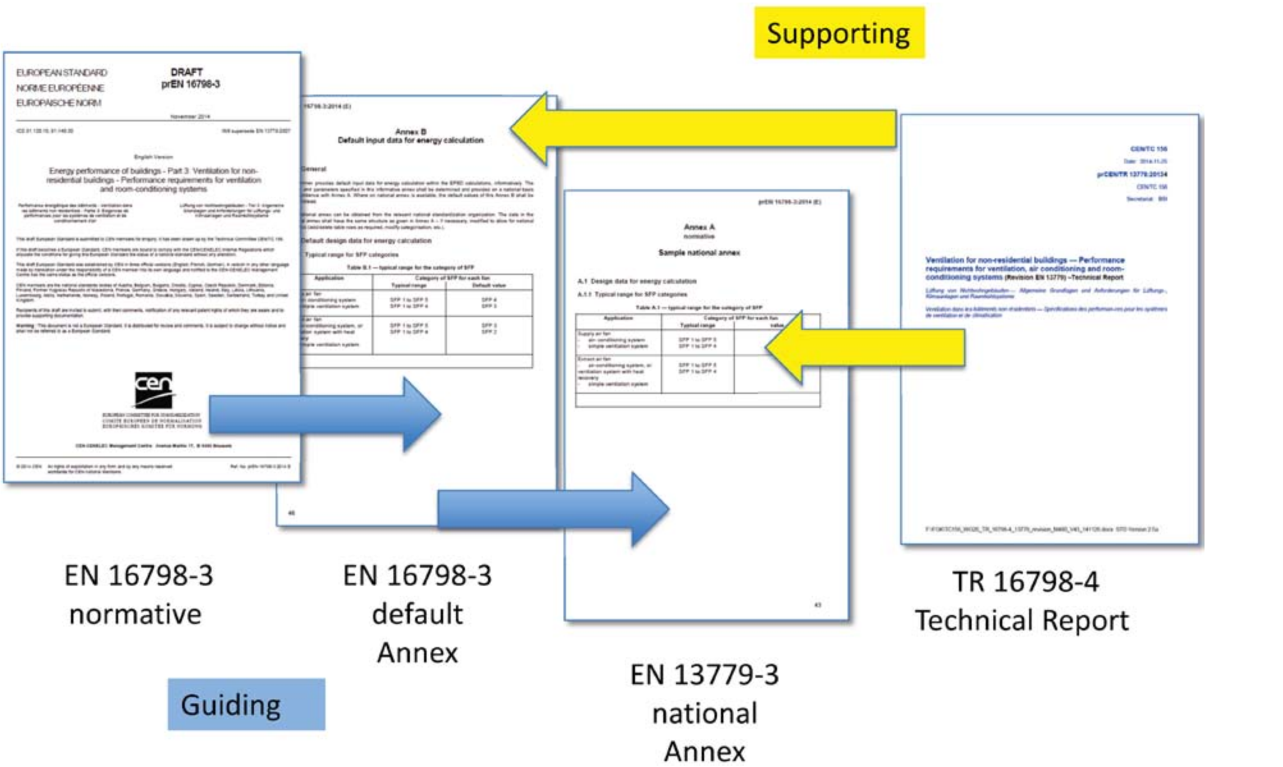

Figure 1. Structure of EN 16798-3 and -4.

The classification shall be divided into two categories: ODA (G) for gaseous components and ODA (P) for particle components.

For Supply air classification, the following approach is suggested.

- SUP1 applies where the supply air fulfils the WHO (2005) guidelines limit values and any National air quality standards limit values or regulations with a factor x 0,25
- SUP2 applies where the supply air fulfils the WHO (2005) guidelines limit values and any National air quality standards limit values or regulations with a factor x 0,5
- SUP3 applies where the supply air fulfils the WHO (2005) guidelines limit values and any National air quality standards limit values or regulations with a factor x 0,75
- SUP4 applies where the supply air fulfils the WHO (2005) guidelines limit values and any National air quality standards limit values or regulations.

Filtration

The dimensioning of filter sections has been updated and clearly linked to the revision of EN 779. Depending on outdoor particle pollution level (ODA (P)) and desired supply air quality (SUP) different levels of filtration will be required (**Table 3**).

Table 3. Minimum filtration efficiency based on particle outdoor air quality.

Outdoor air quality	Supply air class			
	SUP 1	SUP 2	SUP 3	SUP 4
ODA (P) 1	88%*	80%*	80%*	80%*
ODA (P) 2	96%*	88%*	80%*	80%*
ODA (P) 3	99%*	96%*	92%*	80%*

* Combined average filtration efficiency over a single or multiple stage filtration an accordance to average filtration efficiency specified in EN 779

The required total filtration efficiency can be achieved by using single or multiple stage filtrations depending on the individual design process. In case of multiple stage filtrations, the combined filtration efficiency shall be calculated as follows:

$$E_t = 100 \cdot \left(1 - \left(\left(1 - \frac{E_{s1}}{100}\right) \cdot \left(1 - \frac{E_{s2}}{100}\right) \cdot \ldots \cdot \left(1 - \frac{E_{sn+1}}{100}\right)\right)\right)$$

Where:
E_t = the total filter efficiency
E_{sn+1} = the efficiency of each filter step

To maintain a good hygiene level in the ventilation system the minimum combined filtration efficiency needs to meet filtration class F7 in accordance with EN 779.

Table 2. Types of Ventilation-, Air-conditioning-, and Room Conditioning-Systems based on functions.

System	Supply Air Fan	Exhaust Air Fan	Secondary Fan	Heat Recovery	Waste heat pump	Filtration	Heating	Cooling	Humidification	Dehumidification
Unidirectional supply air ventilation system (Positive pressure ventilation)	x	-	-	-		o	o	-	-	-
Unidirectional exhaust air system	-	x	-		o	-	-	-	-	-
Bidirectional ventilation system	x	x	-	x	o	x	o	-	-	-
Bidirectional ventilation system with humidification	x	x		x	o	x	o	-	x	-
Bidirectional air-conditioning system	x	x		x	o	x	o	(x)	o	(x)
Full air-conditioning system	x	x		x	o	x	x	x	x	x
Room air conditioning system (Fan-Coil, DX-Split-Systems, VRF, local water loop heat pumps, etc.)	-	-	x	-	-	o	o	x	-	(x)
Room air heating systems	-	-	x	-	-	o	x	-	-	-
Room conditioning system	-	-	-	-	-	-	o	x	-	-

x equipped with (x) equipped with, but function might be limited - not equipped with o may or may not equipped with

In cases where supply air level of SUP 1 or 2 is required and where the outdoor air quality based on gaseous components is of level ODA (G) 2 or ODA (G) 3 the particle filtration shall be optional complemented with suitable gas phase filtration to reduce harmful levels of gaseous components like CO, NOx, SOx, VOC and O_3.

Specific Fan Power and AHU related SFP values

The specific fan power of fans (*SFP*) is a well introduced value and implemented in many national building regulations. Although the value seems to be quite simple, there are many options how to calculate. The different ways to calculate have been clarified and the new *SFP* internal has been introduced.

ErP Regulation EU 1253/2014 uses the SFP_{int} to limit the electricity demand for ventilation functions. Three parts of *SFP* (internal, additional and external pressure loads) are defined separately (**Figure 2**).

The **specific fan power, SFP_{int}** is the electric power, in kW, supplied to a fan and related to the internal pressure of all ventilation components (Filters, heat recovery and related casing) divided by the air flow expressed in m³/s under design load conditions.

The **specific fan power, SFP_{add}** is the electric power, in kW, supplied to a fan and related to the internal pressure of all internal additional ventilation components (coolers, heaters, humidifier, etc.) divided by the air flow expressed in m³/s under design load conditions.

The **specific fan power, SFP_{ext}** is the electric power, in kW, supplied to a fan and related to the external pressure divided by the air flow expressed in m³/s under design load conditions.

$$P_{SFP,\,SUP} = P_{SFP,\,SUP,\,int} + P_{SFP,\,SUP,\,add} + P_{SFP,SUP,\,ext}$$

$$P_{SFP,\,EXT} = P_{SFP,\,EXT,\,int} + P_{SFP,\,EXT,\,add} + P_{SFP,EXT,\,ext}$$

$$P_{SFP} = \frac{\Delta p_{\text{int } tot}}{\eta_{tot}} + \frac{\Delta p_{add\ tot}}{\eta_{tot}} + \frac{\Delta p_{ext\ tot}}{\eta_{tot}} = \frac{\Delta p_{\text{int } stat}}{\eta_{stat}} + \frac{\Delta p_{add\ stat}}{\eta_{stat}} + \frac{\Delta p_{ext\ stat}}{\eta_{stat}}$$

$$P_{SFP,int} = P_{SFP,\,SUP,\,int} + P_{SFP,\,EXT,\,,int}$$

Where:

$\Delta p_{\text{int tot}}$ = total internal pressure rise from the ventilation components (fan casing, heat recovery, and filters) in Pa

$\Delta p_{\text{add tot}}$ = total additional pressure rise from the additional components (cooler, heat exchanger, humidifier, silencer, etc.) in Pa

$\Delta p_{\text{ext tot}}$ = total external pressure rise from the ductwork and external components in Pa

$\Delta p_{\text{int stat}}$ = static internal pressure rise from the ventilation components (fan casing, heat recovery and filters) in Pa

$\Delta p_{\text{add stat}}$ = static additional pressure rise from the additional components (cooler, heat exchanger, humidifier, silencer, etc.) in Pa

$\Delta p_{\text{ext stat}}$ = static external pressure rise from the ductwork and external components in Pa

η_{tot} = $\eta_{\text{fan tot}} \cdot \eta_{\text{tr}} \cdot \eta_{\text{m}} \cdot \eta_{\text{c}}$ based on total pressure

η_{stat} = $\eta_{\text{fan stat}} \cdot \eta_{\text{tr}} \cdot \eta_{\text{m}} \cdot \eta_{\text{c}}$ based on static pressure

$P_{SFP,\,SUP}$ = the SFP-value on supply air side

$P_{SFP,\,EXT}$ = the SFP value on extract air side

$P_{SFP,int}$ = the internal SFP value of the bidirectional air handling unit.

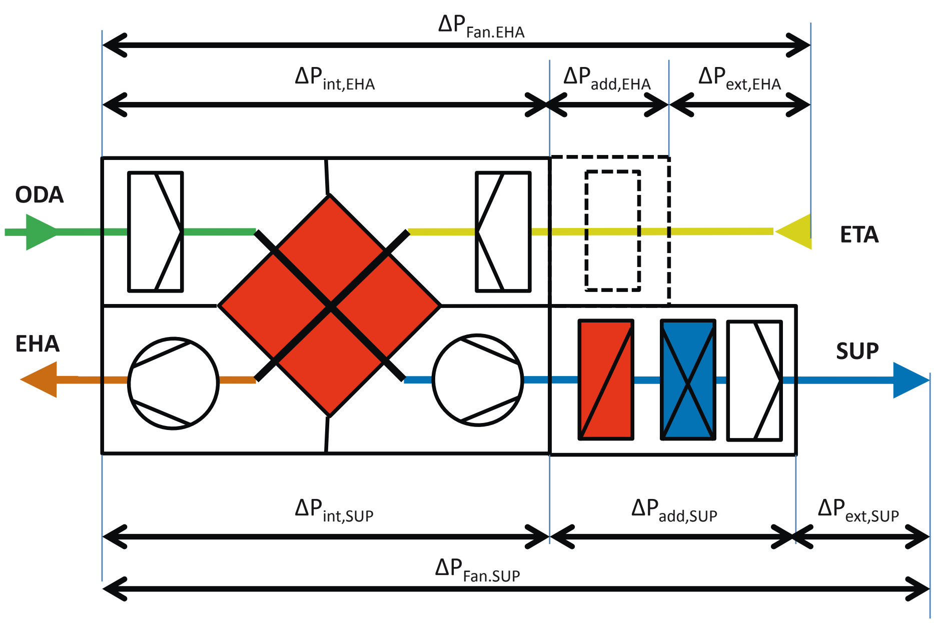

Figure 2. AHU related SFP values.

Leakages in ventilation systems and heat recovery

Leakages impact hygiene aspects, energy efficiency in ventilation systems, and functional problems. There are three different leakages types which have to be considered:

- leakages in heat recovery;
- leakages of the AHU casing;
- leakages of the air distribution (ducts).

Two new criteria to specify the leakages in heat recovery have been introduced:

- Exhaust Air Transfer ratio (EATR) [%]:
- Outdoor Air Correction Factor (OACF) [–]:

EATR provides information on the level of carry-over of the supply air by the exhaust air in the heat recovery component.

$$EATR = \frac{a_{SUP,HR} - a_{ODA,HR}}{a_{EXT,HR}}$$

Where:

$a_{SUP,HR}$ = the concentration in supply air leaving the HR component
$a_{ODA,HR}$ = the concentration in outdoor air entering the HR component
$a_{EXT,HR}$ = the concentration in extract air entering the HR component

The Outdoor Air Correction Factor (OACF) is the ratio of the entering supply mass airflow rate and the leaving supply mass airflow rate:

$$OACF = \frac{q_{m,ODA,HR}}{q_{m,SUP,HR}}$$

Where:

$q_{m,ODA,HR}$ = the air mass flow of outdoor air entering HR component
$q_{m,SUP,HR}$ = the air mass flow of supply air leaving the HR component

Further detailed specifications will be made in EN 308 revision and TR 16798-4.

- If OACF>1: air is transferred from the supply to the exhaust air
- If OACF<1: air is transferred from exhaust to supply air (air recirculation)

EATR and OACF shall be calculated and classified by the heat recovery manufacturer for the nominal design condition of the air handling unit (**Table 4**).

Table 4. Classification of Outdoor air correction factor.

	OACF	
Class	**Supply to exhaust air**	**Exhaust to supply air**
1	1,03	0,97
2	1,05	0,95
3	1,07	0,93
4	1,10	0,9
5	Not classified	

Energy rating of ventilation systems

Energy performance calculations for the entire building includes many different processes and energies. To allow designing engineers an overview, process orientated index are needed. For ventilation systems, the following benchmarks have been introduced.

Heat recovery efficiency

The annual energy efficiency of the heat recovery is calculated based on recovered energy and heating need of ventilation

$$\varepsilon_{SUP} = 1 - \frac{Q_{H;V;in;req}}{Q_{H;V;tot}}$$

Where:

ε_{SUP} = annual energy efficiency of heat recovery (–)
$Q_{H;V;in;req}$ = annual heating energy of ventilation supply (or/and intake) air (kWh)
$Q_{H;V;tot}$ = annual heating energy of supply (or/and intake) air without heat recovery (kWh)

Annual heating energy of ventilation may be calculated for one ventilation system or for all ventilation systems in the building.

Coefficient of performance of heat recovery shall be calculated according EN 13053:

$$\varepsilon = \frac{Q_{hr}}{E_{V;hr;gen;in;el}}$$

Where:

ε = coefficient of performance (–)
Q_{hr} = heat transferred by heat recovery (kW)
$E_{V;hr;gen;in;el}$ = Electric energy of the heat recovery section required by fans and auxiliaries (kW)

Primary energy use of ventilation

Electrical energy for air transportation and thermal energy for heating, humidification and possibly cooling and dehumidification are linked somehow, because components with a higher thermal efficiency may have a higher pressure drop. A low SFP values might lead to a low heat recovery performance or heating coil performance, or the other way round.

A combined value of thermal and electrical energy demand might be helpful to benchmark the ventilation system within a specified building. The primary energy use of ventilation systems shall be calculated as follows:

$$E_{P;V} = q_{H;V;in;req} \cdot f_{H} \cdot f_{P,H} + e_{V;gen;in;el} \cdot f_{P,E} + e_{HU;cr} \cdot f_{P;cr} + (w_{V;aux} + w_{HU;aux}) \cdot f_{P,E}$$

Where:

$E_{P;V}$ = Primary energy use of ventilation in Wh/(m³/h·a)

$q_{H;V;in;req}$ = Specific required AHU heating coil input in Wh/(m³/h·a)

f_{H} = Delivered energy factor for heat (taking into consideration distribution and generation)

$e_{HU;cr}$ = Specific humidification generation input in Wh/(m³/h·a)

$f_{P;cr}$ = Primary energy factor of carrier required by the humidifier

$f_{P,E}$ = Primary energy factor for electricity

$f_{P,H}$ = Primary energy factor for heat

$e_{V;gen;in;el}$ = Specific electrical energy requirement for supply and extract air delivery in Wh/(m³/h·a)

$w_{V;aux}$ = Specific ventilation auxiliary energy in Wh/(m³/h·a)

$w_{HU;aux}$ = Specific humidification auxiliary energy in Wh/(m³/h·a)

Conclusion

In the first months of 2015, the enquiry for EN 16798-3 will be launched. Parallel to the enquiry, the Technical Report CEN/TR 16798-4 will be finished. This report will additionally give some guidance to natural ventilation systems. ■

Literature

EN 16798-3: prEN 16798-3 - Energy performance of buildings - Part 3: Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems.

CEN/TR 16798-4: Draft CEN/TR 167798-4: Ventilation for non-residential buildings — Performance requirements for ventilation, air conditioning and room-conditioning systems (Revision EN 13779) –Technical Report (currently available at CENTC156 CEN Livelink as document CEN/TC 156/WG 20 N 83 or CEN/TC 156 N 1303).

EN 16798-1: prEN16798-1 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.

Current drafts of EPBD Technical reports of TC 156 will be available soon for public information on www.normen.fgk.de

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Calculation of the energy performance of ventilation and cooling systems

GERHARD ZWEIFEL
Professor
Lucerne University of Applied sciences and Arts, Lucerne School of Engineering and Architecture
gerhard.zweifel@hslu.ch

In the present paper, an overview of the new calculation related standards from CEN TC 156 in the area of ventilation and cooling, the prEN 16798-family, is given.

An introduction to the content of the 3 standards on ventilation is given, where an hourly and a monthly calculation method are available in separate documents for the duct system and air handling unit parts.

For the cooling related standard, the content of the standards and the interconnection is shown based on the general part prEN 16798-9, which connects the calculation pieces of the other standards for emission, distribution, storage and generation to a complete system.

The standards revised under the lead of CEN TC 156 "Ventilation for buildings" have all been allocated a new number: prEN 15798, with different parts for the different areas.

This article described the standards of this family which deal with the calculation methods for the energy performance of ventilation, air conditioning and cooling systems. The parts 1, 3 and 17 of the prEN 16798 family are not covered in this article, since there are separate articles on the indoor environment parameters (prEN 16798-1, the revision of EN 15251, see [1]), the performance requirements of ventilation and room conditioning systems (prEN 16798-3, the revision of EN 13779, see [2]) and inspection of ventilation and air conditioning systems (prEN 17898-17, the revision of EN 15239 and 15240, see [3]), including their accompanying technical reports.

The calculation standards consist of the following parts:

prEN 16798-5-1: Energy performance of buildings – Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 – Ventilation for buildings – Calculation methods for energy requirements of ventilation and air conditioning systems – Part 5-1: Distribution and generation (revision of EN 15241) – method 1.

prEN 16798-5-1: Energy performance of buildings – Modules M5-6, M5-8 – Ventilation for buildings – Calculation methods for energy requirements of ventilation systems – Part 5-2: Distribution and generation (revision of EN 15241) – method 2.

prEN 16798-7: Energy performance of buildings – Module M5-5 – Ventilation for buildings – Calculation methods for energy requirements of ventilation and air conditioning systems – Part 7: Emission (determination of air flow rates, revision of EN 15242).

prEN 16798-9: Energy performance of buildings – Module M4-1 – Ventilation for buildings – Calculation methods for energy requirements of cooling systems – Part 9: General.

prEN 16798-11: Energy performance of buildings – Module M4-3 – Calculation of the design cooling load.

prEN 16798-13: Energy performance of buildings – Module M4-8 – Ventilation for buildings – methods for the calculation of the energy performance of cooling systems – Part 13: Generation.

prEN 16798-15: Energy performance of buildings – Module M4-7 – Calculation of cooling systems – Part 15: Storage – General.

The documents with the even numbers are the accompanying technical reports going along with the standards. As can be seen in the titles, the standards are designed to cover specific modules in the modular structure. This is also shown in **Table 1**.

Figure 1 shows a schematic view of a ventilation and cooling system with the areas that are covered by the different standards. It also includes reference to the two standards from CEN TC 228 which have been agreed to cover cooling issues: these are prEN 15316-2 for the emission of water based cooling systems and prEN 15316-3 for the distribution of water based cooling systems.

Ventilation standards

Emission

The ventilation related systems and standards are indicated in green in **Figure 1**. The start of the calculation of ventilation systems is in the occupied space and is described in prEN 16798-7, the former EN 15242. This standard was changed to fully cover module M5-5 "emission". For this, it was extended to include:

- the calculation of air flow rates also for mechanical ventilation system, including VAV systems;
- the required conditions of the supply air (depending on system type and control).

For required air flow rates there is a reference to prEN 16798-1 (EN 15251 rev.) and for the definition of the ventilation effectiveness to prEN 16798-3 (EN 13779 rev.). The parts on the leakage of distribution systems were moved to prEN 16798-5. The accompanying Technical Report and spreadsheet are available, see [4], [5].

Distribution and generation

In the course of development of prEN 16798-5, which is intended to cover a number of modules in the areas of distribution, i.e. the duct system, and "generation", which for the ventilation and air conditioning service is meant to be the air handling unit (AHU), including humidification and dehumidification, it was decided to divide the work item into two separate documents because the scope of the two calculation methods is different:

- Part 5-1 describes a detailed method for ventilation and air conditioning systems and uses an hourly calculation step. It is a comprehensive calculation of all aspects of AC systems. The accompanying TR is available [6].
- Part 5-2 is a simplified method for compact systems, based on a proposal from TC 156 WG 2 (the residential ventilation working group). It uses a monthly calculation step and includes heat generation (like air-to-air heat pumps) and domestic hot water heating. It does, on the other hand, not cover the full range of technologies which are contained in part 5-1. Although it is

Table 1. Areas of the modular structure covered by the CEN TC 156 standards.

Overarching		Technical Building Systems					
	Descriptions		Descriptions	Cooling	Ventilation	Humidification	Dehumidification
sub1	M1	sub1		M4	M5	M6	M7
1	General	1	General	prEN 16798-9	prEN 16798-3		
2	Common terms and definitions; symbols, units and subscripts	2	Needs				
3	Applications	3	Maximum Load and Power	prEN 16798-11			
4	Ways to Express Energy Performance	4	Ways to Express Energy Performance	prEN 16798-9	prEN 16798-3		
5	Building Functions and Building Boundaries	5	Emission & control		prEN 16798-7	prEN 16798-5	prEN 16798-5
6	Building Occupancy and Operating Conditions prEN 16798-1	6	Distribution & control		prEN 16798-5		
7	Aggregation of Energy Services and Energy Carriers	7	Storage & control	prEN 16798-15			
8	Building Partitioning	8	Generation & control	prEN 16798-13	prEN 16798-5	prEN 16798-5	prEN 16798-5
9	Calculated Energy Performance	9	Load dispatching and operating conditions				
10	Measured Energy Performance	10	Measured Energy Performance				
11	Inspection	11	Inspection	prEN 16798-17	prEN 16798-17	prEN 16798-17	prEN 16798-17

primarily dedicated to residential systems, the scope is intentionally not restricted to these, since there are many non-residential applications with smaller units of this type. A separate TR and a spreadsheet are available [8], [9].

Part 5-1 has a lot of options to be chosen, many of them being control options with a link to the building automation CEN TC 247, especially EN 15232 rev., which will be updated to reflect these options:

- Different air flow control types
- Supply air temperature and humidity control types
- Different types of heat recovery:
  - flat plate;
  - Rotary;
  - Pumped circuit.

  For the calculation there is a connection to product standards (EN 308, 13053), and it includes the aspects of
  - Control;
  - Frost protection;
  - Auxiliary energy consumption.
- Recirculation control
- Fan control
  - Several options, based on an input from CEN TC 247, different for single zone / multi zone systems; experience showed that this has a big impact on the fan energy consumption and was too optimistic in the current version of EN 15241;
  - Link to inputs from product standards (on fans, from WG 17 in TC 156).
- Ground preheating / -cooling
- Adiabatic cooling by humidification of extract air and heat recovery.

Figure 2 shows the scheme used for the explanation of the nomenclature in the standard, which is also used in the accompanying spreadsheet [7]. The latter is fully functional and covers all options offered in the standard. In order to ease its use, the options choices are given in drop down menus as shown in **Figure 2**.

Cooling calculation standards

General

The core of the cooling related calculation standards is prEN 16798-9, the "general" part, which is supposed to be the revision of the current EN 15243. However, not much of the content of the latter remained in the new draft: some parts were moved to other standards (such as the cooling load related issues to prEN 16798-11 or the generation related information, as far as normative, to prEN 16798-13). A big part of the content was in informative annexes, and some remaining part of this was moved to the accompanying prCEN TR 16798-10 [10].

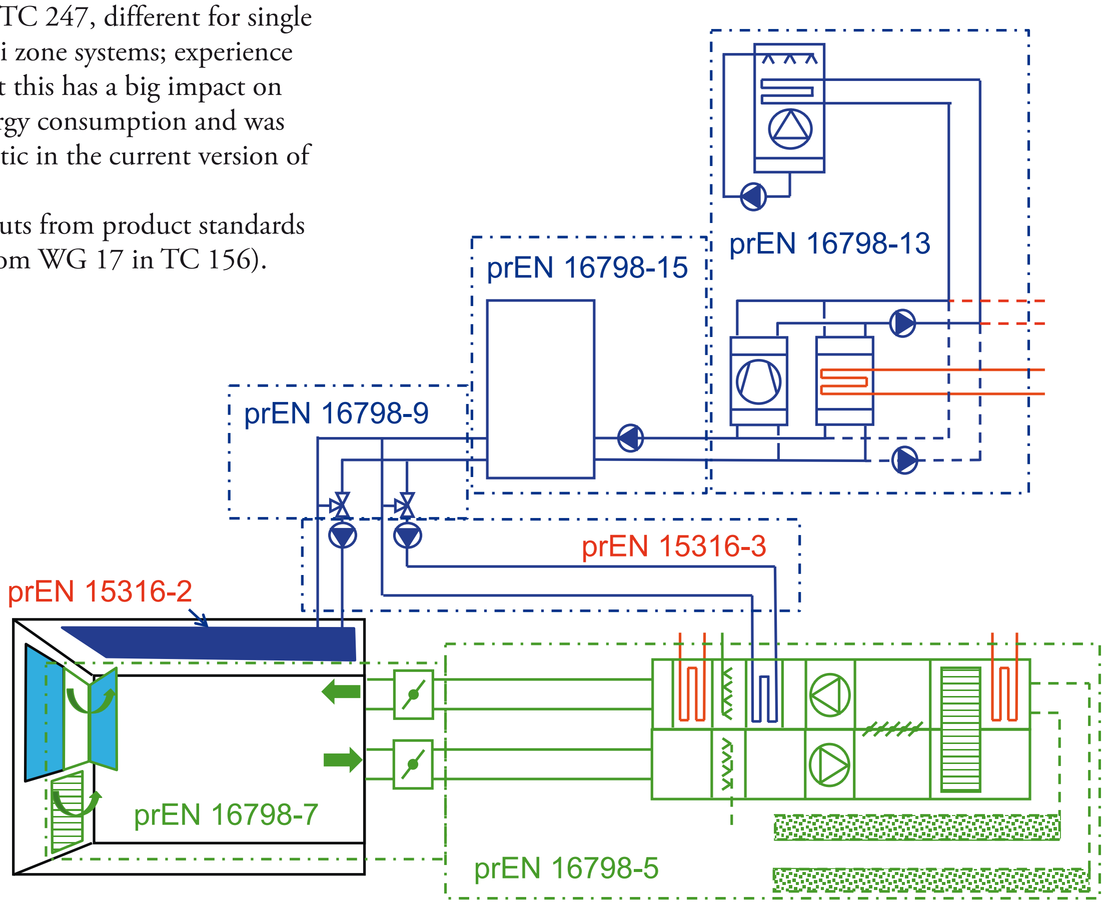


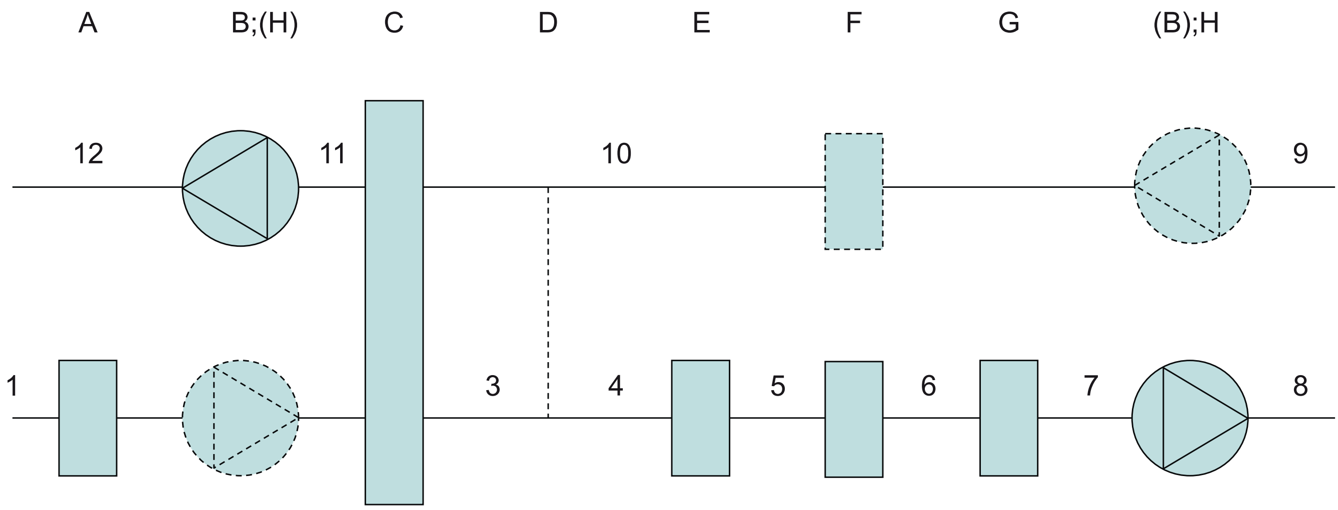
Figure 1. System schematic with the covered areas of the different standards.

Similar to prEN 15316-1, the general part of the heating and DHW calculation standards, part 9 connects the calculation pieces of the other standards for emission, distribution, storage and generation to a complete system, considering the flow rate and temperature control of the distribution branches and the load dispatching in case of insufficient energy supplied by the generation system. It follows (as the other parts do) the principle (agreed by the CEN TC 371 CTL), that a subsequent energy using module reports the **required** energy supply to the delivering module per calculation interval, and this in turn reports the energy **really delivered**, based on its operational conditions, back to the using module per calculation interval.

Figure 3 shows the schematic representation from the standard, illustrating the boundaries of the involved modules and the nomenclature used in the standard.

As already mentioned, modules M4-5 and M4-6 are supposed to be covered by the TC 228 standards prEN 15316-2 and 3. The (non-exhaustive) system shown in **Figure 3** with a generation, storage and two distribution branches, each serving two thermal zones and one air handling unit, is exactly represented in the spreadsheet going along with the standard [11]. In this spreadsheet, a full annual data set of hourly values is implemented to test the calculation. This also to test the partial performance indicator calculation as mentioned below. Apart from the water based systems shown above, the standard also addresses direct expansion (DX) systems. In this case the calculation becomes generally simpler. A schematic representation is given in the accompanying TR [10].

Part 9 also covers module M4-4 with two partial performance indicator proposals for cooling systems:



General	A	B	C	D	E	F	G	H
Volume flow rates Detailed	Frost protection / ground preheating/-coo-ling	Exhaust air fan	Heat recovery	Recirculation	Cooling / dehumidification	Humidification	Heating	Supply fan
Air handling unit localosation	Ground air preheating and -cooling	localisation	Heat recovery type			Humidifier type		Fan motor localisation
NC	else	DOWN_HR	ROT_SORBT	yes		CONTACT		OUTS_AIR
Supply air temperature control	Frost protection type		only for FLAT_PLATE and ROT_HYG	Recirculation control		humidifier control		System type for variable air volume flow rate fan energy calculation
ODA_COMP	PREH		-	VARIABLE		SPEED		SINGLE_ZONE
Control of the volume flow rate	Control of the frost protection		Control of the heat recovery device			Adiabatic cooling		Control of the fan
VARIABLE	INDIRECT		SPEED					DIRECT
								localisation
								DOWN_HR

Figure 2. Ventilation/AC-system scheme and technology choice options in prEN 16798-5-1.

The annual efficiency of the total cooling system can be calculated with **Equation (1)** and the annual efficiency of the cooling generation system with **Equation (2)**.

An issue of importance repeatedly mentioned by stakeholders is ventilative cooling, i.e. cooling by enhanced natural and/or mechanically assisted ventilation. This cannot be covered by one standard; since it involves the thermal zone calculation as well as flow rate calculations and control issues. Therefore, a description of the necessary procedure, the modules involved and the information flow is given in the accompanying TR [10]. The respective scheme is shown in **Figure 4**.

Generation

prEN 16798-13 is a new standard for the cooling generation calculation, which was until now covered only in an informative annex of EN 15243. It contains 2 Methods:

- Method A for an hourly calculation step;
- Method B for a monthly calculation step.

$$\eta_{C;tot;an} = \frac{\sum_{t_{ci}} \sum_{i} \left(\sum_{j} Q_{C;zt,j;i} + \sum_{k} Q_{C;ahu,out;k;i} \right)}{\sum_{t_{ci}} \left(E_{C;gen;el;in} + Q_{H;C;gen;abs;in} + W_{C;aux;gen} + W_{C;aux;sto} + \sum_{i} W_{C;aux;dis;i} + \sum_{i} \sum_{j} W_{C;aux;em;j;i} \right)} \qquad \textbf{(1)}$$

$$\eta_{C;gen;an} = \frac{\sum_{t_{ci}} Q_{C;dis;in}}{\sum_{t_{ci}} (E_{C;gen;el;in} + Q_{H;C;gen;abs;in} + W_{C;aux;gen})} \qquad \textbf{(2)}$$

Where:

t_{ci} = Calculation interval [h]
$E_{C;gen;el;in}$ = Electric energy input to the cooling generation [kWh]
$Q_{H;C;gen;abs;in}$ = Heat input to the absorption cooling generation [kWh]
$W_{C;aux;gen}$ = Auxiliary energy input to the cooling generation [kWh]
$W_{C;aux;sto}$ = Auxiliary energy input to the cooling storage [kWh]
$W_{C;aux;em;j;i}$ = Auxiliary energy input to the cooling emission in zone j of distribution system i [kWh]

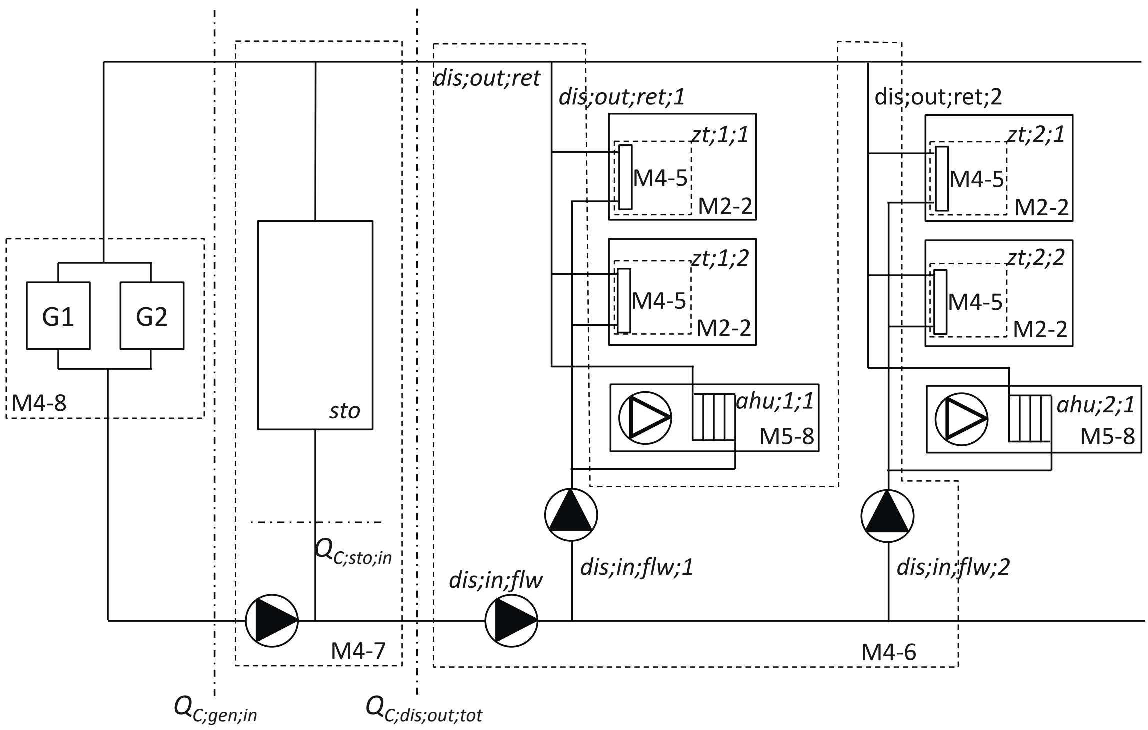


Figure 3. Cooling system scheme with module boundaries and nomenclature given in prEN 16798-9.

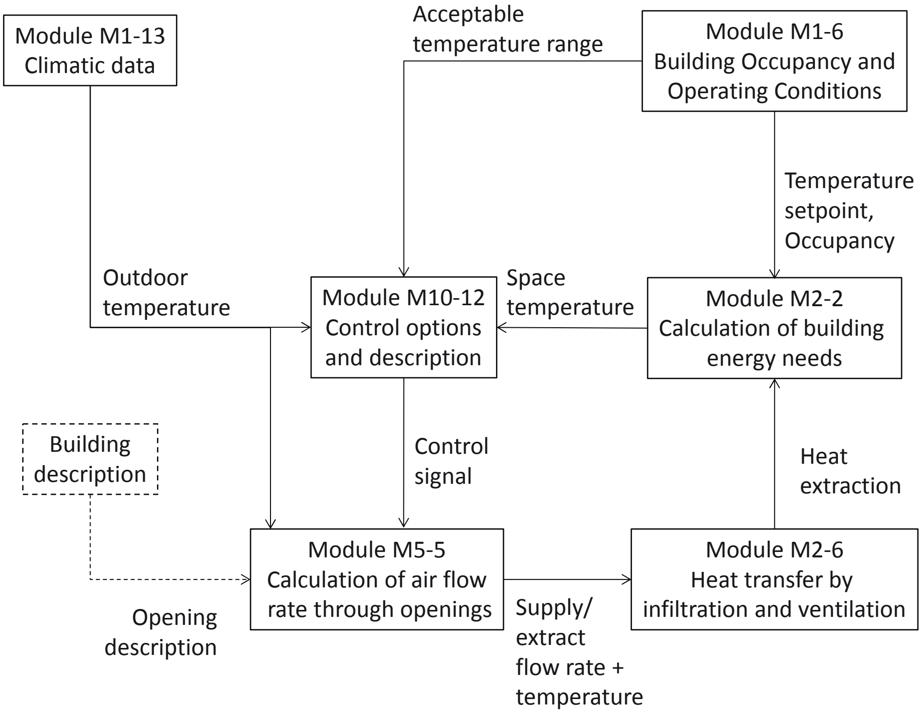


Figure 4. Scheme from prCEN TR 16798-10 for the calculation of ventilative cooling.

The technologies covered in both methods are

- Compression and absorption chillers;
- Place holder for "other" type of generator, being used for direct use of boreholes, ground or surface water;
- Multiple generators handling;
- "Free cooling" control option, i.e. direct cooling via heat rejection device
- Different Heat rejection types:
  - Air cooled condensers;
  - Dry, wet and hybrid heat recovery devices;
  - Control options for the heat rejection (e.g. switch between dry and wet operation for hybrid heat rejectors);

In method A, there is a connection to product standards for compression chillers: A performance map is used, which is generated on the base of the measurement points from EN 14511 tests, which are used in EN 14825 for the calculation of the SEER. However, the 4 measurement points are not sufficient; a fifth point outside the range of the four is needed. Discussions with manufacturers have shown that there is willingness in the industry that more data shall be made available.

An accompanying TR [12]and two separate spreadsheets for the two methods ([13] and [14]) are available for this standard.

Storage

A new standard prEN 16798-15 was developed for the calculation of cooling storage systems. This was done in close collaboration with TC 228, to ensure the same philosophy as for heating and DHW storage calculation. The method is applicable to any calculation time step and covers different storage types:

- Water tanks
- Ice storage
- Phase change materials (PCM)

The calculation of the storage charging circuit is included in the standard, as shown in **Figure 3**. There is an accompanying TR [15] and a spreadsheet for PCM devices [16] available.

Outlook

All standards of the prEN 16798 family are in public enquiry until April 2015. ■

References

[1] See separate article from Bjarne W. Olesen in this issue.

[2] See separate article from Claus Händel in this issue.

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[4] CEN/TC 371 N377 – CEN/TC 156 N1281 – prCEN TR 16798-8 WD.

[5] CEN/TC 371 N378 – CEN/TC 156 N1282 – prEN 16798-7 spreadsheet.

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[7] CEN/TC 371 N380 – CEN/TC 156 N1284 – prEN 16798-5-1 spreadsheet.

[8] CEN/TC 371 N398 – CEN/TC 156 N1302 – prCEN TR 16798-6-2 WD.

[9] CEN/TC 371 N397 – CEN/TC 156 N1301 – prEN 16798-5-2 spreadsheet.

[10] CEN/TC 371 N381 – CEN/TC 156 N1285 – prCEN TR 16798-10 WD.

[11] CEN/TC 371 N382 – CEN/TC 156 N1286 – prEN 16798-9 spreadsheet.

[12] CEN/TC 371 N383 – CEN/TC 156 N1287 – prCEN TR 16798-14 WD.

[13] CEN/TC 371 d N384 – CEN/TC 156 N1288 – prEN 16798-13 method A spreadsheet.

[14] CEN/TC 156 WG21 N93–M4-8_ prEN 16798-13 –Cooling-generation-draft-method B spreadsheet.

[15] CEN/TC 371 N351 – CEN/TC 156 N1255 – prCEN TR 16798-16 WD.

[16] CEN/TC 156 N1241 – prEN 16798-15 PCM spreadsheet.

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Guidelines for inspection of ventilation and air conditioning systems

– *Revision of EN 15239 and EN 15240*

FRANÇOIS RÉMI CARRIÉ
ICEE,
Lyon, France
Convenor of working group in charge of the revision of EN 15239 and EN 15240

ANNE-MARIE BERNARD
ALLIE'AIR,
Meximieux, France
Convenor of working group in charge of the revision of EN 15239 and EN 15240

The new pre-standard prEN 16798-17 dealing with the inspection of ventilation and air conditioning systems was launched for public enquiry in December 2014. Although it is based on previous standards EN 15239 and EN 15240, it includes substantial changes in structure form and content to support the requirements of the EPBD recast taking into account the lessons learnt from the implementation of the first EPBD.

Context and focus of the revision

The first Energy Performance of Buildings Directive (2002/91/EC) required all EU countries to take measures to inspect air conditioning systems of an effective rated output of more than 12 kW. Two standards had been developed to support this requirement: EN 15240 dealt with air conditioning systems and referred to EN 15239 for systems including ventilation. The European Concerted Action (Maldonado et al., 2013) as well as the European project of the Intelligent Energy Europe named Harmonac (Knight et al., 2010) identified issues on the first EPBD inspection schemes to be addressed in the revision of the EPBD standards in accordance with the EPBD directive recast (2010/31/EU).

The working group in charge of revising these standards inferred several key recommendations from these analyses, including:

- to focus on the primary objective of the inspection, i.e., to provide a report intelligible to non-expert building owners with advice on ways of reducing their energy consumption while maintaining acceptable indoor environmental conditions;
- to merge the inspection standards of technical systems into a single standard;
- to develop straightforward step-by-step actions with checklists; and
- to differentiate inspections aiming at identifying features of system operation wasting energy versus more detailed inspections requiring measurements.

The changes implemented in the new standard and detailed below reflect these aspects.

New pre-standard structure

The ventilation and air conditioning standards have been merged into a single pre-standard. Although we had considered merger with the heating standard revised in another group, both groups considered it was premature for this recast because of their present form and time constraints. The new ventilation and air conditioning pre-standard includes 4 major clauses:

- A general clause that applies to ventilation and air conditioning systems. This clause gives general information about the purpose of the inspection and the methods. It details the information to be gathered prior to the inspection (pre-inspection) as well as the expected output of this pre-inspection.
- A clause specific to ventilation systems. This clause explains how the pre-inspection data should be used during the field inspection, and details the actual steps of the inspection leading to advice for improvements. The expected output data consists of the delivered air flow rates and the specific fan power demand which may be derived from the inventory of the system.
- A clause specific to air conditioning systems. This clause is similar in principle to the previous one. The expected output data include: the specific cooling load; the specific cooling capacity; the air conditioning efficiency; and the sizing compared to the cooling requirements of the building;
- A clause which consists mainly of two checklists of items to be reported in the inspection report.

Introduction of inspection levels

On key change in this pre-standard is that it introduces 3 inspection levels. The underlying idea is to allow member states to require a basic inspection level which, although based on visual checks without measurements, gives useful information on system operation features that are wasteful of energy. Therefore, it is left to the member states or the person ordering an inspection to require additional checks, in particular, measurements which are included in levels 2 and 3.

Output and follow-up of pre-inspection

Pre-inspection becomes an essential part of the inspection process. Its output shall include:

- Identification of lacking/outdated information. The standard provides a checklist;
- Advice to building manager on completing missing issues;
- Priority areas for the actual inspection for collecting missing information during inspection on site;
- Priority areas for the inspection where foreseen deviations from good practice are likely to affect the system performance.

As a follow-up, the first step of the actual inspection is to collect missing information, to check correspondence between the information gathered and the installed components, and to report any differences.

Inspection report

This pre-standard includes a summary in form two checklists of all items that shall be included in the inspection report. There is no need to issue 2 reports in case of air conditioning systems including ventilation. The checklists can be seen as a quality control tools for

Table 1. Inspection levels as defined in prEN 16798-17.

Inspection level [a]	Type of inspection	Description
Checklist 1	Pre-inspection and functional checks	This basic level of inspection has two purposes: a) to gather all relevant documentation on the system type and size, and to identify any priority inspection areas where the design, installation or operation of the system departs from good practice in a manner likely to affect its energy consumption; b) to non-intrusively identify on site (normally visually) features of system operation that are wasteful of energy. It does not include measurements.
Checklist 2	Functional measurements	This level requires, in addition to level 1, measurements to check that the system is operating as intended and to identify sources of energy wastage. These can include, for example, specified design conditions and set points.
Checklist 3	Special measurements	This level requires, in addition to level 1 and 2, additional measurements to provide more detailed assessments of system performance. Such measurements can, for example, cover extended periods of time, or technical aspects such as in-situ component performance.

[a] Level 1 is the minimum requirement and is sufficient for EPBD inspections of air conditioning systems.

Table 2. Excerpt of Table 3 in prEN 16798-17 "Information to be given in the inspection report depending on the method (1 of 2)".

Information	Method 1	Method 2	Part
General			
Name, address and status of the person and organization in charge of the inspection.	X	X	—
Official designation and address of the property.	X	X	—
Name and address of the building owner.	X	X	—
Date of the inspection.	X	X	—
Pre-inspection / Compliance with design documentation			
Status of the documentation or information, see Table 4, including identification of lacking and outdated documentation	X	X	5.3.6
Priority areas for the collection of missing information during the inspection on site.	X	X	5.3.6
Priority areas for the inspection where the design installation appear to depart from good practice in a manner likely to affect its performance.	X	X	5.3.6
Any difference between documentation and actual installed components.	X	X	6.3, 7.3
Any difference between working or as-installed drawings and the actual system.	X	X	6.3, 7.3
Aspects of the inspections simplified or reduced because of clear evidence that a good practice program of maintenance is being carried out.	X	X	6.4.1.1, 7.4.2

Table 3. Excerpt of Table 4 in prEN 16798-17 "Status of the documentation or information".

Document or information	Status of the documentation			Method		Part
	Available	Not available	Outdated	1	2	
Design documents which define the relevant design criteria against the actual installation and use include every items detailed in 5.3.2.				X	X	5.3.1, 5.3.2
System manufacturer and model (type) of the ventilation system.				X	X	5.3.1, 5.3.2
Additional documentation, indicating any modifications or alterations of the building, the system or the use since the original documents.				X	X	5.3.1

the inspector as it summarises all requirements stated in the pre-standard including reference to the relevant paragraph.

Additional information in the technical report

The pre-standard comes with an accompanying technical report including important additional information. In particular, the technical report includes a number of indicative checklists for specific items to be inspected depending on the chosen inspection level. While these checklists give a solid basis for implementation in the member states, it allows them to have some flexibility in the extent of the inspection.

Conclusion

The inspection of ventilation systems and air-conditioning systems is now dealt with in a single pre-standard, with an accompanying technical report. The pre-standard defines 3 inspection levels, including one basic level with no measurements which is sufficient to comply with the EPBD requirements. The new pre-standard gives the essential steps for the inspection and clarifies the outputs of each step. It gives a number of checklists which should help for its implementation and use. Note however that significant changes may occur after the public enquiry process depending on the nature of the comments. This second phase in the new standard development is expected to start mid-2015.■

References

Please see the html-version of this article at **www.rehva.eu** -> REHVA Journal

Inspection of boilers and heating systems *– Revision of EN 15378-1*

LAURENT SOCAL
Convenor of working group in charge of the revision of EN 15378, Consultant
socal@iol.it

This article describes the revision of EN 15378 about the inspection of heating systems. It has been updated following changes in the EPBD requirements. It is now easier to use and software proof. Specific solutions have been introduced to meet the demanding requirements of EPBD articles 14 and 16.

Keywords: inspection – heating – boiler – EPBD – CEN - standards – recast

Context of the revision

EPBD requirements

The original EPBD Directive (2002/91/EC) required two types of inspection:

- a ”*regular inspection of boilers*”, to be repeated periodically and limited to the assessment of the boiler efficiency.
- a ”*one-off inspection of heating systems*” to be performed only once on ”older” systems, extending to the whole heating systems and requiring to check the sizing of the boiler.

Therefore EN 15378:2006 had two separate procedures for boiler and heating system inspection.

Now art. 14 of Directive 2010/31/EU (”EPBD recast” in the following) asks only for a ”regular inspection of the accessible parts of systems used for heating buildings… (omissis) … with boilers of an effective rated output of more than 20 kW”. According to this new requirement, in the prEN15378-1:

- the ”*heating systems inspection*” procedure has been updated to comply with the EPBD recast requirements;
- the ”*boiler inspection*” procedure has been kept indeed, because in many Member States such procedures are in place independently from EPBD inspection requirements and it might be useful to organise them in a consistent way.

The inspection requirements are also quite demanding:

- Art. 14 of EPBD recast states that the ”**inspection shall include an assessment of** the **boiler efficiency** and **the boiler sizing** compared with the heating requirements of the building”.
- Art. 16 of EPBD recast requires that ”An inspection report shall be issued after each inspection of a heating or air-conditioning system. The inspection report shall contain the result of the inspection performed … and **include recommendations for the cost-effective improvement of the energy performance of the inspected system**. … The inspection report shall be handed over to the owner or tenant of the building”.

The issues of assessing boiler efficiency, assessing boiler sizing and finding cost-effective improvements are described in the following.

The scope of the directive is restricted to ”heating systems with boilers with a higher output than 20 kW”. This does not exclude the possibility to use this standard for other types of generation devices (e.g. warm air heaters, heat pumps, thermal solar, CHP, etc) and to domestic hot water systems if appropriate additional levels are defined.

Level and details of inspection

One may expect quite different levels of inspection depending on the size, type and complexity of the building and of the heating system. **Moreover, these expectations are quite different in the EU countries**.

The old EN 15378:2006 included a fully flexible mechanism called "*inspection classes*". It was based on a series of tables that allowed to define independently "inspection classes" and the corresponding inspection details. Information on how to proceed for the inspection of any subsystem was given in a series of informative annexes. This was like a huge toolbox, with quite few "ready to use" examples. This required a lot of work by national standardisation bodies.

The new revision has kept the high flexibility but it is easier to handle, two "ready to use" inspection classes are defined and there is a clear correlation between the normative text that gives the basic procedure, the inspection class definition and the inspection checklist and report.

Coordination with other standards

The current EN 15378 included all the required calculation methods in the informative annexes. They have been moved into the new prEN 15378-3 "Measured energy performance".

Software proof

All EPB calculation standards can be applied practically only if professional software tools are available. This is obvious for energy performance calculation methods.

The inspection standard can also be supported by software tools. Generating statistics on inspection requires a high standardisation in format and structure of the acquired data.

This is supported by the definition of "inspection items" in clause A.1.3 that requires specification of the type of data to be acquired following inspection, including predefined set of possible answers.

The structure of the new prEN 15378-1:2014

Clauses 1 to 4 are regulated clauses (scope, definitions, normative references, symbols etc.).

Clause 5 gives the general principle of the inspection and sets how to define custom inspection levels.

Clause 6 and 7 describe the inspection procedures related to:

- inspection of the heat generators;
- inspection of the entire heating systems according.

Clause 7 shall be applied to comply with requirements of EPBD recast.

Annex A (normative) is the template for the specification of inspection detailed requirements and default data.

Annex B (informative) contains 2 default inspection levels, considered to be the minimum to comply with EPBD recast for small (e.g. single family houses) and large buildings (block buildings) respectively.

Annex C (informative) are 2 default inspection reports, consistent with the 2 default inspection classes given in annex B.

All other information can be found in the accompanying prCEN/TR 15378-2.

Specific issues

Inspection levels

Inclusion/omission/alternatives of individual inspection items as well as border lines between levels are specified through tables compiled according to the template given in annex A.

A default specification of two basic inspection levels is given in informative annex B:

- default level 1 inspection is intended for single family dwellings;
- default level 2 inspection is intended for block buildings with a centralised heating system and for non-residential buildings.

Inspection classes are defined freely and given a unique name using a first table.

A second table gives the overview of the required inspection steps and inspection methods depending on the inspection class. Each procedure step is a row with:

- the reference to the to the procedure clause in the core text of the standard;
- the information if this inspection step is required or not (some inspection steps are optional);
- the reference to an inspection methodology given in the accompanying CEN/TR 15378-2 or in suitable existing national procedures.

Table 1 is an excerpt of table B.2 of prEN 15378-1 that defines default inspection level 1.

The referenced procedure can be a table of inspection items (see **Table 2**), a reference to an EN standard or to a national procedure.

Then the inspection items are specified in tables. Each inspection item is a row with:

- the reference to the procedure clause;
- the name of the inspection item;
- the type of information to be recorded (string, number and units, list of options, etc.);
- the rating value (efficiency or points) associated to that item.

Table 2 is an excerpt of table B.3 of prEN 15378-1 that defines the heating system and inspection identification for level 1 inspections.

For each inspection item, one field shall be made available in the inspection checklist and report. **Table 3** is an excerpt of annex C (roughly corresponding to the items shown in **Table 2**) where a default inspection report for inspection level 1 is given. There is one field in the report for each inspection item.

Table 1. Excerpt of Table B.2 – Overview of required sections for level 1.

Ref	Section	Required	Referenced procedures
7.3	Heating system and inspection identification	Yes	Table B.3
7.4	Document identification	Yes	Table B.4
7.5	Heating system functionality check	NO	
…			
7.13	Boiler performance	Yes	prEN 15378-3 – clause 7 Table B.12
…			

Table 2. Excerpt of Table B.3 – Heating system and inspection identification for level 1.

Ref	Inspection item	Type of information / values	Efficiency / points
7.3	Date of inspection	Date	n.a.
7.3	Inspector name	String	n.a.
7.3	Inspection level	Level identification	n.a.
7.3	Building unit identifier	String	n.a.
…			
7.3	Services provided by the heating system	One or more of the following • heating • domestic hot water • other	n.a.

Table 3. Excerpt of annex C3 – Heating system inspection report for level 1.

Date of inspection	________ / ________ / ________	Inspector name	____________________
Inspection level	1	Building category	____________________
Address	____________________	Zip / City ____________	____________________
Building unit identification	____________________	Heating system ID code	____________________

…

Services provided by the heating system	☐ heating	
	☐ domestic hot water	
	☐ other	____________________

Boiler efficiency

”**Boiler efficiency**” is an ambiguous term: one may understand ”combustion efficiency”, ”seasonal efficiency”, ”thermal efficiency”... Given the context, it is reasonable to expect that the ”seasonal efficiency” $\eta_{blr;seas}$ has to be estimated.

The following equations are given (now in EN 15378-3) for a quick estimation:

$$\eta_{blr;seas} = \eta_{cmb} - \left(\frac{1}{\beta_{cmb}} - 1\right) \cdot \alpha_{ch,off} - \frac{1}{\beta_{cmb}} \cdot \alpha_{ge}$$

or

$$\eta_{blr;seas} = \left(\eta_{cmb} - \alpha_{ge}\right) \cdot \frac{100 - \frac{\alpha_{P0}}{\beta_{cmb}}}{100 - \alpha_{P0}}$$

Where:

η_{cmb}	=	the combustion efficiency that can be easily measured
α_{ge}, $\alpha_{ch;off}$, α_{P0}	=	the losses factors are taken from tables or sometimes can be obtained from estimations (α_{ge})
β_{cmb}	=	the load factor can be derived from the actual fuel consumption or from default values tables.

Boiler sizing

The ”**boiler sizing**” assessment is potentially time consuming because it implies a comparison between a boiler property (available heat power output) and the building heat load. The following methods have been made available to get a quick estimation of the boiler sizing:

- using a default specific heat load per floor area (W/m²) depending on building typology;
- using a default fuel consumption per unit power (kWh/kW).

The method based on fuel consumption can be interpreted as the result of a simplified energy signature, as shown in **Figure 1:**

- Point ”A” is the shut-off temperature, typically 2…4°C less than the internal set temperature so 0 kW @ 17°C.
- Point ”B” (80 kW @ 6°C) is obtained as the average seasonal power (from yearly fuel consumption and yearly boiler operating hours) and seasonal external temperature (from degree days)
- The simplified energy signature is defined by points ”A” and ”B”.
- The required peak power 170 kW can be read on the energy signature at ”C”, the design external temperature which is –6°C in the example.

The resulting ratio between yearly energy and peak power is the number of utilisation hours of the peak power. This simplified method is quite useful, provided that no significant reheat power is needed and that the historic fuel consumption refers to the continuous use of the whole building, which is normally the case in the collective residential sector.

Cost effective improvements

Finding ”**cost effective improvements**” implies a comparison between costs and benefits. A reliable answer implies the estimation of:

- the cost of the suggested improvement action;
- the running costs before the implementation of the suggested action;
- the running costs after the implementation of the suggested action.

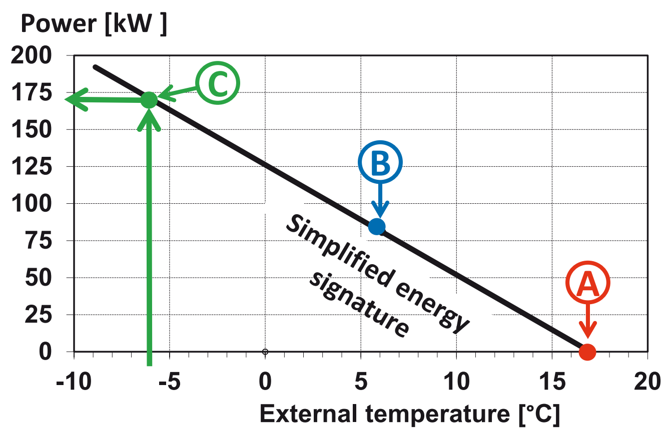

Figure 1. Generator sizing example using the simplified energy signature.

This is the basic work of a full energy audit. This cannot be done in the context and with the expected cost and effort of an "inspection". Cost effective improvements may be identified with little effort only if they are already known for repetitive cases. The list of possible improvement actions should support this approach.

The suggested layout of the report reminds that there are two types of possible improvement actions:

- low cost or highly effective actions with a short pay back (e.g. less than about 5 years) that can and should be immediately implemented;
- actions with long or even no pay back that are not immediately cost effective but that can and should be implemented following specific events when the marginal cost of an upgrade is low (e.g. an existing boiler should be upgraded when it has to be replaced)

If this is not mentioned, either there will be few cost-effective recommendations or both components and appliances might be replaced missing a possible upgrade.

Inspection report

The list of inspection items is the inspection checklist but it is also the basis of the inspection report. The only difference is the presentation order of items and the addition of recommendations.

The first page of the inspection report includes the most relevant information for the tenant or owner of the building such as:

- building and inspection identification;
- advice for improvements;
- estimated boiler efficiency;
- estimated sizing;
- report delivery receipt.

All other details are given in the subsequent pages. This layout emphasizes the intended message to the owner or tenant.

Conclusion and comments

The inspection of heating systems standard has been updated to comply with the new requirements of EPBD recast. The mechanism of inspection classes has been improved and made clearer. The inspection checklist is structured so that it is made easy to design software tools to assist the inspection task. The standard now includes finished, ready to use, inspection checklists and reports. Significant changes may still occur after the public enquiry process depending on the nature of the comments.

Further improvements may include extension to other types of generation systems.

The weak point remains the fact that it is not easy to meet all the requirements for recommendations and information if this has to be based on inspection evidence only. It is the author's opinion that the inspection may raise some recommendations in evident cases but in most cases it would be wise to recommend an energy audit (even to impose it in case of evidence of very high energy use) instead of giving generic recommendations.

EPBD recast requires the inspection of heating, ventilation and air conditioning systems. It is surprising that though most of the attention in the past was given to the thermal protection of buildings, no "building inspection" is required. Improvement potentials can be identified on buildings as well as on systems. ■

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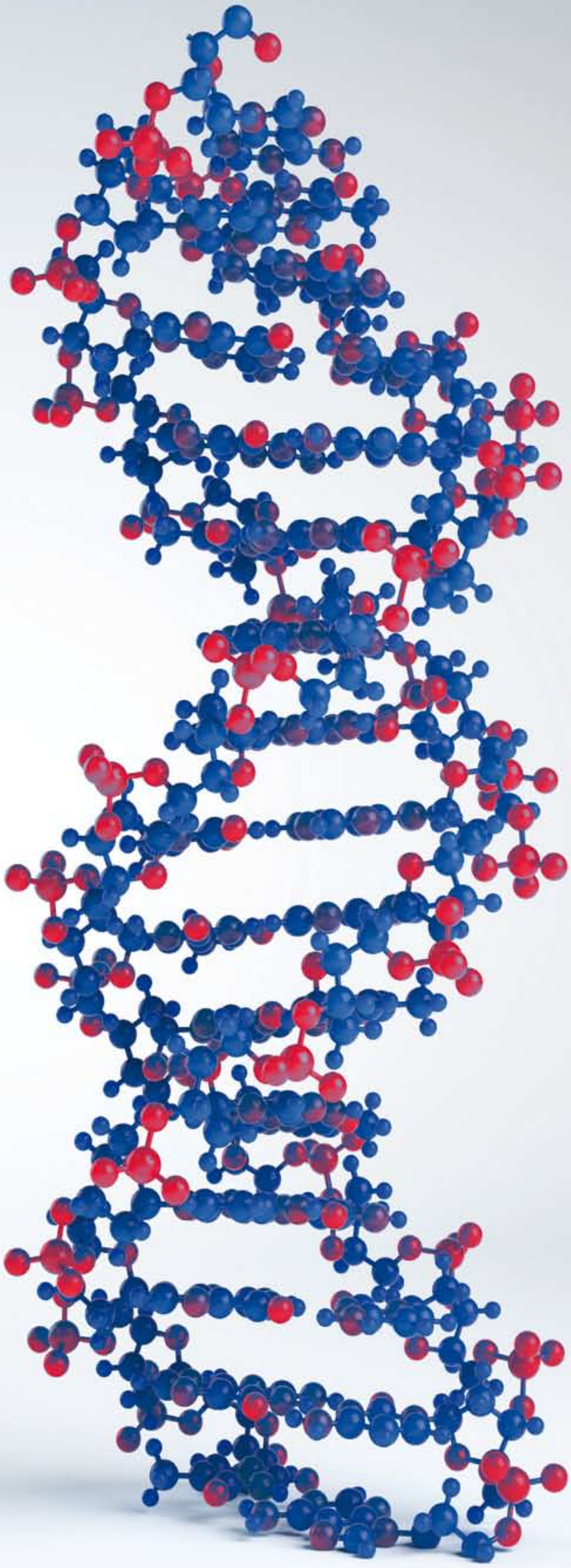

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Making the EPBD-CEN package software proof

– The development of the ICT calculation tool under Mandate 480

JOHANN ZIRNGIBL
Software team leader,
Head of Division, Centre Scientifique
et Technique du Bâtiment,
johann.zirngibl@cstb.fr

BENJAMIN HAAS
Software team expert,
Centre Scientifique
et Technique du Bâtiment
benjamin.haas@cstb.fr

PIM VAN DEN HELM
Software team expert,
Netherlands Organisation for
Applied Scientific Research TNO
pim.vandenhelm@tno.nl

The complexity of the EPBD calculation (e.g. nZEB), the interaction between the building and the technical building systems make the use of software necessary. The absence of software tools has been identified as one of the limitations for the correct usage of EPBD standards and for the right implementation of EPBD requirements. Therefore the whole package of the EPBD-CEN standards has to be software proof.

These challenges have clearly been identified and addressed at the beginning of the development of the second generation of EPBD-CEN standards under mandate 480.

A dedicated team is in charge of developing a software tool that will demonstrate the validity and the possibility of a holistic computation based on this second generation of standards.

In the present paper, the first actions of the team are described.

More and more areas of the energy consumption of buildings are covered by the EPDB standards. The complexity of the calculation (e.g. nZEB), the interaction between the building and the technical building systems make the use of software necessary. The absence of software tools has been identified as one of the limitations for the correct usage of EPBD standards and for the right implementation of EPBD requirements.

Daily work in the building energy efficiency will be based on software. This has been recalled and emphasized by the EUPPD (European Union Public Procurement Directive) voted by the European Parliament in January 2014: The building information modelling (BIM) should be used as much as possible in the building sector. In this context, ensuring the using of the standards in software, and especially BIM software, is essential. European funded projects already work on the integration of calculation tools in the BIM. The EPBD-CEN standards must be part of them as a common scheme for assessing the building energy performance.

Therefore the whole package of the EPBD-CEN standards has to be software proof.

Making the EPBD-CEN standards software proof – the task and the team

These challenges has been clearly identified and addressed at the beginning of the development of the second generation of CEN standards under mandate

480. Standards developed under mandate M480 should pay attention to unambiguous expression of the overall energy performance of buildings and their systems, including clearly specified options for different applications to be defined at national or regional level.

CEN has proposed that a dedicated team supports the TC's writing the standards to check the unambiguous expression of the standards as well as their interaction. This team is also in charge of developing a software tool that will demonstrate the validity and the possibility of a holistic computation based on this second generation of standards.

The team is composed by CSTB (Centre Scientifique et Technique du Bâtiment), who is also the team leader, TNO (Netherlands Organisation for Applied Scientific Research) and Beelas. The team is involved in the development of the standards in Phase I and Phase II of the mandate 480. The software team is working in close cooperation with the experts developing the standards.

It has to be underlined that the task of the software tool team is not to develop a commercial software tool neither even a kernel. The task of the software team is to check:

- the consistency between the standards (from the point of view of inputs and outputs and of the calculation sequence);
- the unambiguous and detailed description of algorithms.

Content of work

The set of standards includes two types of standards:

- **Phase 1 / Mandate 480**: The overarching standard, prEN15603 specifies a general framework for the assessment of overall energy use of a building and the calculation of energy performance assessments in terms of primary energy or other energy related metrics.
- **Phase 2/ mandate 480**: The underlying standards in the EPBD-CEN set provide methodologies that may be used to calculate the energy use of services within a building (heating, cooling, domestic hot water, ventilation and lighting) and produce results that are used here in combination to show overall energy use.

Phase 1

In phase I, the skeleton of the demonstration tool has been built and a quality procedure has been developed. As a first step a modular structure has been proposed for the standards. It was shown that this modular structure is implementable in a software computing kernel. Among the modules that have been implemented, prEN15603 plays the central role of the overarching structure. The first task of the software tool team has been to check on prEN15603 software-proofness. PrEN15603 is fully parameterized by Annex A and B making policy factors and choices transparent and visible. These factors are primary energy factors, CO_2 emission, energy cost, or conventions to take into account exported and redelivered energy and definitions (e.g. renewable energy ratio, perimeters, and floor areas). Other inputs of prEN15603 come from the underlying standards. prEN 15603 has been integrated in the software testing tool together with some test versions of the underlying standards.

The framework of the modular structure is depicted in **Figure 1**.

Phase 2

The underlying standards, developed under phase II, are organized in a modular way so that each functionality is a module, identified as such in the detailed modular structure of EPBD –CEN package (see **Figure 2**).

A module is defined by variable inputs and outputs. This structure allows easy replacement of modules by some other coming, for example, from national/regional computations. In Phase II, the testing software tool is designed to show that this "plug-and-play" procedure is indeed reality.

EPBD-CEN standards propose several calculation options. In the proposed holistic approach computation are performed per time step (e.g. hourly, monthly, seasonally, bin). The exchange of information between the standards is per time step. A software tool is more required when the calculation is complex. Therefore the tool focuses on the hourly calculation time step.

Specific effort was put to anticipate the integration into a BIM structure. Coupling with the widely recognized format for energy simulation GbXML has been developed. It can be easily coupled to the standard IFC format, as well as other proprietary ones. This coupling allows a simple integration in the existing software environments.

Conclusions

The integration of a software team in the process of developing the standards is new. The more and more performing buildings (e.g. nZEB's) make necessary the

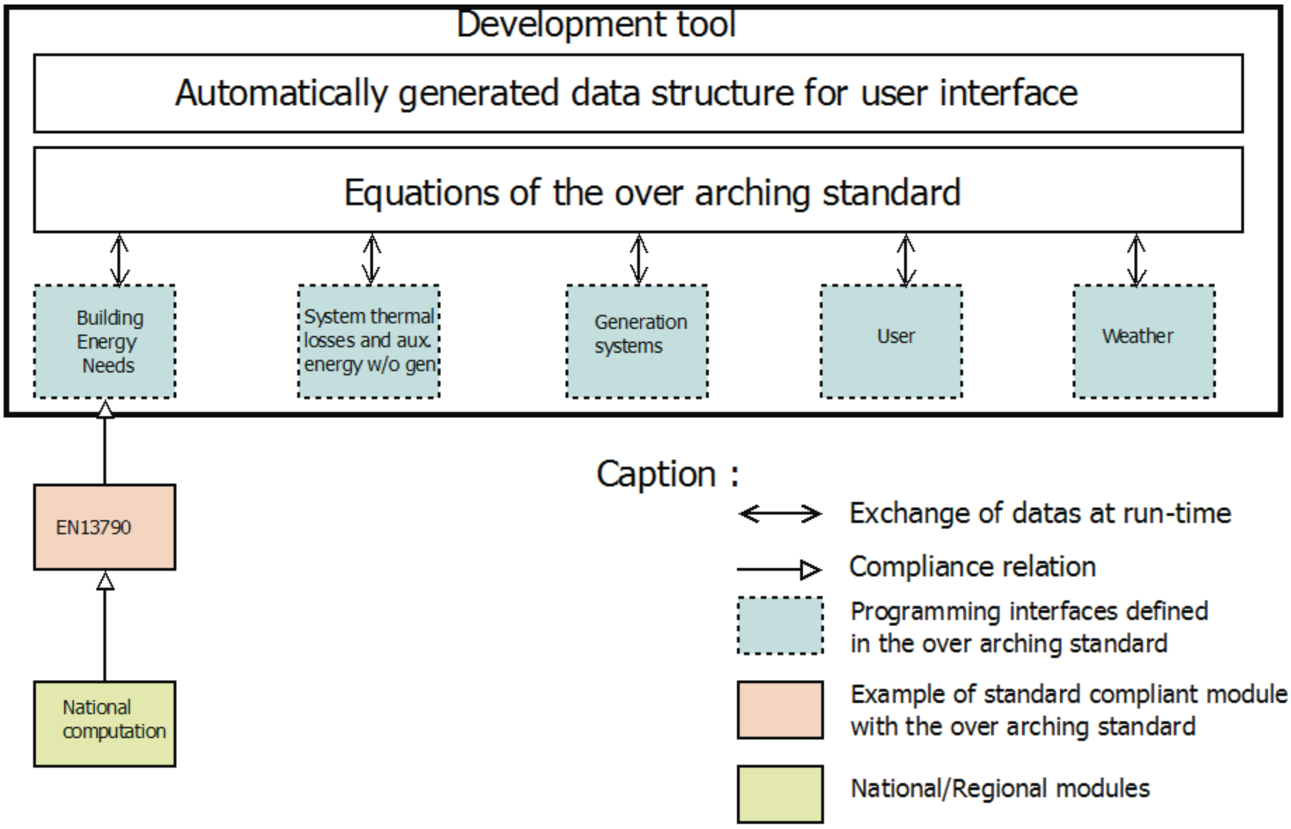

Figure 1. Proposed structure of the development software.

Overarching			Building (as such)			Technical Building Systems											
	Description	Standards		Description	Standards		Description	Heating	Cooling	Ventilation	Humidifi.	Dehumidifi.	DHW	Lighting	Build.control	Electr prod.
sub	M1		sub	M2		sub		M3	M4	M5	M6	M7	M8	M9	M10	M11
1	General		1	General		1	General									
2	Common definitions		2	Building Energy Needs		2	Needs									
3	Applications		3	Indoor Conditions		3	Maximum Load / Power									
4	Perform. Expression		4	Performance Expression		4	Perform. Expression									
5	Building Boundaries		5	Heat Transmission		5	Emission & control									
6	Building Occupancy		6	Infiltration, Ventilation		6	Distribution & control									
7	Aggregation of Energy		7	Internal Heat Gains		7	Storage & control									
8	Building Partitioning		8	Solar Heat Gains		8	Generation									
9	Calculated Perform.		9	Building Dynamics		9	Operating conditions									
10	Measured Perform.		10	Measured Performance		10	Measured Performance									
11	Inspection		11	Inspection		11	Inspection									
12	Indoor Comfort		12			12	BMS									
13	External Conditions															
14	Economic Calculation															

Standards under development

Figure 2. Detailed modular structure of EPBD –CEN package M480.

use of more and more performing tools. Therefore the EPBD-CEN package should be able to be integrated in modern software tools. The cooperation between the software tool team and standard writers will help to increase applicability and use of the EPBD-CEN package. ■

Draft EPB Standards – CEN Enquiry ongoing

REHVA commenting on CEN EPB STANDARDS

REHVA is involved in the review of EPB related standards as CEN liaison organization and regularly informs supporters and member associations about the updates and draft standards in a protected REHVA website section.

Public enquiry for most of the EPB related standards relevant for REHVA Supporters is now ongoing, for standards under CEN/TC 156 the deadline for national replies is 27 April 2015. For most of the CEN/TC 228 standards listed below, the enquiry will close already in March 2015.

REHVA will follow the process, and REHVA website will be updated as soon as more details of the enquiry process is available. Supporters and their experts are encouraged both to send comments directly to REHVA office and to contact their national CEN member organizations in order to influence on national replies.

Some relevant EPD standards are still being finalized for CEN enquiry. These include the revision of EN 15251, to be renumbered and, according to the most recent information to be sent to CEN enquiry in January 2015.

– JORMA RAILIO

CEN/TC 156

prEN 16798-9, Energy performance of buildings. Part 9: Ventilation for buildings. Module M4-1. Calculation methods for energy requirements Calculation methods for energy requirements of cooling systems. General – 2015-04-15.

prEN 16798-3, Energy performance of buildings. Part 3: Ventilation for non-residential buildings. Performance requirements for ventilation and room-conditioning systems.

prEN 16798-17, Energy performance of buildings. Part 17: Ventilation for buildings. Module M4-11, M5-11, M6-11, M7-11. Guidelines for inspection of ventilation and air conditioning systems.

prEN 16798-13, Energy performance of buildings. Part 13: Module M4-8. Calculation of cooling systems. Generation.

prEN 16798-15, Energy performance of buildings. Part 15: Module M4-7. Calculation of cooling systems. Storage. General.

prEN 16798-7, Energy performance of buildings. Part 7: Ventilation for buildings. Modules M5-1, M5-5, M5-6, M5-8. Calculation methods for the determination of air flow rates in buildings including infiltration.

CEN/TC 228

prEN 15316-4-4, Heating systems and water based cooling systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 4-4: Heat generation systems, building-integrated cogeneration systems.

prEN 15316-4-5, Heating systems and water based cooling systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 4-5: District heating and cooling.

prEN 15316-4-2, Heating systems and water based cooling systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 4-2: Space heating generation systems, heat pump systems.

prEN 15459-1, Heating systems and water based cooling systems in buildings. Energy performance of buildings. Part 1: Economic evaluation procedure for energy systems in buildings.

prEN 15316-2, Heating systems and water based cooling systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 2: Space emission systems (heating and cooling).

prEN 15316-3, Heating systems and water based cooling systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 3: Space distribution systems (DHW, heating and cooling).

prEN 15316-4-8, Heating systems and water based cooling systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 4-8: Space heating generation systems, air heating and overhead radiant heating systems, including stoves (local).

prEN 15316-5, Heating systems and water based cooling systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 5: Space heating and DHW storage systems (not cooling).

prEN 15378-1, Heating systems and water based cooling systems in buildings. Heating systems and DHW in buildings. Part 1: Inspection of boilers, heating systems and DHW.

prEN 15316-1, Heating systems and water based cooling systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 1: General and Energy performance expression.

prEN 15378-3, Heating systems and water based cooling systems in buildings. Heating systems and DHW in buildings. Part 3: Measured energy performance.

requirements and system efficiencies. Part 4-1: Space heating and DHW generation systems, combustion systems (boilers, biomass).

prEN 15316-4-3, Heating systems and water based cooling systems in buildings. Method for calculation of system energy requirements and system efficiencies. Part 4-3: Heat generation systems, thermal solar and photovoltaic systems. ■

Ecodesign regulation for ventilation units published

COMMISSION REGULATION (EU) No 1253/2014 of 7 July 2014, implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for ventilation units, has been published in the Official Journal of the European Union, issue L 337 (for versions in all official languages in the EU), dated 25 November 2011.

The requirements and target dates for their entry into force have not unchanged. This means that after 1 January 2016, all ventilation units shall fulfil the minimum requirements defined in the regulation. More stringent requirements for the same characteristics will enter into force on 1 January 2018.

Industry leaders predict essential redefinition of HVAC&R within the next 20 years

Eurovent provided effective platform to discuss future challenges and opportunities.

October saw the first-ever Eurovent Summit taking place in Berlin (Germany), with more than 320 industry representatives from around the globe elaborating on key issues ranging from energy efficiency to air quality. Themed 'HVAC&R Rethought', 38 different working sessions and events have led to lively discussions with guests such as EU Commissioner Connie Hedegaard, high association representatives and renowned academics – resulting in many thought-provoking results.

One major event marked the 'Energy Efficiency Symposium', organized in partnership with Eurovent members German Engineering Federation (VDMA) and Danish Ventilation. It brought together the EU Commissioner for Climate Action with leading associations from major economic regions. In her keynote speech, Hedegaard stressed the need for joint actions to tackle the 'double challenge' of global warming and increasing energy demands resulting from a growing worldwide population. Energy efficiency and the HVAC&R industry would play a central role in this respect. Adding current geopolitical challenges and energy dependencies to this context, the Commissioner reinforced that 'if there were ever a time where energy efficiency makes sense, then it is now'.

EU Commissioner Connie Hedegaard together with Secretary General Felix Van Eyken and Eurovent President Christian Herten.

International association representatives discussing with Connie Hedegaard.

Energy efficiency as an 'investment for future generations'

Yet, Hedegaard identified two obstacles: a lack of support from a national political level, and a wrong distribution of financial resources. Referring to the recently published "New Climate Economy Report", the Commissioner remarked that the same amount of money should not be spent on the same products and policies each year. Instead, a share of available resources should be invested in new policies and technologies – as an 'investment for future generations' and means to providing sustainable jobs. Connie Hedegaard described the EU as a frontrunner as it is aiming to dedicate 20 percent of its budget to climate and efficiency measures. She hopes for a similar 'spillover effect' as regards the HFC phase-out – with many regions following Europe's move towards safe refrigerants.

Call for effective global standards and coordinated legislation

In the subsequent panel discussion of the 'Energy Efficiency Symposium' with participants from Australia, Brazil, China, the EU, Korea, Japan, Latin and North America, Russia and Turkey, the topics 'global standards', 'uncoordinated policies', and 'air quality'

REHVA Secretary General Jan Aufderheijde handing over certificate to Eurovent President Christian Herten to highlight friendship of both associations.

predominated. While many participants called for global standards in order to lessen market barriers, others identified the need to manage increasing regional legislation and resulting complexities. Again others specifically remarked that air quality aspects should not be ignored when thinking about energy efficiency measures.

Health and air quality aspects expected to steer future industry

These and other topics were further addressed in the Eurovent Summit's 'Connecting Global Minds' event. Its aim was to connect Eurovent with ICARHMA (the International Council of Air-Conditioning, Refrigeration, and Heating Manufacturers Associations) members to develop global responses to shared challenges. Participants interactively discussed industry issues around eight roundtables addressing topics ranging from 'the future of our industry' to 'best practices in marketing HVAC&R'. The results proved to be inspiring, leading Eurovent President, Mr **Christian Herten**, to call for the development of a 'global position paper'.

Amongst others, it was concluded that healthy living and air quality requirements are to steer the future HVAC&R sector. Participants held that human factors and environmental considerations are increasingly shaping discussions on energy efficiency and use of renewable energy, stressing healthy living requirements aiming to keep costs of ageing populations and air pollution within limits. In its different forms and applications, HVAC&R will have to adapt to these evolutions and redefine itself within the next 20 years based on predicted demographic and environmental developments. This could also help rising the industry's overall attractiveness. Moreover, industry representatives might have to think along 'provocative operations', incorporating entirely new technologies while cooperating with sectors that no one would have thought of before.

Eurovent and its members prepared for the future

The Eurovent Summit consisted of 38 different sessions over four days, allowing for an extensive exchange beyond product and issue lines. Widening the scope through joint evening events and seminars, while inviting progressive and green thinkers such as Hans-Josef Fell (Energy Watch Group), Ian Knight (University of Cardiff) or Geo Clausen (Technical University of Denmark), enabled participants to think outside the box.

320 attendees from 34 countries, 208 manufacturers and 28 associations were also able to experience ongoing changes in the Eurovent structure. Eurovent and its 18 national member associations acknowledge that products are no longer components or part of a system, but have to be seen from a wider societal point of view that is creating dynamics, phasing out products while introducing entirely new concepts.

In 2016, the Eurovent Summit will take place in Warsaw (Poland).

Morten Schmelzer
Strategic Relations Manager at Eurovent

ISH China & CIHE 2015

13-15 May 2015
Beijing, China

ISH China & CIHE, Asia's largest HVAC, plumbing and sanitation exhibition, will be held at the New China International Exhibition Center in Beijing from 13 – 15 May 2015. Organised by Messe Frankfurt (Shanghai) Co Ltd and Beijing B&D Tiger Exhibition Co Ltd, the three-day event expects to host over 1,100 exhibitors, span over 90,000 sqm across seven halls. Amongst is a new hall showcasing comprehensive collection of intelligent and energy-efficient HVAC solutions. Concurrent events play an important role in ISH China & CIHE's success. In 2015, the reputable Sino-European HVAC Congress will officially be renamed to "China International HVAC Congress", focusing on renewable energies, intelligent HVAC technologies, floor heating, ventilation and indoor air quality, and heat pump technologies. Moreover, rainwater harvesting and utilization, as well as grease separation technology will be discussed at the second edition of the China International Building Water Supply & Drainage Forum. www.ishc-cihe.com

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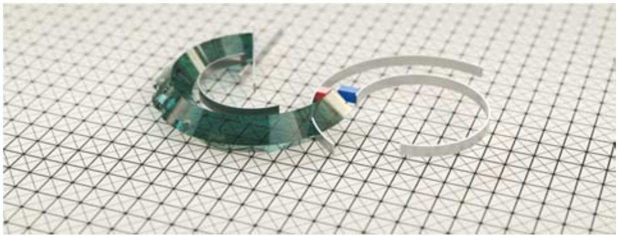

The application shall include:

- Name and surname of author and all co-authors
- Name of company or institution, address, telephone number, e-mail for all authors
- Title in Croatian and English
- Abstract in Croatian and English (1 page in Croatian and 1 page in English, maximum)
- Key words in Croatian and English

The papers will be accepted by the Program Committee based on the abstracts submitted. The Program Committee shall review the papers and make its decision on the papers that will be accepted. Three papers with best review of the Program Committee shall be presented to the Congress participants after the presentations of the invited speakers. Other papers will be presented as posters and full papers will publish in the Congress Proceedings. The Congress Proceedings will be available in printed and electronic format.

Deadlines:

Paper application.......... 31 December 2014
Notification on paper acceptance.......... 20 January 2015
Submittal of papers for the Proceedings.......... 25 February 2015
Submittal of presentations.......... 15 March 2015
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- Energy Efficiency Watch Conference
- Energy-Efficient Commercial Buildings Conference
- European Smart Windows Conference

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- Technical site-visits
- B2B Meetings

The **European Nearly Zero Energy Building Conference** is dedicated to high efficiency buildings supplied by renewable energy. Experts from all over the world will discuss innovative concepts and present solutions taken from real-life examples of efficient building technologies and renewable energy. The conference provides information on technologies, strategies and definitions, focuses on costs and financing and presents flagship projects in the areas of new construction and retrofitting.

The **European Pellet Conference** with more than 600 participants every year, the European Pellet Conference held in Wels has become the largest annual pellet event in the world. The conference is the meeting place for the global pellet business and research community and offers information on technologies, markets, policies and finance.

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FINVAC seminar on energy efficiency of buildings

FINVAC* seminar on energy efficiency of buildings in last November attracted over 250 top experts in Finland. The audience was a combination of business and public sector people. The focus of the seminar was not in technology but in business: how to make business with energy efficiency. The seminar was organised in cooperation with the Ministry of the Environment and Energy Authority.

The opening speech in the seminar was delivered by the Finnish minister of financial affairs. He stressed the importance of the construction sector in the Finnish energy policy, and predicted increasing activity in the energy related activities.

The main invited speakers came from the DG Energy of the EC and from Denmark. Ms **Claudia Canevari**, the deputy head of the energy efficiency unit, presented an overview of current and future energy policy in EU, and stressed the role of building sector in it. Ms **Kirsten Engelund Thomsen** from SIB, Denmark made an objective presentation and analysis of the Danish Energy policy and its implementation. Her presentation gave an insight in the success stories in the Danish energy policy.

The greetings from REHVA were delivered by Professor **Jarek Kurnitski**, vice-president of REHVA. He made a review of the upcoming CEN standards related to the implementation of EPBD. The set of 50 new standards will be in public inquiry early 2015. Interesting presentations were made by the Professors **Seppo Junnila** and **Peter Lund** from Aalto University, showing with hard data the business potential in the energy efficiency and use of the renewable energies. Successful business cases were presented by Caverion, Skanska, Halton, Saint Gobain Isover, Schneider Electric and Equa Simulation Finland.

The seminar was very well received by the participants. Due to great success of the seminar the board of FINVAC decided to organize the next seminar on October 8th, 2015 in the Finlandia Hall (the same venue were Clima 2007 took place). Over 600 experts are expected to participate.

Prof. Olli Seppänen
FINVAC President

* **FINVAC** is the Finnish member of REHVA, representing over 5 000 HVAC professionals in Finland. Its President is Professor **Olli Seppänen** and Secretary-General Ms **Siru Lönnqvist**.

Integrated (Energy) Design: Tool-kit and lessons learned from practice

The IEE-project MaTrID – market transformation towards nearly zero energy buildings through widespread use of integrated energy design – started in June 2012 and ended in December 2014. The project aimed to support the implementation of the Directive on the Energy Performance of Buildings. Integrated design is a proven method of achieving high-performance buildings that meet the set goals without sacrificing architectural quality or causing excessive costs. Stakeholders start to collaborate within the very early phases of the project. Therefore, an easily applicable IED tool-kit has been developed and pilot projects have been accompanied.

Key words: Integrated Design, Integrated Energy Design, Nearly Zero Energy Buildings, high energy performance buildings, design process, life cycle costs.

STEFAN AMANN
e7 Energie Markt Analyse GmbH
stefan.amann@e-sieben.at

Major outputs and results of the MaTrID project:

- Establishing a common understanding among building developers and designers with respect to the advantages and requirements of IED;
- Strengthening the know-how in applying IED by improving availability of IED procedures, guidelines and contractual stipulations;
- Large scale test for integrating IED in design processes in 10 partner countries: Austria, Greece, Italy, Norway, Sweden, Slovenia, Slovakia, Poland, Latvia, UK;
- Broad dissemination and promotion of IED on the national level as well as on the EU level.

The IED tool-kit:

During the past 2.5 years an easily applicable IED tool-kit has been developed. The tool-kit consists of an ***ID Process Guide***, a ***Tenant Brief***, a ***Client Brief***, a ***Supplement on Remuneration Models*** and a ***Supplement on Case Studies and Lessons learned*** (see **Figure 1**). This tool-kit helps to get all stakeholders started in the very early planning phase. The guidelines and its supplements address clients, contractors, engineers from all disciplines and facilitators to learn about the benefits from application of an Integrated Design approach. Also the ID Tool-kit has been translated and adapted to national regulations and circumstances.

The relevance of the concept is based on the well-proven observation that changes and improvements of the design are relatively easy to make at the beginning of the design process, but become increasingly difficult and disruptive as the process unfolds.

Thus, the performance of buildings should be assessed in a lifecycle perspective, both regarding environmental performance (LCA) and costs (LCC). The ID model of collaborative design emphasizes that the very early

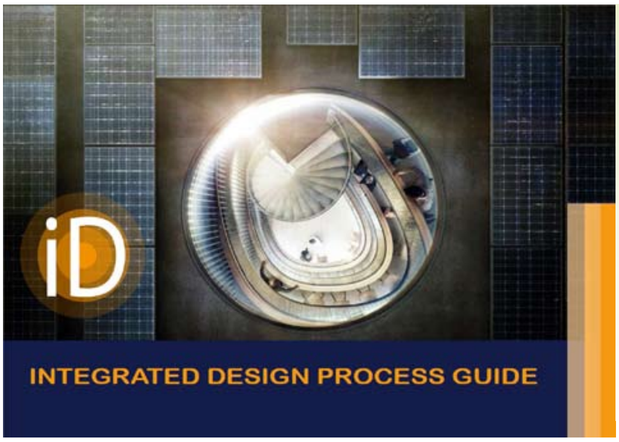
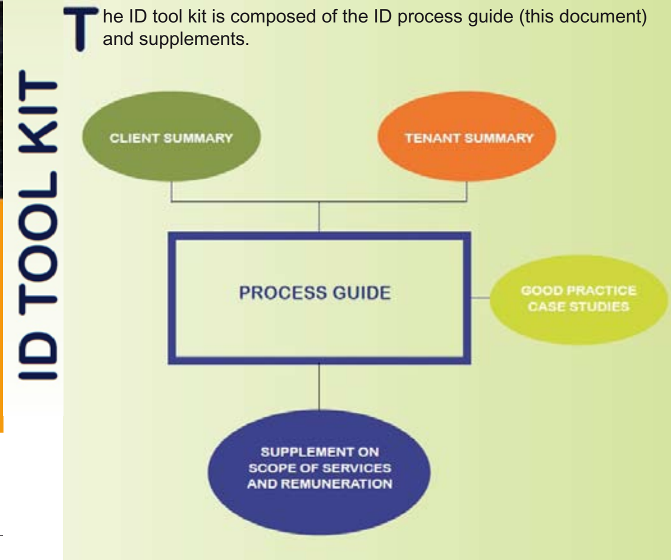


Figure 1. The Integrated Design Process Guide (Source: The ID Process Guide; www.integrateddesign.eu).



phases of design need more attention because well informed decisions here will pay off in the rest of the building process, as well as through into the lifecycle of the completed building. Well informed planning from the start can allow buildings to reach very low energy use and reduced operating costs at very little extra capital cost, if any.

When considered against the whole life cycle of a building, the running costs are significantly higher than construction and refurbishment costs; thus, it becomes obvious that it is a short-sighted approach to squeeze the first design phase regarding resources. Experience from building projects applying ID shows that the investment costs may be about 5% higher, but the annual running costs will be reduced by as much as 40–90% (see **Figure 2**).

The ID process has been prepared in an easily applicable step-by-step manner (**Figure 3**) with comprehensive explanation. All documents can be found at **www.integrateddesing.eu**.

Integrated Design in building projects

The core of the project was the application of the ID process in the building design phase. This was demonstrated in 21 pilot projects among Europe. Demonstration projects have been accompanied from the first idea of the project until the detailed planning phase. The following issues have been taken into account:

- Suitability for ID;
- Aim of the project to achieve an energy performance close to NZEB;
- Possibility to influence the design process from the beginning;
- Replication potential;
- Size: large projects with a complex design process rather than small projects with simple design processes.

Reports from all demonstration projects are available online. These ID projects were carried out in Austria, Greece, Italy, Latvia, Norway, Poland, Slovakia, Slovenia, Sweden and UK. Predominantly service buildings have been accompanied, but also educational institutions, hotels, cultural/arts centres and apartment buildings.

TASKS	COSTS	COMMENTS
Concept and Pre-design	5 -10 % more	Based on experience
Detailed engineering	< 5 % more the first projects 5-10% less in the next projects	Based on experience – smoother process caused by more detailed concept design
Building costs	5 – 10 % more	3-6 % for Passive houses
Operational costs	40 – 90 % less	Based on experience
Building faults	10 – 30 % less	Because of better planning and better follow up during construction

Figure 2. Estimations of increased/ reduced costs connected to ID (Source: The ID Process Guide; www.integrateddesign.eu).

Good practice example and lessons learned from *Smart Campus*, Vienna, Austria

Before initiating the design phase, a "moodboard" was developed together M.O.O.CON by capturing the corporate identity in images which serve as a significant source of inspiration for architects. The Wiener Netze was perceived as: trust worthy, reliable, honest, assertive, practical, tolerant, cooperative. The new building should represent these characteristics in front of clients and the surroundings. To comply with these requirements an anonymous, two-stage competition for general planners was organized in Europe. Since the company's core business is energy supply, the project shall be exemplary without the employees losing their comfort. The target was to build an energy efficient building and to apply renewable energies wisely as well as to make users aware of their usage patterns. Some more details on the project and on the ID process.

- Type of the building: service building
- Gross floor space: 93,000 m²
- Staff: 1,400
- To be completed: 2016
- The administrative building is the biggest building with passive house quality in Europe.
- 50–60% of the energy used comes from renewable energy sources.
- Special emphasize was given to life cycle costs. The method **www.lzk-tool.at** revealed a high degree of accuracy since the investment costs for the winning project calculated before the competition still remained the same during the final design phase. The LCA helped choosing the right building materials.
- The design team was not composed by the same people during the whole process but the core team accompanied the project through the entire process.
- The multidisciplinary team increased the effectiveness of the design phase. Thanks to their expertise they were able to make decisions very quickly.
- The team created interfaces between individuals and activities in order to avoid problems during the process. Experts, decision makers, responsible for user matters as well as appraisers and civil engineers supported the core team in every phase of the project. The design of the detailed engineering serves as a good example. First a pool of user representatives and appraisers was established. Then regular weekly meetings were held and suitable people from the pool were chosen to share their user or expert perspective and to help with the detailed engineering. This way high user satisfaction could be ensured.

Good practice example and lessons learned from *Hotel in Milos*, Greece

The construction of a hotel in a coastal area with an archeological interest which should also have a high energy and environmental performance preserving at the same time the local biodiversity was a major chal-

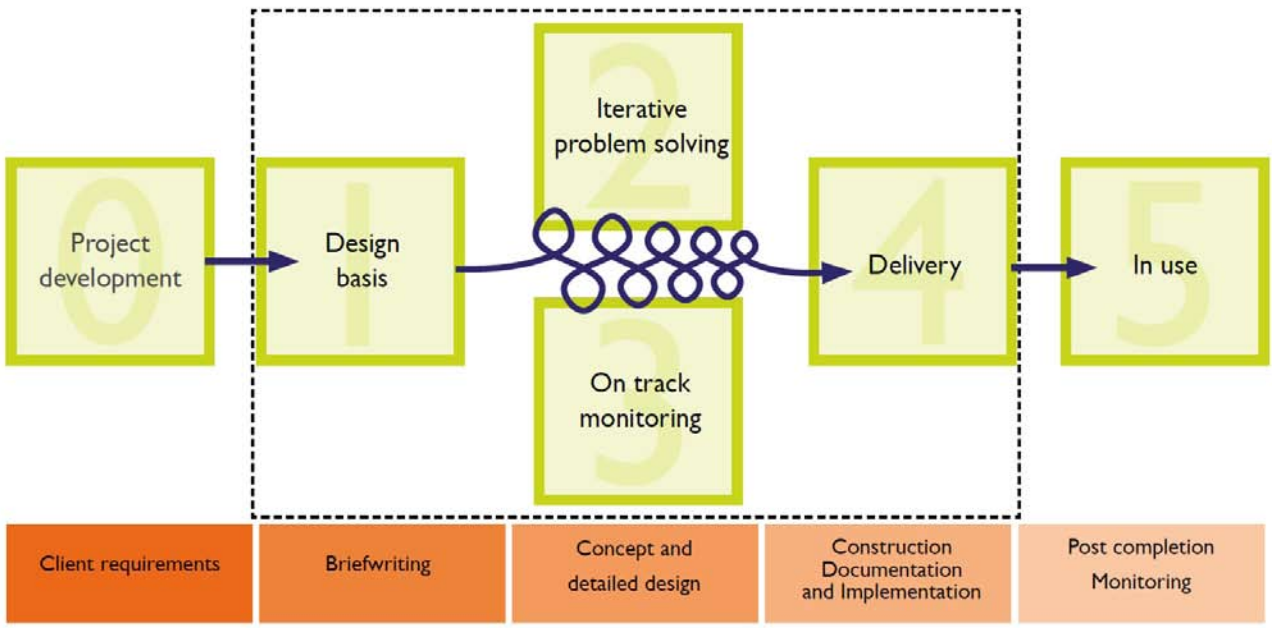


Figure 3. Overview of the ID process. The creative problem solving process (2) runs parallel in time with monitoring the progress according to the goals (3) (Source: The ID Process Guide; www.integrateddesign.eu).

lenge for the design process. The owner in cooperation with the architect, the engineers and the consultants adopted the ID principles from the early stages of the process.

- Owner: MILOS COVE SA
- Location: Milos island, Greece
- Type of the building: five star hotel
- Gross floor space: 3,800 m²
- Investment costs: 4.5 million €
- Year of completion: to be completed 2016

About the ID process: The multidisciplinary team was consisted from the very early phases of the project and this helped to developing good cooperation between the members. Identifying, stating and overcoming problems is a major challenge in the ID processes. The basic steps that are followed are these:

- Kick off meeting with multidisciplinary design team, discussion of needs and demands. Assessment of the current situation by performing reports. Definition of project goals.
- Workshops and meeting between architect, engineers and consultant to propose improvement solutions.
- Meetings with developer to present and discuss the concepts.

Lessons learned from ID process: The agreement of the owner and the design team for proceeding with ID from the early design phase is crucial. The new approaches have to be introduced, defined and incorporated as soon as possible and this demands willingness and good cooperation between the team members. At first the team was sceptical about the procedure, but the positive results and the facilitation of problem solving convinced them about the procedure and the investment.

Figure 4. Smart Campus (Source: Holzbauer und Partner ZT – GmbH).

General lessons learned and suggestions from European pilot projects

Every partner has evaluated each pilot project and gathered information about lessons learned. In almost all pilot projects good communication has been mentioned as one of the key activities to achieve a great project result. Good communication between the project team members in the initial interaction phases dramatically reduces system interaction problems during subsequent phases, as well as improves a team's common understanding of the potential future building development and operation problems and possible related solutions.

It is important that the client understands the advantages and benefits of applying an ID process. In **Figure 2** tasks and related costs can be found. Furthermore the role of an ID facilitator is crucial. If a facilitator becomes involved – as early as possible – various elements can still be influenced and directed.

All design team members must understand how they are expected to contribute in the various planning phases to the whole team. There is a huge need of clarity about what the design team has to do and how the ID process works. A major challenge is to keep the iterative solution methodology ongoing and not falling back into the traditional way of working.

The result of several projects was that there is a need of a better file sharing system, where project team members can work in parallel in the same documents at the same time. Various programs linked to BIM-system have been used.

In **Table 1** results of a SWOT-analysis of ID processes can be found.

GreenBuilding Integrated Design Award 2014

In 2014 the GB ID Award has been awarded. The objective of the Award was to give European visibility to outstanding integrated design processes. It was granted on 1 April 2014 in Frankfurt during the IEECB conference.

The winner of the GB ID Award 2014 is Wirtschaftsagentur Wien and ATP architects engineers with the building aspern IQ in Vienna, Austria. Commendations go to i) Kobra Team d.o.o. and Protim Ržišnik Percd.o.o with the Plus Energy Business Building Kobra in Slovenia and ii) the Municipality of Evrotas (Greece) and National and Kapodistrian University of Athens with the Bassourakos Building-Cultural Center.

Table 1. Results from the MaTrID pilot projects have been analyzed by the SWOT method (Source: The ID Process Guide; www.integrateddesign.eu).

Strengths	Weaknesses	Opportunities	Threats
ID is an Iterative process which secures that all energy related issues will be handled before the process leave for the next step. The outcome of the planning process will be more thorough and consist of fewer contradictions and inconsistencies. This in turn will result in fewer last minute changes and fewer building faults.	Relatively unknown in the construction industry. Difficult to change traditional way of planning and constructing. Demands good communication. Demands an ID facilitator, which is a new role in the planning process. The project manager needs to share responsibility and mandate to the ID facilitator. Increased planning costs.	EU directive about NZEB will increase the market for NZEB buildings and ID is an effective method for reaching NZEB energy demands. The ID process gather expertise from different work fields resulting in synergies. Fewer last minute changes and fewer building faults will show that in total the ID process is cost effective. Future improvements of the method is relatively simple, e.g. it would be easy to add a process for increased accessibility for disabled people.	Lack of knowledge and information about ID and the benefits using it among stakeholders. Difficulties in finding the right way of using ID for each single project. Client willingness of paying more for the planning process. For best results it is important to use ID from the very beginning of the project, preferably even before there is a drawing. This can be a threat, as many projects demand a drawing to achieve funding.

Recommendations

- **Capacity Building**: There is a need for educational and informational activities towards potential clients and construction project developers about the advantages of using the ID process in conjunction with planning. With a higher level of understanding of the benefits using ID, clients and the project developers will use the method and give the design team the mandate required to fully succeed. Furthermore there is a need for educational activities directed at members of the design team, e.g. architects, engineers, project manager, facility manager and future buildings users. Focus in these activities should be on how ID functions and on the advantages that come about when using the ID process in conjunction with planning a construction project.
- **Environmental certification schemes**: ID should be promoted according to environmental certification schemes. One of the main purposes with all schemes is to promote buildings with high environmental performance targets. ID is a very powerful tool to achieve these targets. An ID certification scheme could be created or integrated into existing schemes which benchmarks the stages of a construction project and certifies that particular ID steps have been achieved up to specific points in the process. This would create a solid framework upon which designers, engineers, contractors and project managers could structure a design process, and demonstrate their application of ID within a project.
- Local authorities could take their leading role in the introduction of NZEB. Public procurement is one of the most important instruments that local authorities have to achieve sustainability targets. ID could be indicated as a beneficial asset. ■

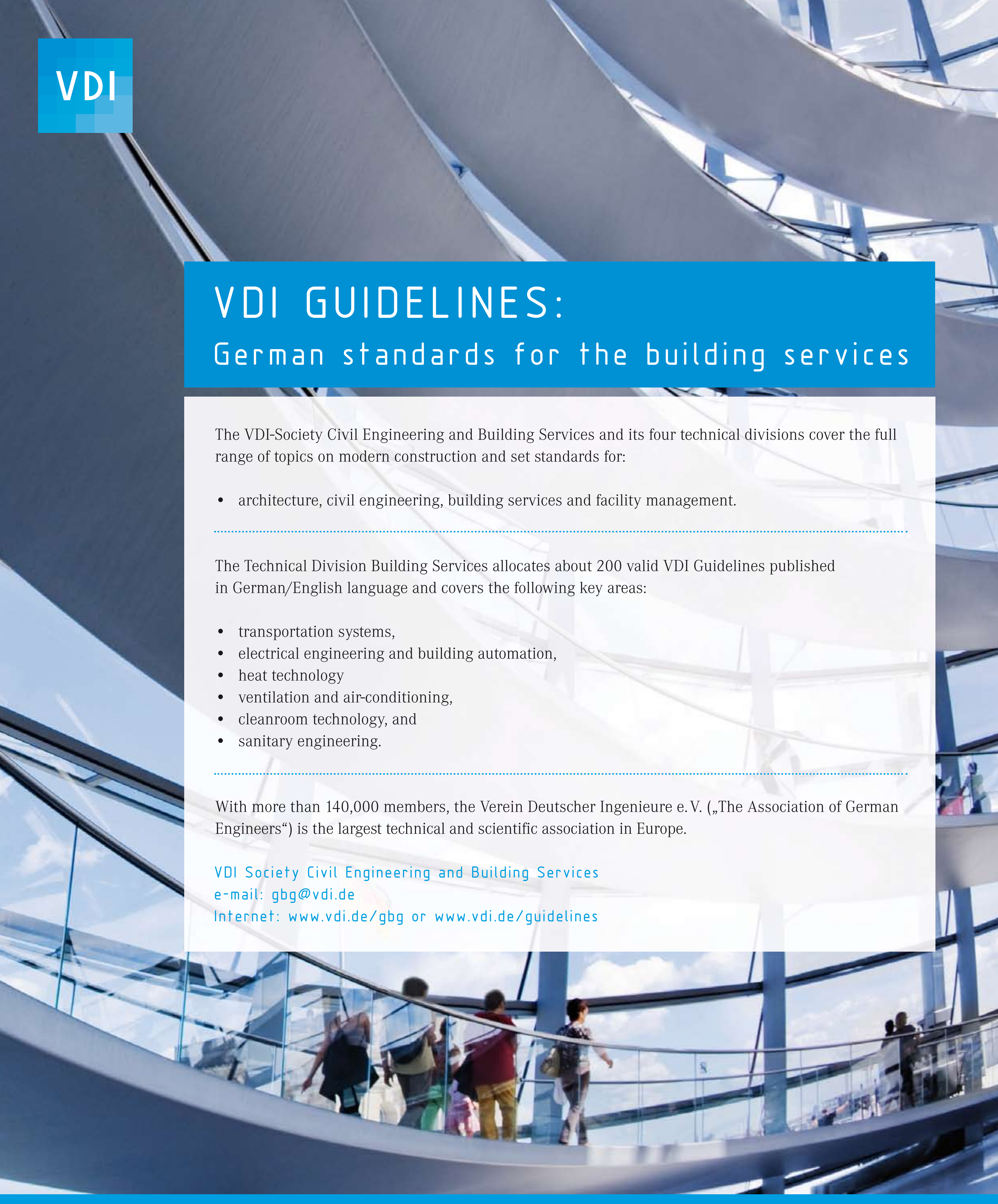
Figure 5. Hotel in Milos (Source: ALD Architects).

All information

Please visit **www.integrateddesign.eu** for comprehensive information.

Legal disclaimer

This project was co-funded by the Intelligent Energy for Europe Programme of the European Union. The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.



VDI- Standards published in December 2014

D VDI 2050/1.1 "Requirements for technical equipment rooms; Space for service shafts"

The standard VDI 2050 Part 1.1 arose because of the importance of an economic and a technically correct execution of installations of the systems of building services in the vertical circulation of the building. Problems arise often between the various trades in the planning, preparation of specifications for the design, the correct statement of the tendered services in consideration of legitimate requirements for additional remuneration due to increased assembly costs. For object planners the basic evaluation for the planning of buildings and their technical facilities are often lacking detail on minimum gross area requirements and/or minimum net area requirement of the installation areas. Therefore, necessary clearance for the use of tools, or to be considered measures of handling and for brackets in addition to the insulated pipe cross section often result to supplements in the assembly planning because of more difficult working conditions. Compensating for this, spaces for shafts are specified in this standard. The application of this standard helps to ensure a reasonable space planning in accordance with the acknowledged rules of technology.

C VDI 2053/1 "Air conditioning; Car parks; Exhaust ventilation"

This standard applies to ventilation and air-conditioning for garages. Garages are buildings, or parts of buildings, which are dedicated to the parking of motor vehicles. Medium-sized (100 square metres, up to 1000 square metres) and large garages (above 1000 square metres) with a closed building envelope require sufficient ventilation to ensure operation without health hazards. The application of this standard ensures that pollutant concentrations do not exceed the limits which are deemed acceptable. The described required protection is intended for short-term exposure only. The standard does not apply to automated garages, open garages and rooms where extended occupation by persons is intended.

D VDI 3805/17 "Produkt data exchange in the building services; Drinking water system assemblies"

Based on VDI 3805 Part 1, the standard describes a manufacturer and IT system independent and unified data format for the exchange of product data for drinking water system assemblies used in building services.

D VDI 6008/1.2 "Barrier-free buildings; Trainings"

This standard defines requirements for training, training contents and the training documentation with reference to the series of standards VDI 6008 "Barrier-free environments". Thus, it gives a quality-standard for trainings of executive craft, technical planners, architects/civil engineers and interested persons.
The standard thus provides a training concept for all experts who are active in the planning and execution.

D Draft Guideline

C VDI Ventilation Code of Practice

Send information of your event to Ms Cynthia Despradel cd@rehva.eu

Events in 2015 - 2016

Conferences and seminars 2015

January 24-28	2015 ASHRAE Winter Conference	Chicago, Illinois, USA	www.ashrae.org/membership--conferences/conferences/2015-ashrae-winter-conference
February 25-27	World Sustainable Energy Days 2015	Wels, Austria	www.wsed.at
April 16-18	International Conference Ammonia and CO_2 Refrigeration Technologies	Ohrid, Republic of Macedonia	www.mf.edu.mk/web_ohrid2015/ohrid-2015.html
April 27-28	37th Euroheat & Power Congress	Tallinn, Estonia	www.ehpcongress.org/registration/
May 6-7	REHVA Annual Meeting	Riga, Latvia	www.hvacriga2015.eu
May 8-9	REHVA Annual Conference "Advanced HVAC and Natural Gas Technologies"	Riga, Latvia	www.hvacriga2015.eu
May 18-20	Healthy Building 2015 Europe	Eidhoven, The Netherlands	www.hb2015-europe.org
June 14-17	International Building Physics Conference	Torino, Italy	http://ibpc2015.org/
August 16 – 22	IIR International Congress of Refrigeration	Yokohama, Japan	www.icr2015.org
September 10-11	CLIMAMED	Juan Les Pins, France	http://aicvf.org/blog/actualites/climamed-congress-juan-les-pins-10-et-11-septembre-2015/
October 20-23	Cold Climate HVAC	Dalian, China	www.coldclimate2015.org
October 26-28	11th International Conference on Industrial Ventilation	Shanghai, China	www.ventilation2015.org

Exhibitions 2015

January 26-28	2015 AHR Expo	Chicago, Illinois, USA	www.ahrexpo.com
February 3-6	AQUATHERM Moscow	Moscow, Russia	www.aquatherm-moscow.ru/en/
February 17-19	AQUATHERM Novosibirsk	Novosibirsk, Russia	www.aquatherm-novosibirsk.ru/en/
February 26-28	ACREX India	Biec, Bangalore, India	www.acrex.in
March 10-14	ISH	Frankfurt, Germany	http://ish.messefrankfurt.com
March 18-21	AQUATHERM St.Petersburg	St. Petersburg, Russia	www.aquatherm-spb.com/en/
May 13-15	ISH China & CIHE	Beijing, China	www.ishc-cihe.com
September 23-25	ISH Shanghai & CIHE	Shanghai, China	www.ishs-cihe.hk.messefrankfurt.com
November 2-6	Interclima+Elec	Paris, France	www.interclimaelec.com

Conferences and seminars 2016

May 22-25	12th REHVA World Conference - CLIMA 2016	Aalborg, Denmark	www.clima2016.org
July 3-8	Indoor Air 2016	Ghent, Belgium	twitter @IA2016

Exhibitions 2016

January 25-27	2016 AHR Expo	Orlando, Florida, USA	www.ahrexpo.com
March 1-4	AQUATHERM Prague	Prague, Czech Republic	www.aquatherm-praha.com/en/
March 13-18	Light and Building	Frankfurt, Germany	http://ish.messefrankfurt.com
March 15-18	Mostra Convegno Expocomfort	Milan, Italy	www.mcexpocomfort.it/
October 12-14	FinnBuild	Helsinki, Finland	www.messukeskus.com/Sites1/FinnBuild/

REHVA Guidebook on
Active and Passive Beam Application Design Guide
For Global Application

Editors: John Woollett and Julian Rimmer

Co-Chairs of Authoring Committee: Peter Simmonds, Darren S. Alexander, Jonathan Chan, Ken Loudermilk, Chris Lowell, Jonas Akesson, Carlos Lisboa, Rafael Urculo, Maija K. Virta, Thomas Wolters and Risto Kosonen

This design guide is a revision of the REHVA Chilled Beam Application Guidebook, which was published in 2004. ASHRAE and REHVA decided to collaborate on a revision of the guidebook and enlisted experts from both organizations to revise the document.

This new guide is aimed at consulting engineers, architects, owners, and contractors who are involved in the design, operation, and installation of active and passive beam systems.

This book provides tools and guidance to design, commission, and operate active and passive beam systems to achieve a determined indoor climate. It also presents examples of active and passive beam calculations and selections. Online tools can be found at ashrae.org/beamcalc.

This is a global Guide for Designing Chilled-Beam SystemsThe Active and Passive Beam Application Design Guide is the result of collaboration by worldwide experts to give system designers a current, authoritative guide on successfully applying active and passive beam technology. Active and Passive Beam Application Design Guide provide energy-efficient methods of cooling, heating, and ventilating indoor areas, especially spaces that require individual zone control and where internal moisture loads are moderate. The systems are simple to operate, with low maintenance requirements.

This book is an essential resource for consulting engineers, architects, owners, and contractors who are involved in the design, operation, and installation of these systems. Building on REHVA's Chilled Beam Application Guidebook, this new guide provides up-to-date tools and advice for designing, commissioning, and operating chilled-beam systems to achieve a determined indoor climate, and includes examples of active and passive beam calculations and selections. Dual units (SI and I-P) are provided throughout.

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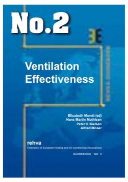
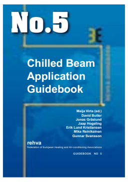
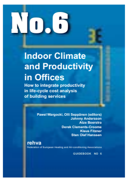


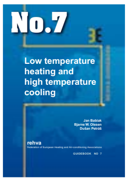
Ventilation Effectiveness. Improving the ventilation effectiveness allows the indoor air quality to be significantly enhanced without the need for higher air changes in the building, thereby avoiding the higher costs and energy consumption associated with increasing the ventilation rates. This Guidebook provides easy-to-understand descriptions of the indices used to measure the performance of a ventilation system and which indices to use in different cases.



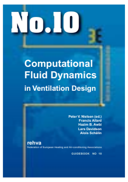
Chilled Beam Cooling. Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature hot water system. Primary air supply induces room air to be recirculated through the heat exchanger of the chilled beam. In order to cool or heat the room either cold or warm water is cycled through the heat exchanger.



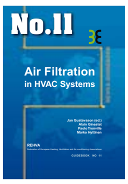
Indoor Climate and Productivity in Offices. This Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available. The quantitative relationships presented in this Guidebook can be used to calculate the costs and benefits of running and operating the building.



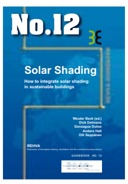
Low Temperature Heating And High Temperature Cooling. This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in all types of buildings and work with heat carriers at low temperatures for heating and relatively high temperature for cooling.



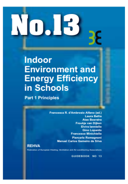
Computational Fluid Dynamics in Ventilation Design. CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary conditions. Computational Fluid Dynamics (CFD) – in Ventilation Design models is written by a working group of highly qualified international experts representing research, consulting and design.



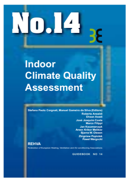
Air Filtration in HVAC Systems. This Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on external conditions such as levels of existing pollutants, indoor air quality and energy efficiency requirements.



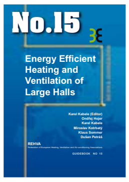
Solar Shading – ***How to integrate solar shading in sustainable buildings.*** Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy for cooling, heating and lighting. The book gives also practical guidance for selection, installation and operation of solar shading as well as future trends in integration of HVAC-systems with solar control.



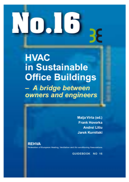
Indoor Environment and Energy Efficiency in Schools – *Part 1 Principles.* School buildings represent a significant part of the building stock and also a noteworthy part of the total energy use. Indoor and Energy Efficiency in Schools Guidebook describes the optimal design and operation of schools with respect to low energy cost and performance of the students. It focuses particularly on energy efficient systems for a healthy indoor environment.



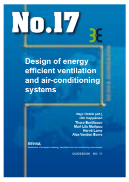
Indoor Climate Quality Assessment. This Guidebook gives building professionals a useful support in the practical measurements and monitoring of the indoor climate in buildings. Wireless technologies for measurement and monitoring have allowed enlarging significantly number of possible applications, especially in existing buildings. The Guidebook illustrates with several cases the instrumentation.



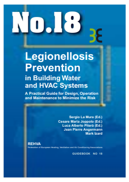
Energy Efficient Heating and Ventilation of Large Halls. This Guidebook is focused on modern methods for design, control and operation of energy efficient heating systems in large spaces and industrial halls. The book deals with thermal comfort, light and dark gas radiant heaters, panel radiant heating, floor heating and industrial air heating systems. Various heating systems are illustrated with case studies. Design principles, methods and modelling tools are presented for various systems.



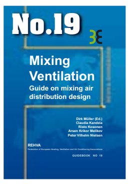
HVAC in Sustainable Office Buildings – ***A bridge between owners and engineers.*** This Guidebook discusses the interaction of sustainability and heating, ventilation and air–conditioning. HVAC technologies used in sustainable buildings are described. This book also provides a list of questions to be asked in various phrases of building's life time. Different case studies of sustainable office buildings are presented.



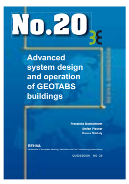
Design of energy efficient ventilation and air-conditioning systems. This Guidebook covers numerous system components of ventilation and air-conditioning systems and shows how they can be improved by applying the latest technology products. Special attention is paid to details, which are often overlooked in the daily design practice, resulting in poor performance of high quality products once they are installed in the building system.



Legionellosis Prevention in Building Water and HVAC Systems. This Guidebook is a practical guide for design, operation and maintenance to minimize the risk of legionellosis in building water and HVAC systems. It is divided into several themes such as: Air conditioning of the air (by water – humidification), Production of hot water for washing (fundamentally but not only hot water for washing) and Evaporative cooling tower.



Mixing Ventilation. In this Guidebook most of the known and used in practice methods for achieving mixing air distribution are discussed. Mixing ventilation has been applied to many different spaces providing fresh air and thermal comfort to the occupants. Today, a design engineer can choose from large selection of air diffusers and exhaust openings.



Advanced system design and operation of GEOTABS buildings. This Guidebook provides comprehensive information on GEOTABS systems. It is intended to support building owners, architects and engineers in an early design stage showing how GEOTABS can be integrated into their building concepts. It also gives many helpful advices from experienced engineers that have designed, built and run GEOTABS systems.

REHVA nZEB Report. In this REHVA Report in cooperation with CEN, technical definitions and energy calculation principles for nearly zero energy buildings required in the implementation of the Energy performance of buildings directive recast are presented. This 2013 revision replaces 2011 version. These technical definitions and specifications were prepared in the level of detail to be suitable for the implementation in national building codes.

REHVA – Rue Washington, 40 – 1050 Brussels – Belgium
Telephone: +32 2 514 11 71 • Fax + 32 2 512 9062 • E-mail: info@rehva.eu • website: www.rehva.eu