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REHVA Journal is a technical, practical journal for the HVAC industry professionals. It is read by Designers, Consultants, Manufacturers, Investors, Mechanical Contractors, Sales and Representative Companies, Architects Energy sector's professionals, governmental institutions authorities, etc.

Energy Performance of Buildings

This REHVA Journal is providing information on the set of Energy Performance of Buildings (EPB) standards. These standards have been published for Final (Formal) Vote and all have been accepted January 2017. REHVA member-associations, REHVA's MOU organisations like ISHRAE and their members play an important role in improving the Energy Performance of Buildings on national and regional level.

Why is it that important that these standards are accepted to be published as European (EN) and/or international ISO standards? The modularly structured, transparent, unambiguous, but flexible set of EPB standards is an important instrument to support the proper implementation of the Energy Performance Buildings improvement programs in Europe and globally. These standards are also expected to be the basis for the European voluntary certification scheme for non-residential buildings.

The need for these EPB standards is even more urgent given the COP21 targets. This EPB set is essential to promote the unambiguity and harmonisation in the energy-efficiency and energy-transition market. Globally about 40% of energy consumption is due to buildings of which 2/3 for the residential sector. Our first task is reducing building energy use (by measures like insulation, passive solar, system efficiency improvement, etc.). The next or parallel step is to increase the fraction (and production) of renewable energy, locally on the building site or nearby and finally decarbonise the total energy grid. All these measures and how to weigh their impact, are addressed in the overarching standard ISO 52000-1 and the connected several other EPB standards.

It is essential that we use these standards at national and regional level and stop using local assessment procedures. The use of these typical local procedures, is considered a barrier of innovation, trade and services for many energy saving technologies and products, due to the diverse assessment procedures. Using EPB standards to assess the Energy Performance of Buildings is essential to stimulate innovation in our HVAC&R industry. This harmonisation will reward energy saving products, systems and technologies the same way throughout the globe. This will offer great market opportunities for our industry and professionals. Bigger market opportunities mean more possibilities to invest in more energy efficient technologies. This will also have a positive effect on the cost-effectiveness of these technologies and enlarge their market.

Widely used EPB standards will give REHVA and its MOU organisations like ISHRAE a unique position to support their professionals in developing training schemes, supporting tools, dissemination programs, webinars etc. As partner in the EPB-CENTER initiative REHVA supports setting up programs supporting professionals with the implementation of these EPB standards in daily practise. Via this EPB-CENTER experiences will be shared. Also with the aim to develop tools that can be used EU-wide and globally and deliver feedback to the standardisation field, as improvement of standards is always possible. ■

JAAP HOGELING
Editor-in-Chief

The set of EPB standards in CEN and ISO: common characteristics

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).

This paper summarizes some key aspects that characterize this set of EPB standards.

Keywords: energy performance of buildings, EPB, EPB regulations, system inspection, energy performance rating.

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A comprehensive series of European (CEN) and international (CEN & ISO) standards have been prepared, 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 [5] were adopted in the Mandate.

This article summarizes some key aspects that characterize this set of CEN and ISO standards.

European directive and mandate to CEN

The EPBD

The EPBD promotes the improvement of the energy performance of buildings within the European Union, taking into account all types of energy uses (heating, lighting, cooling, air conditioning, ventilation) and outdoor climatic and local conditions, as well as indoor climate requirements and cost effectiveness (Article 1).

The directive requires Member States to adopt measures and tools to achieve the prudent and rational use of energy resources. In order to achieve those goals, the EPBD requires increasing energy efficiency and the enhanced use of renewable energies in both new and existing buildings. One tool for this is the application by Member States of minimum requirements on the energy performance of new buildings and for existing buildings that are subject to major renovation, as well as for minimum performance requirements for the building envelope if energy-relevant parts are replaced or retrofitted. Other tools are energy certification of buildings, inspection of boilers and air-conditioning systems.

European standards

The use of European standards increases the accessibility, transparency and objectivity of the energy performance assessment in the Member States facilitating the comparison of best practices and supporting the internal market for construction products. The use of EPB-standards for calculating energy performance, as well as for energy performance certification and the inspection of heating systems and boilers, ventilation and air-conditioning systems will reduce costs compared to developing different standards at national level.

History

The first mandate to CEN to develop a set of CEN EPBD standards (M/343, [4]), to support the first edition of the EPBD [3] resulted in the successful publication of all EPBD related CEN standards in 2007-2008. However, although these standards were implemented in many countries, in a practical way, they were not yet fit to be applied as a ready-to-use, compatible and unambiguous set.

The mandate M/480 was issued to review the mandate M/343 as the recast of the EPBD raised the need to revisit the standards and reformulate and add standards so that they become on the one hand unambiguous and compatible, and on the other hand a clear and explicit overview of the choices, boundary conditions and input data that need to be defined at national or regional level. Such national or regional choices remain necessary, due to differences in climate, culture & building tradition, policy and legal frameworks.

Consequently, the set of CEN-EPBD standards published in 2007-2008 had to be improved and expanded on the basis of the recast of the EPBD.

Target groups

The EPB standards are flexible enough to allow for necessary national and regional differentiation and facilitate Member States implementation and the setting of requirements by the Member States.

Further target groups are users of the voluntary common European Union certification scheme for the energy performance of non-residential buildings (EPBD art.11.9) and any other regional (e.g. Pan European) parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

The set of EPB standards

What is an "EPB standard"?

An "EPB standard" is a standard that complies with the requirements given in the following three documents: CEN/TS 16628 [6], the basic principles for EPB standards, CEN/TS 16629 [7], the detailed technical rules of EPB standards and EN ISO 52000-1 [8], the overarching EPB standard.

Modular structure

EN ISO 52000-1 [8], 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** and **Table 2**.

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. The modular structure of the set of EPB standards.

	Overarching		Building (as such)	
Sub-module	Descriptions		Descriptions	
sub1		M1		M2
1	General		General	
2	Common terms and definitions; symbols, units and subscripts		Building Energy Needs	
3	Applications		(Free) Indoor Conditions without Systems	
4	Ways to Express Energy Performance		Ways to Express Energy Performance	
5	Building categories and Building Boundaries		Heat Transfer by Transmission	
6	Building Occupancy and Operating Conditions		Heat Transfer by Infiltration and Ventilation	
7	Aggregation of Energy Services and Energy Carriers		Internal Heat Gains	
8	Building zoning		Solar Heat Gains	
9	Calculated Energy Performance		Building Dynamics (thermal mass)	
10	Measured Energy Performance		Measured Energy Performance	
11	Inspection		Inspection	
12	Ways to Express Indoor Comfort			
13	External Environment Conditions			
14	Economic Calculation			

	Technical Building Systems									
	Descriptions	Heating	Cooling	Ventilation	Humidi-fication	Dehumidi-fication	Domestic Hot water	Lighting	Building automation & control	PV, wind
		M3	M4	M5	M6	M7	M8	M9	M10	M11
	General									
	Needs									
	Maximum Load and Power									
	Ways to Express Energy Performance									
	Emission & control									
	Distribution & control									
	Storage & control									
	Generation & control									
	Load dispatching and operating conditions									
	Measured Energy Performance									
	Inspection									
	BMS									

The shaded modules are not applicable

Unambiguous, but flexible: the "Annex A/Annex B" approach

The "Annex A/Annex B" approach

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency.

At the same time, all EPB standards provide a certain flexibility with regard to the methods, the required input data and references to other EPB standards, by the introduction of a normative template in Annex A and Annex B with informative default choices.

For the correct use of the EPB standards, each EPB standard typically contains a normative template in Annex A to specify these choices. And informative default choices are provided in Annex B.

The main target groups for this document are architects, engineers and regulators.

Use by or for regulators:

In case an EPB standard is used in the context of national or regional legal requirements, mandatory choices may be given at national or regional level for such specific applications. These choices (either the informative default choices from Annex B or choices adapted to national / regional needs, but, in any case, following the template of this Annex A) can be made available as national annex or as separate (e.g. legal) document (national data sheet).

Note that in this case:

- the regulators will **specify the choices**;
- the individual user will apply the standard to assess the energy performance of a building, and thereby use the choices made by the regulators

Topics addressed in a standard can be subject to public regulation. Public regulation on the same topics can override the default values in Annex B of the EPB standard. Public regulation on the same topics can even, for certain applications, override the use of the standard. Legal requirements and choices are in general not published in standards, but in legal documents. In order to avoid double publications and difficult updating of double documents, a **national annex** may refer to the legal texts where national choices have been made by public authorities.

Different national annexes or national data sheets are possible, for different applications.

It is expected, if the default values, choices and references to other EPB standards in Annex B are not followed due to national regulations, policy or traditions, that:

- national or regional authorities prepare data sheets containing the choices and national or regional values, according to the model in Annex A. In this case the national annex (e.g. NA) refers to this text;
- or, by default, the national standards body will consider the possibility to add or include a national annex in agreement with the template of Annex A, in accordance to the legal documents that give national or regional values and choices.

Further target groups are parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

More information is provided in the Technical Report accompanying the overarching EPB standard, CEN ISO/TR 52000-2 [6].

Step by step implementation

The modular EPB structure and the "Annex A/ Annex B" approach, in particular with the option to (preferably for a limited period) reference to a specific national standard instead of a specific EPB standard, strongly facilitates a step by step implementation of the set of EPB standards by individual countries or regions.

Accompanying technical report

The Detailed Technical Rules for the set of EPB standards [7], responding to the mandate M/480 [2], 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 [7], and in agreement with the mandate M/480 [2], for each EPB-standard containing calculation procedures an accompanying spreadsheet has been prepared to test and validate the calculation procedure. The spreadsheet also includes 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 a fully worked example of the application (the calculation method between the set of input and output quantities) for validation and demonstration.

These spreadsheets have been made publicly available at: https://isolutions.iso.org/ecom/public/nen/Livelink/open/35102456

CEN and ISO

Several EPB standards have been prepared or revised as combined EN ISO standards under the so-called Vienna Agreement between CEN and ISO.

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.

Up until now, 17 of the EPB standards are EN ISO standards: the overarching EPB standard, plus the EPB standards on building and building components (ISO/TC 163 in cooperation with CEN/TC 89). The other 30 EPB standards are up until now only available at European (CEN) level.

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 [10], [11], [12] 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.

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

Upon initiative of the above-mentioned 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 ISO 52000-1 [8]. 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 standard 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 EPB overarching standard received the number EN ISO 52000-1 and the accompanying technical report is CEN ISO/TR 52000-2. ▶

Collecting errata in Final Drafts of the EPB standards during the final voting

Almost all CEN and EN ISO EPB standards and accompanying technical reports are under Final Vote during the period from (roughly) early November 2016 until (roughly) end of January 2017. The precise dates differ per subset. Inevitably, during the evaluation of the standards to prepare the voting, editorial or technical errors are and will be found. The intention is to collect these errata in the form of a standard comment sheet for each relevant standard, at a publicly accessible location at NEN Isolutions.

This will enable the readers to learn which corrections are already envisaged. In particular: for some of the EPB standards, the editors at the central ISO secretariat applied the internal editing rules so strictly, that for instance references to specific paragraphs or terms in other EPB standards were replaced by references to specific paragraphs or terms in the *earlier published drafts* of these standards for Enquiry, because references are only allowed to published documents. ■

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The authors and CTL of CENTC371 also like to acknowledge the good cooperation with the representatives from the EC member states, and, in particular, the initiatives and efforts by the EPBC-CEN Liaison Committee who successfully translated the wishes and needs from the regulators to the EPB standard writers. The informal communication supported by the CA-II and CA-III EPBD programs[1] where several CEN Task Leaders had the opportunity to exchange ideas how to address these wishes and needs from the EU MS regulators.

[1] The Concerted Action supporting transposition and implementation of Directive 2002/91/EC of the European Parliament and of the Council and its recast (CA EPBD III), henceforth CA, is an activity which aims to foster exchange of information and experience among Member States (MS). It involves the national authorities implementing the Directive, or those bodies appointed and entrusted by the national authorities to do so.

References

[1] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast), OJ 153, 18.6.2010.

[2] Mandate M/480, Mandate to CEN, CENELEC and ETSI for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings, in accordance with the terms set in the recast of the Directive on the energy performance of buildings (2010/31/EU) of 14th December 2010.

[3] EPBD, Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings.

[4] Mandate M/343 Mandate to CEN, CENELEC and ETSI for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and estimating the environmental impact, in accordance with the terms set forth in Directive 2002/91/EC; 30 January 2004.

[5] Van Dijk, Dick,: Set of recommendations: Towards a second generation of CEN standards related to the Energy Performance of Buildings Directive (EPBD), CENSE "Arching Document 2", CENSE WP6.1_N05rev02, May 27, 2010.

[6] CEN/TS 16628, Energy Performance of Buildings – Basic principles for the set of EPB standards, July 2014.

[7] CEN/TS 16629, Energy Performance of Buildings – Detailed technical rules for the set of EPB standards, July 2014.

[8] EN ISO 52000-1 Energy performance of Buildings – Overarching EPB assessment – Part 1: General framework and procedures.

[9] CEN ISO TR 52000-2, Energy performance of Buildings – Overarching EPB assessment – Part 2: Explanation and justification of ISO 52000-1, ISO/TC 163/WG 4, Energy Performance of Buildings using the Holistic Approach, a joint working group (JWG) of ISO/TC 163, Thermal performance and energy use in the built environment and ISO/TC 205, Building Environment Design. Co-convenors Dick van Dijk (NL) and Essam Khalil (Eg).

[10] Dick (H.A.L.) van Dijk and Essam E. Khalil, Future cities – Building on energy efficiency, ISO Focus+, The magazine of the international organization for standardization, Vol. 2, No 5, May 2011 (theme: Building energy efficiency with ISO standards - Construire l'efficacité énergétique avec les normes ISO).

[11] ISO News. Boosting energy efficiency of buildings through ISO's holistic approach, by Elizabeth Gasiorowski Denis on 5 August 2015. http://www.iso.org/iso/home/news_index/news_archive/news.htm?Refid=Ref1990.

[12] ISO focus January-February 2016, Boosting energy efficiency of buildings. ISO pushes for zero net energy construction worldwide http://www.iso.org/iso/isofocus_114.pdf.

[13] The REHVA European HVAC Journal, issue: "Focus on EPB standards", Vol. 52, Issue 1, January 2015 (various articles).

[14] The REHVA European HVAC Journal, issue: " EPB standards", Volume 53, Issue 3, May 2016 (various articles).

Overview of expected EPB standards at CEN and ISO level

This overview is presented to illustrate the list of EPB standards expected to be published after the formal vote at CEN and ISO level. For most of the standards this final voting will close around end of January/February 2017. Voting takes place through the National Standard Bodies (NSB's). Formal Vote implies that NSB's can only accept or not, editorial issues may be reported but technical changes are not possible. After a positive outcome, the NSB's will have the task to publish these standards. For the CEN members, this also implies that they have to consider to withdraw the conflicting national standards. Publishing these standards by the NSB's could just include adding a national coversheet where they have the opportunity to include some national information regarding the role of this standard in the national regulation.

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Another most important task is to consider if a National Annex A is needed in case the informative default Annex B values and choices are not expected to be applicable. These national Annexes A could be different for different applications such as new buildings and existing buildings and/or different for different building categories (functions) like residential and non-residential. It is expected that the NSB's will publish these national annexes if needed. Given the situation that it may include various stake holders reaching consensus on these values and choices, also taking into account regulator issues, it is expected to require some time to produce these national Annexes if needed.

This modularly structured, transparent, unambiguous, but flexible set of EPB standards is an important instrument to support the proper implementation of measures to improve the Energy Performance Buildings. These standards are also expected to be the basis for the EU voluntary certification scheme for non-residential buildings in Europe. The need for these EPB standards is given the COP21 targets, the 20-20-20 targets for EU 2020 obvious. This EPB set is essential to promote the unambiguity and harmonisation in the energy-efficiency and -transition market.

To illustrate: in EU-28, 40% of energy consumption is due to buildings, 2/3 for residential of which 80% by gas which the EU imports for 55% (2013). A level playing field for awarding energy saving technologies is essential for the market and the policy makers.

Our first task: reduce building energy need (by measures like insulation, system efficiency improvement etc.). Next, we have to increase the fraction (and production) of renewable energy.

For this we need Energy Performance Buildings (EPB) standards suited for local, regional national & global application.

The schedule gives an overview of the EPB-standards and the EPB calculation procedure according the set of EPB standards. Apart from these standards there are many related Technical Reports giving background information, explanation, justification and calculation examples related to that standard.

This overview illustrates that only a limited number of these EPB standards are currently ISO standards, most of them are EN (Which means European standards). However, it is the intention to upgrade them where possible to ISO level as well.

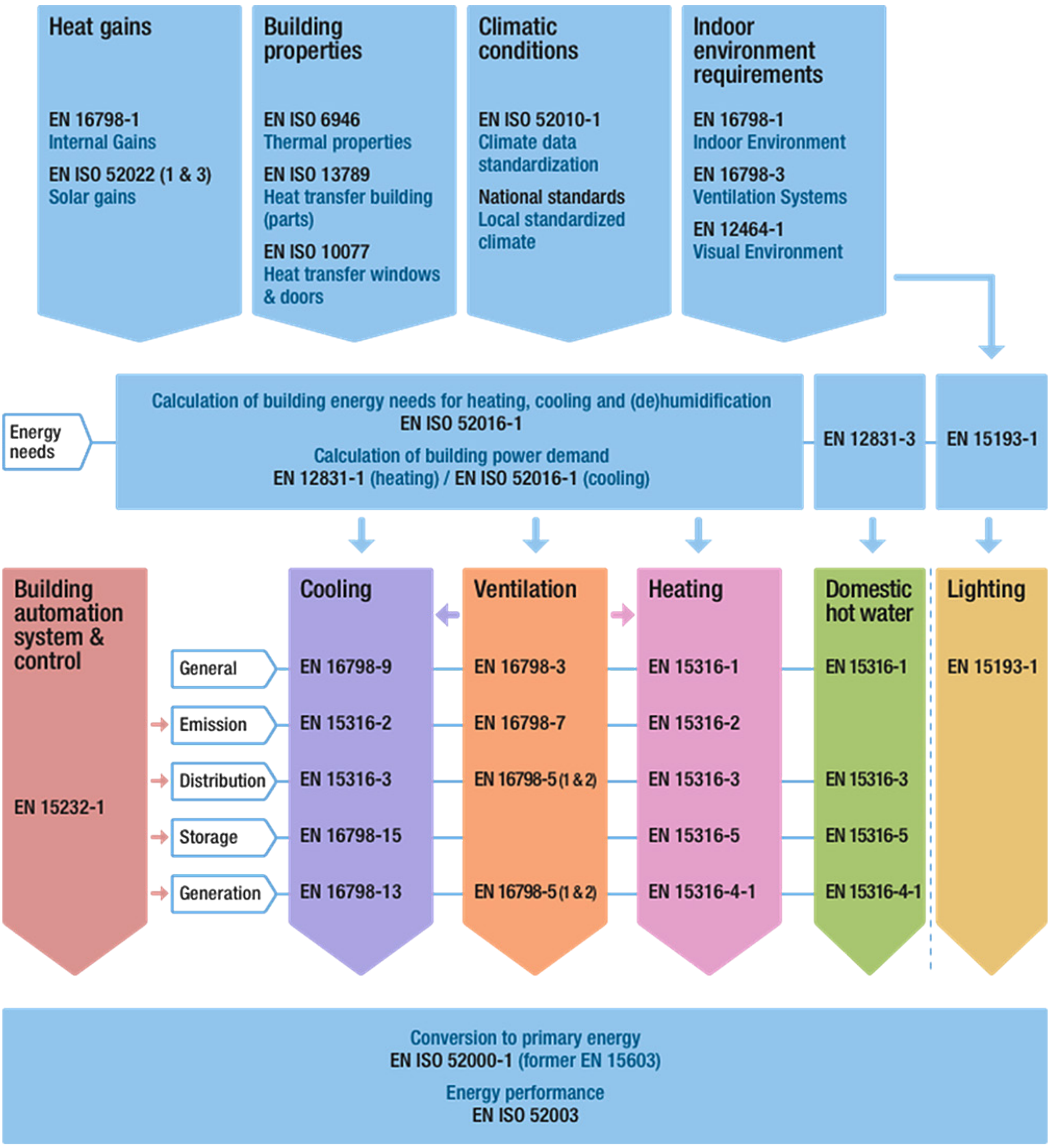
Standards to be considered

To calculate the energy need and energy use of a building with its installations you need to determine:

- The heat gain: how much free heat by solar and other internal gains (Plug loads, lighting etc.) is entering the building;
- Building properties: The thermal properties of the building envelope and materials of all building elements;
- External climate: the climatic data: temperatures, humidity, solar data, location/ orientation of the building etc.;
- Indoor environment: the indoor environmental requirements (IEQ) for amongst others: indoor temperatures, humidity, ventilation rate, lighting and the related assumptions for the user behaviour (schedules for presence and usages).

These input date are the basis for the energy need calculation.

To satisfy the energy needs the building systems for heating, cooling, humidification, dehumidification, venti-



lation, domestic hot water and lighting have to provide these IEQ conditions in the most energy efficient way. These calculations are included in the standards related to these systems where the EPB standards related to Building Automation, Controls and Building Management play an important role in reaching the assumed setpoints.

Overview of EPB Standards (see also Table B.1)

The overarching EPB standard

- ISO 52000-1 Energy performance of buildings – Overarching EPB assessment – Part 1: General framework and procedures EPB Standards related to Energy Need calculation
- EN 16798-1 Energy performance of buildings – Indoor environmental Quality – part 1: Indoor environmental input parameters for the design and assessment of energy performance of buildings
- EN 16798-3 Ventilation for non-residential buildings – Performance requirements for ventilation, air conditioning and room-conditioning systems

EPB Standards related to the Energy Need Calculation

- ISO 52022-1 Energy performance of buildings – Thermal, solar and daylight properties of building components and elements – Part 1: Simplified calculation method of the solar and daylight characteristics for solar protection devices combined with glazing
- ISO 6946 Building components and building elements – Thermal Resistance and thermal transmittance – Calculation methods
- ISO 13789 Thermal performance of buildings – Transmission and ventilation heat transfer coefficients – Calculation method
- ISO 10077-1 Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 1: General
- ISO 10077-2 “Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 2: Numerical method for frames”
- ISO 52016-1 Energy performance of buildings – Energy needs for heating and cooling, internal temperatures and sensible and latent head loads – Part 1: Calculation procedures
- ISO 52022-3 Energy performance of buildings – Thermal, solar and daylight properties of building components and elements – Part 3: Detailed calculation method of the solar and daylight characteristics for solar protection devices combined with glazing
- ISO 52017-1 Energy performance of buildings – Sensible and latent heat loads and internal temperatures – Part 1: Generic calculation procedures
- ISO 52010-1 Energy performance of buildings – External climatic conditions – Part 1: Conversion of climatic data for energy calculations
- ISO 13786-1 Thermal performance of building components – Dynamic thermal characteristics – Calculation methods
- ISO 13370 Thermal performance of buildings – Heat transfer via the ground – Calculation methods
- ISO 10211 Thermal bridges in building construction – Heat flows and surface temperatures – Detailed calculations
- ISO 14683 Thermal bridges in building construction – Linear thermal transmittance – Simplified methods and default values
- ISO 12631 Thermal performance of curtain walling – Calculation of thermal transmittance

EPB Standards related to Building Automation, Controls and Building Management

- EN 15232-1 Energy Performance of Buildings – Energy performance of buildings – Part 1: Impact of Building Automation, Controls and Building Management – Modules M10-4,5,6,7,8,9,10
- EN 12098-1 Energy Performance of Buildings – Controls for heating systems – Part 1: Control equipment for hot water heating systems – Modules M3-5, 6, 7, 8
- EN 12098-3 Energy Performance of Buildings – Controls for heating systems – Part 3: Control equipment for electrical heating systems – Modules M3-5,6,7,8
- EN 12098-5 Energy Performance of Buildings – Controls for heating systems – Part 5: Start-stop schedulers for heating systems – Modules M3-5,6,7,8
- EN 15500-1 Energy Performance of Buildings – Control for heating, ventilating and air conditioning applications – Part 1: Electronic individual zone control equipment – Modules M3-5, M4-5, M5-5
- EN 16946-1 Energy Performance of Buildings – Inspection of Automation, Controls and Technical Building Management – Part 1: Module M10-11
- EN 16947-1 Energy Performance of Buildings – Building Management System – Part 1: Module M10-12

Table B.1. Positions of EPB standards in the EPB modular structure.

Overarching			Building (as such)			Technical Building Systems		
	Description	Standard		Description	Standard		Description	Heating
sub1	M1		sub1	M2		sub1		M3
1	General	ISO 52000-1 ISO/TR 52000-2	1	General	- -	1	General	EN 15316-1
2	Common terms and definitions; symbols, units and subscripts	ISO 52000-1 ISO/TR 52000-2	2	Building Energy Needs	ISO 52016-1, ISO 52017-1 ISO/TR 52016-2	2	Needs	
3	Applications	ISO 52000-1 ISO/TR 52000-2	3	(Free) Indoor Conditions without Systems	ISO 52016-1, ISO 52017-1 ISO/TR 52016-2	3	Maximum Load and Power	EN 12831-1
4	Ways to Express Energy Performance	ISO 52003-1 ISO 52003-2	4	Ways to Express Energy Performance	ISO 52018-1 ISO/TR 52018-2	4	Ways to Express Energy Performance	EN 15316-1
5	Building Functions and Building Boundaries	ISO 52000-1 ISO/TR 52000-2	5	Heat Transfer by Transmission	ISO 13789 ISO 13370 ISO 6946 ISO 10211 ISO 14683 ISO/TR 52019-2 ISO 100771 ISO 100772 ISO 12631	5	Emission & control	EN 15316-2 EN 1500 CEN/TR 15500 EN 12098-1 CEN/TR 12098-1 EN 12098-3 CEN/TR 12098-3 EN 12098-5 CEN/TR 12098-5
6	Building Occupancy and Operating Conditions	EN 16798-1 CEN/TR 16798-2 (ISO 17772-1, ISO/TR 17772-2)	6	Heat Transfer by Infiltration and Ventilation	ISO 13789	6	Distribution & control	EN 15316-3 EN 12098-1 CEN/TR 12098-1 EN 12098-3 CEN/TR 12098-3 EN 12098-5 CEN/TR 12098-5
7	Aggregation of Energy Services and Energy Carriers	ISO 52000-1 ISO/TR 52000-2	7	Internal Heat Gains	See M1-6	7	Storage & control	EN 15316-5 EN 12098-1 CEN/TR 12098-1 EN 12098-3 CEN/TR 12098-3 EN 12098-5 CEN/TR 12098-5
8	Building Zoning	ISO 52000-1 ISO/TR 52000-2	8	Solar Heat Gains	ISO 52022-3 ISO 52022-1 ISO/TR 52022-2	8	Generation & control	EN 12098-1 CEN/TR 12098-1 EN 12098-3 CEN/TR 12098-3 EN 12098-5 CEN/TR 12098-5 EN 15316-4-1 EN 15316-4-2 EN 15316-4-3 EN 15316-4-4 EN 15316-4-5 EN 15316-4-6 EN 15316-4-8
9	Calculated Energy Performance	ISO 52000-1 ISO/TR 52000-2	9	Building Dynamics (thermal mass)	ISO 13786	9	Load dispatching and operating conditions	
10	Measured Energy Performance	ISO 52000-1 ISO/TR 52000-2	10	Measured Energy Performance	- -	10	Measured Energy Performance	EN 15378-3
11	Inspection	- -	11	Inspection	(existing standards on IR inspection, airtightness, ...)	11	Inspection	EN 15378-1
12	Ways to Express Indoor Comfort	EN 16798-1 CEN/TR 16798-2 (ISO 17772-1, ISO/TR 17772-2)	12	- -		12	BMS	
13	External Environment Conditions	ISO 52010-1 ISO/TR 52010-2						
14	Economic Calculation	EN 15459-1						

	Cooling	Ventilation	Humidification	Dehumidification	DHW	Lighting	BACS	Electricity
	M4	M5	M6	M7	M8	M9	M10	M11
	EN 16798-9 CEN/TR 16798-10	EN 16798-3 CEN/TR 16798-4	EN 16798-3 CEN/TR 16798-4	EN 16798-3 CEN/TR 16798-4	EN 15316-1	EN 15193-1	EN 15232 CEN/TR 15232	
					EN 12831-3	EN 15193-1	a	
	EN 16798-11 CEN/TR 16798-12				EN 12831-3			
	EN 16798-9 CEN/TR 16798-10	EN 16798-3 CEN/TR 16798-4	EN 16798-3 CEN/TR 16798-4	EN 16798-3 CEN/TR 16798-4	EN 15316-1	EN 15193-1 CEN/TR 15193-2	EN 15232 CEN/TR 15232	
	EN 15316-2 EN 15500 CEN/TR 15500	EN 16798-7 CEN/TR 16798-8 EN 15500 CEN/TR 15500	EN 16798-5-1; EN 16798-5-2 CEN/TR 16798-6-1 CEN/TR 16798-6-2	EN 16798-5-1; EN 16798-5-2 CEN/TR 16798-6-1 CEN/TR 16798-6-2			EN 15232 CEN/TR 15232	
	EN 15316-3	EN 16798-5-1; EN 16798-5-2 CEN/TR 16798-6-1 CEN/TR 16798-6-2			EN 15316-3		EN 15232 CEN/TR 15232	
	EN 16798-15 CEN/TR 16798-16				EN 15316-5 EN 15316-4-3		EN 15232 CEN/TR 15232	
	EN 16798-13 CEN/TR 16798-14 EN 15316-4-2 EN 15316-4-5	EN 16798-5-1; EN 16798-5-2 CEN/TR 16798-6-1 CEN/TR 16798-6-2	EN 16798-5-1; EN 16798-5-2 CEN/TR 16798-6-1 CEN/TR 16798-6-2	EN 16798-5-1; EN 16798-5-2 CEN/TR 16798-6-1 CEN/TR 16798-6-22	EN 15316-4-1 EN 15316-4-2 EN 15316-4-3 EN 15316-4-4 EN 15316-4-5 EN 15316-4-6		EN 15232 CEN/TR 15232	EN 15316-4-3 EN 15316-4-4 EN 15316-4-5 EN 15316-4-7
							EN 15232 CEN/TR 15232	
					EN 15378-3	EN 15193-1 CEN/TR 15193-2	EN 15232 CEN/TR 15232	
	EN 16798-17 CEN/TR 16798-18	EN 16798-17 CEN/TR 16798-18	EN 16798-17 CEN/TR 16798-18	EN 16798-17 CEN/TR 16798-18	EN 15378-1	EN 15193-1 CEN/TR 15193-2		

[a] The shaded modules are not applicable

EPB Standards related to Cooling, Ventilation and Humidification and Dehumidification

- EN 16798-9 Energy performance of buildings – Module M4-1, M4-4, M4-9 – Ventilation for buildings – Calculation methods for energy requirements of cooling systems – Part 9: General and energy performance expression
- EN 16798-3 Energy performance of buildings – Part 3: Ventilation for non-residential buildings – Performance requirements for ventilation and room-conditioning systems
- EN 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 – Method 1
- EN 16798-5-2 Energy performance of buildings – Modules M5-6,.2 M5-8 .2- Ventilation for buildings – Calculation methods for energy requirements of ventilation systems – Part 5-2: Distribution and generation (revision of EN 15241) – Method 2
- EN 16798-15 Energy performance of buildings – Part 15: Module M4-7 – Calculation of cooling systems – Storage
- EN 16798-13 Energy performance of buildings – Part 13: Module M4-8 – Calculation of cooling systems
- EN 16798-17 Energy performance of buildings – Part 17: Ventilation for buildings – Guidelines for inspection of ventilation and air conditioning systems, Module M4-11, M5-11, M6-11, M7- 11
- EN 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

EPB Standards related to Heating and DHW

- EN 15316-1 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 1: General and Energy performance expression, Module M3-1, M3-4, M3-9, M8-1, M8-4
- EN 15316-2 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 2: Space emission systems (heating and cooling), Module M3-5, M4-5
- EN 15316-3 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 3: Space distribution systems (DHW, heating and cooling), Module M3-6, M4-6, M8-6
- EN 15316-5 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 5: Space heating and DHW storage systems (not cooling), M3-7, M8-7
- EN 15316-4-1 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 4-1: Space heating and DHW generation systems,
- EN 15316-4-2 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 4-2: Space heating generation systems, heat pump systems, Module M3-8-2, M8-8-2
- EN 15316-4-3 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 4-3: Heat generation systems, thermal solar and photovoltaic systems, Module M3-8-3, M8-8-3, M11-8-3
- EN 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
- EN 15316-4-5 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 4-5: District heating and cooling, Module M3-8-5, M4- 8-5, M8-8-5, M11-8-5
- EN 15316-4-8 Energy performance of 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), Module M3-8-8
- EN 15378-3 Energy performance of buildings – Heating and DHW systems in buildings – Part 3: Measured energy performance, Module M3-10, M8-10
- EN 15378-1 Energy performance of buildings – Heating systems and DHW in buildings – Part 1: Inspection of boilers, heating systems and DHW, Module M3-11, M8-11

EPB standard related to Lighting

- EN 15193-1 Energy performance of buildings – Energy requirements for lighting – Part 1: Specifications, Module M9

EPB Standards on expressing the Energy Performance Buildings

- EN ISO 52003-1 Energy performance of buildings – Indicators, requirements, ratings and certificates – Part 1: General aspects and application to the overall energy performance
- ISO 52018-1 Energy performance of buildings – Indicators for partial EPB requirements related to thermal energy balance and fabric features – Part 1: Overview of options
- EN 15459-1 Energy performance of buildings – Heating systems and water based cooling systems in buildings – Part 1: Economic evaluation procedure for energy systems in buildings, Module M1-14

ISO 52010, the overarching EPB standard on external environment conditions

The new standard ISO 52010-1 provides the common standard climatic data to be used as input by all EPB standards. It builds on ISO 15927 (part 1, 2, and 4) and completes a missing link: the calculation of the distribution of solar irradiation and illuminance on a non-horizontal plane based on measured hourly solar radiation data on a horizontal surface; with or without taking into account solar shading.

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Standard ISO 52010-1 [1], accompanied by the technical report ISO/TR ISO 52010-2 [2], provides the common standard climatic data to be used for all relevant EPB standards. It gives procedures to calculate the hourly distribution of solar irradiation on a non-horizontal plane based on measured hourly solar radiation data on a horizontal surface, obtained from ISO 15927 (part 1, 2 and 4) [3]. The calculation procedure described in this standard is based on the widely used "simplified Perez model" [4] proposed in the early 90's.

The procedures include assumptions to assess the impact of surrounding obstacles on the irradiation (shading). A simple method for conversion of hourly solar irradiance to illuminance is provided.

The technical report ISO/TR ISO 52010-2 provides background information, explanation (including examples) and justification (including validation cases).

Main output

The main output from ISO 52010-1 is the solar irradiance and illuminance on a surface with arbitrary orientation and tilt, needed as input for energy and daylighting calculations.

Shading by distant objects is (optionally) taken into account through a shading correction coefficient, Shading by fins and overhangs is calculated in ISO 52016-1 [5].

The standard contains procedures for the use of (other) output from ISO 15927 (part 1, 2, and 4) [3] 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.

Accompanying spreadsheet

In line with the common template for all EPB standards, a spreadsheet has been prepared for demonstration and validation. This spreadsheet shows an overview of all input variables, the (step by step) hourly calculation procedures and an overview of all output variables.

This accompanying calculation spreadsheet (July 2016) provides:

- full year of hourly calculations of solar irradiance (split in components) on a plane with any azimuth and tilt angle;
- validated against BESTEST cases;
- hourly calculations of solar shading by multiple shading objects along the skyline. These calculations also cover the calculation procedures for overhangs from ISO 52016 1 [5]; see parallel article Van Dijk on ISO 52016 & ISO 52017.

Flexibility

Options for national choices provided in "Annex A/ Annex B" of ISO 52010-1 comprise:

- Selection of hourly measured climatic data set.
- Different choices of type of measured irradiation, depending on availability.
- Value(s) for ground reflectivity.
- Include or exclude impact of solar shading by external objects. If excluded: the solar shading calculation is done in application standards, such as ISO 52016-1, enabling to calculate the impact of all shading objects in a coherent way without duplications. If included: a choice is given between different levels of detail.
- Choice between the given simplified Illuminance calculation method or alternative methods.

Validation

The calculation procedures have been validated by using relevant cases from the so called BESTEST series. The BESTEST cases are well established since decades, widely used worldwide and well described. More background information is given in the technical report, ISO/TR 52010-2. Relevant BESTEST cases are also chosen for the validation of the hourly calculation procedures of ISO 52016-1, as presented in the parallel article (see also previous article [6]).

Figures 1-3 show examples of the results of the validation cases. The validation cases concern the hourly calculation of the solar irradiation at vertical planes, using the measured data from a given climate data file.

The results of the comparison show that the method in ISO 52010-1 is very fit for purpose. It has to be taken into consideration that not each software program whose results are available for the comparison use nowadays state-of-the-art algorithms (in that sense these are not

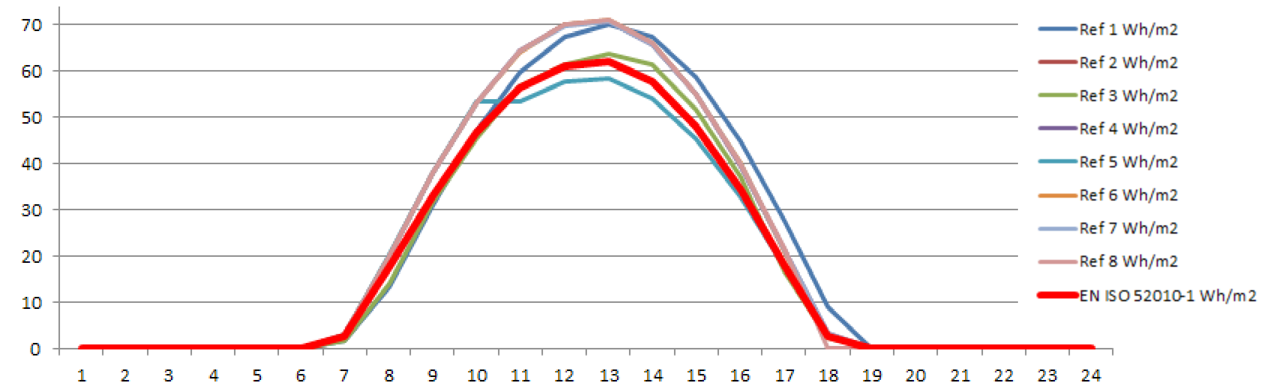

Figure 1. BESTEST validation result: Hourly irradiation on vertical West plane, cloudy day.

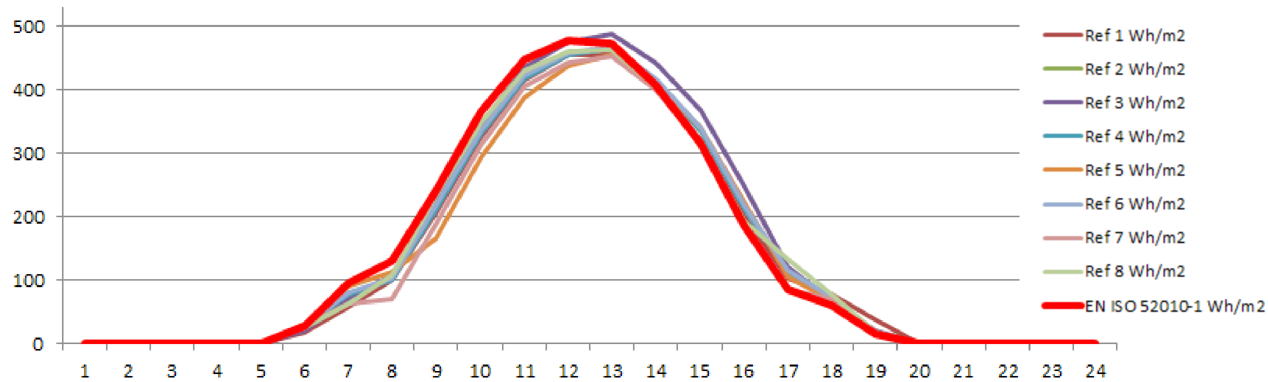

Figure 2. BESTEST validation result: Hourly irradiation on vertical South plane, clear day.

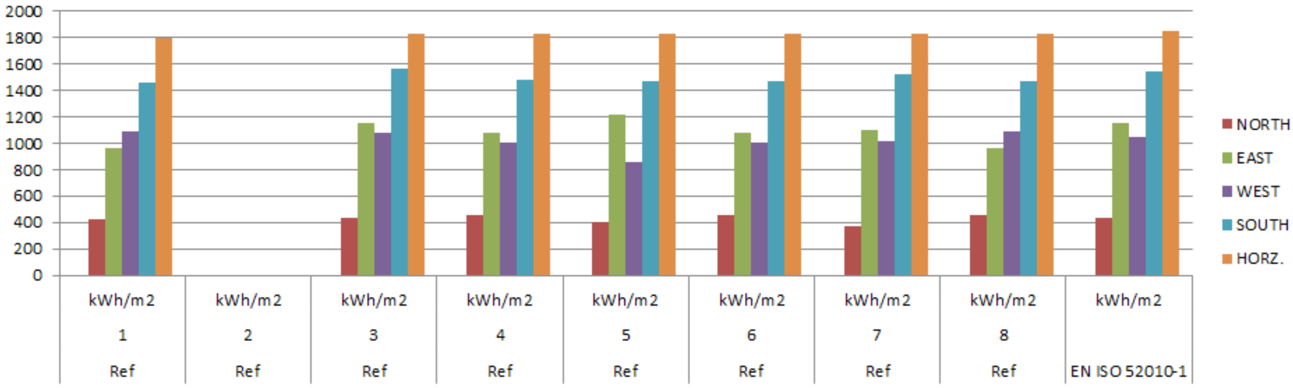

Figure 3. BESTEST validation result: Annual solar radiation on five different planes.

reference results). This is because these base cases of the BESTEST series were created and tested many years ago.

More tests are described in the technical report, ISO/TR 52010-2.

Conclusion

The new ISO 52010-1 completes the (until now) missing link in the conversion of climatic data for energy calculations. The procedures have been validated. Choices are possible at national or regional level to accommodate the specific national or regional situation. ■

Acknowledgments

The authors would like to acknowledge specifically the contributions of the other experts in the team that is responsible for the preparation of ISO 52010, especially **José L. Molina** (Universidad de Sevilla, Spain) and **Francisco José Sánchez de la Flor** (Universidad de Cádiz, Spain) who developed the solar shading calculation procedures for ISO 52010 and ISO 52016.

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[1] ISO 52010-1, Energy performance of buildings — External climatic conditions — Part 1: Conversion of climatic data for energy calculations.

[2] ISO/TR 52010-2, Energy performance of buildings — External climatic conditions — Part 2: Explanation and justification.

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

[4] Perez, R.; Ineichen, P.; Seals, R.; Michalsky, J.; Stewart, R. (1990). *"Modeling Daylight Availability and Irradiance Components from Direct and Global Irradiance."* Solar Energy, 44(5), pp. 271-289.

[5] ISO 52016 1, Energy performance of buildings – Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads – Part 1: Calculation.

[6] Wim Plokker & Dick van Dijk, EPB standard ISO 52010: Conversion of climatic data for energy calculations: completion of a missing link, The REHVA European HVAC Journal, Volume 53, Issue 3, May 2016.

Articles

ISO 52003 and ISO 52018: making good use of the EPB assessment outputs

Documents ISO 52003-1 & -2 and ISO 52018-1 & -2 describe the relation between the indicators to express the various energy performances of buildings (EPB) and the EPB requirements and EPB ratings. These documents provide general insight to private prescribers and public regulators (and all stakeholders involved) on how to make purpose-oriented use of the outputs of the EPB assessment methods.

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EPB, EPB standards, EPB regulations, EPB requirements, EPB rating, EPB certificate, EPB indicators, EPB features, EPB tailoring, fabric, fabric requirements, energy balance, energy balance requirements.

These 2 ISO standards (i.e. parts 1) [1] [2] and their accompanying technical reports (i.e. parts 2) [3] [4] are of an unusual nature in the set of EPB documents. As a rule, the EPB assessment documents concern inspections/measurements or calculations. The documents at hand concern neither of these aspects, but deal with the productive use of the output (EPB indicators) of the assessment standards for setting requirements, for rating, or for other possible applications. This can be called the "post processing" of the results of the EPB assessment.

The documents ISO 52003-1 & -2 deal with the general principles and their application to the overall energy performance. Documents ISO 52018-1 & -2 concern their application to various fabric features and to the thermal energy balances for heating, cooling or free floating temperatures (overheating and/or undercooling).

By describing explicitly different aspects related to the development of EPB regulations, all parties involved can gain a better and explicit understanding of the issues at hand, thus facilitating the policy making process. In the case of public regulations, the parties include not only the regulators themselves, but also all stakeholders involved in the policy development, notably diverse organizations representing citizens, designers, supply industry, construction companies, craftsmen, etc.

ISO 52003-1 & -2: general principles and overall energy performances

Successively, the following concepts are defined and discussed in the standard and its associated technical report (both replacing EN 15217 and ISO 16343):

- EPB features
- Numerical EPB indicators
- Tailoring for requirements and for ratings
- EPB requirements
- EPB rating
- EPB certificate

Several of these aspects are described in more detail in a previous REHVA article [5] and are not repeated here.

ISO 52018-1 & -2: thermal energy balance and fabric features

These documents are new. They list and discuss a variety of possible partial EPB features and indicators for requirements related to the thermal energy balances and to the fabric, notably summer and winter (free floating) thermal comfort, energy needs for heating and cooling, overall envelope thermal insulation, individual element thermal insulation, thermal bridges, window energy performances, envelope air tightness and solar control.

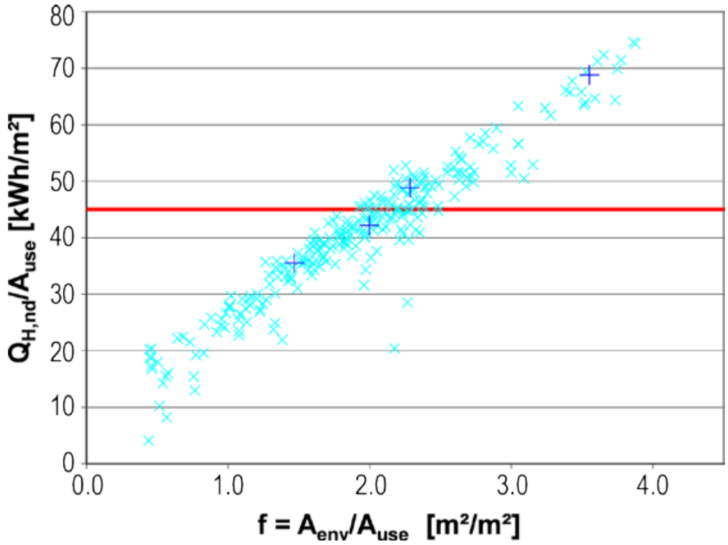

Figure 1. Example of the impact of a fixed (constant value) requirement versus a more appropriate variable value (tailored).

In the standard itself (i.e. in part 1) [2] a very brief possible motivation for each possible requirement is given and different possible EPB indicators are described that can be used for each feature. Annex A provides tables that allow regulators to report in a standardized manner the mix of EPB features and corresponding EPB indicators that have been chosen for the requirements in their jurisdiction. Annex B proposes motivated default requirement mixes for different climates.

The technical report (i.e. part 2) [4] formulates for each EPB feature background considerations with respect to the following aspects (in as far as applicable): a more detailed discussion of possible motivations, possible indicators, comparable economic strictness of the requirements, practical points of attention, testing, new construction and renovation issues, exceptions and other possible aspects.

Part 2 also illustrates in its annex A a practical manner in which fictitious cooling can be integrated in the overall energy performance by means of a conventional probability weighting factor. In this way, an energy efficient overall design can be stimulated that strikes a good balance between summer and winter thermal comfort.

As explained in ISO 52003 ([1], [3] and [5]), for some EPB features/indicators the numeric value that corresponds to the technical and economic optimum often varies strongly from 1 construction project to another, depending on function, size, shape, etc. In order to treat all buildings in the same manner (e.g. reflecting the same technical and economic strictness), it is for these indicators thus of crucial importance to use variable value requirements or references that take into account all relevant project-specific features of each individual building. This is called tailoring.

Figure 1 illustrates on the basis of some 200 real dwelling shapes (each individual cross) how for a given set of technical measures (level of overall thermal insulation, degree of airtightness, energy efficiency of the ventilation system, etc.) the numeric value of the specific heating need (i.e. the heating need per useful floor area) can strongly vary from one project to another. The x-axis is the ratio of the envelope area to the useful floor area. This numeric variability of equal technical-economic strictness obviously explains, in combination with other potentially variable factors, the similar variability of the overall energy performance; see Figure 4 in [5].

If the reference value that is used to set a requirement is a fixed value (in casu: requirement expressed as a constant maximum value in kWh/m² disregarding building shape or size: e.g. red horizontal line), then buildings with a relatively large envelope area[1] (compared to the floor 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. Such mismatch would correspond to a suboptimal use of investments both

[1] I.e. to the right of the graph. For instance small detached dwellings.

on a societal and on a private level. A more equitable reference for the requirement takes into account this variation and determines project-specific, tailored quantitative requirements.

A more detailed discussion of the graph and further analysis and illustrations of the issue for the specific heating need can be found in annex B of ISO 52018-2 [4].

A similar issue arises with a requirement on the mean thermal transmittance of the thermal envelope. It is commonly accepted that the adequate amount of glazing needs to increase with the useful floor area: the broader the building is the more glass is needed for sufficient daylight access and visual outdoor contact. As in practice, the thermal transmittance of transparent elements (windows, etc.) is (due to physical-technical and economic reasons) typically much higher than that of opaque envelope elements, an increasing share of transparent area in the envelope (which reasonably, is thus approximately proportional to the useful floor area) leads to a requirement that increases linearly with the floor to envelope ratio (i.e. the inverse of the shape factor), as illustrated in **Figure 2**. The minimum value of the straight line (for an x-value of 0) corresponds to the (average) thermal transmittance requirement for the opaque elements. The slope of the line depends on the features of the transparent elements: the reasonable fraction as a function of the useful floor area, and their thermal transmittance requirement.

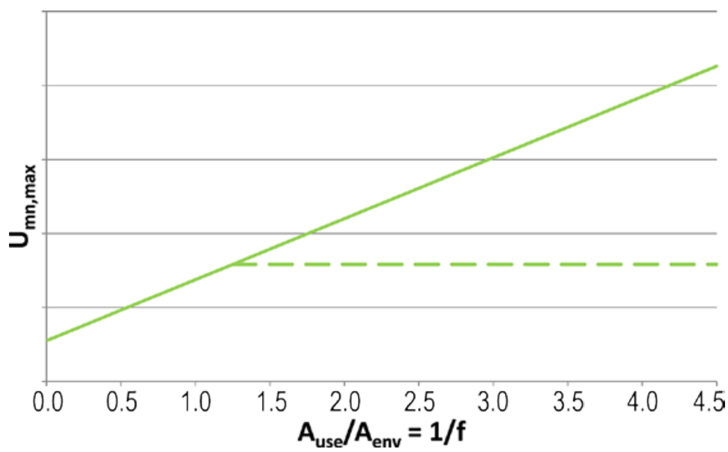

Figure 2. Motivated example of a curve for the maximum mean thermal transmittance as a function of the inverse of the shape factor.

There are however logical limits to the maximal mean thermal transmittance. It should never be larger than value of transparent elements, and in addition, not the entire envelope needs to be glazed: floors are usually opaque, roofs are opaque or only need to be partially transparent, and parts of the facades below the working plane, which do not meaningfully contribute to daylighting anymore, generally do not need transparent elements. In general, the maximum limited is therefore restricted to a constant value above a certain A_{use}/A_{env} value. This is illustrated with the dashed line in **Figure 2**.

Conclusion

Documents ISO 52003-1 & -2 and ISO 52018-1 & -2 document in a critical manner useful knowledge, distilled from decades-long experiences, that supports politicians/regulators and stakeholders in taking well-informed decisions, optimally tailored to their own jurisdiction. In this manner a well-considered EPB regulation can be developed that matches the sophistication of the EPB assessment methods. ■

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[1] ISO 52003-1, Energy performance of buildings – Indicators, requirements, ratings and certification – Part 1: General aspects and application to the overall energy performance.

[2] ISO 52018-1, Energy performance of buildings — Indicators for partial EPB requirements related to thermal energy balance and fabric features — Part 1: Overview of options.

[3] ISO/TR 52003-2, Energy performance of buildings – Indicators, requirements, ratings and certification – Part 2: Explanation and justification of ISO 52003-1.

[4] ISO/TR 52018-2, Energy performance of buildings — Indicators for partial EPB requirements related to thermal energy balance and fabric features — Part 2: Explanation and justification of ISO 52018-1.

[5] Dirk Van Orshoven, Dick van Dijk, EPB standard ISO 52003: How to put the EPB assessment outputs to intelligent use, The REHVA European HVAC Journal, Volume: 53, Issue: 3, May 2016.

ISO 52016 and 52017:

Calculation of the building's energy needs for heating and cooling, internal temperatures and heating and cooling load

ISO 52016-1 presents a coherent set of calculation methods at different levels of detail, for the (sensible) energy needs for the space heating and cooling and (latent) energy needs (de-)humidification of a building and/or internal temperatures and heating and/or cooling loads, including the influence from technical buildings systems, control aspects and boundary conditions where relevant for the calculation. ISO 52017-1 contains a generic (reference) hourly calculation method. Extensive explanation and justification is given in the accompanying ISO/TR 52016-2.

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ISO 52016-1

ISO 52016-1 presents a coherent set of calculation methods at different levels of detail, for the (sensible) energy needs for the space heating and cooling and (latent) energy needs (de-)humidification of a building and/or internal temperatures and heating and/or cooling loads.

The effect of specific system properties can also be taken into account, such as the maximum heating or cooling power and the impact of specific system control provisions. This leads to **system-specific energy loads and needs**, in addition to the **basic energy loads and needs**.

ISO 52016-1 contains both **hourly** and **monthly** calculation procedures. These are closely linked as explained further on.

Link between ISO 52017-1 and ISO 52016-1

ISO 52017-1 is not needed for the actual calculation of the energy performance of buildings. ISO 52017-1 contains a generic (reference) hourly calculation method for (a thermal zone in) a building.

The reference method in ISO 52017-1 is based on and replaces ISO 13791. ISO 52017-1 contains no specific assumptions, boundary conditions, specific simplifications or input data that are not needed to apply the generic calculation method. Compared with ISO 13791 the energy needs for heating and cooling are added to increase the application range. This standard does not include validation cases (unlike ISO 13791). For validation, specific assumptions and input data would need to be given that only apply to the validation cases. To keep a clear distinction between the generic method and a specific application, verification and validation cases are adopted in ISO 52016-1.

ISO 52016-1 replaces ISO 13790:2008. It contains an hourly calculation method and a monthly calculation method. The hourly calculation method is a specific application of the generic method provided in ISO 52017-1.

ISO 52016-1 further contains specific boundary conditions, specific simplifications and input data for the application: calculation of energy needs for heating and cooling. Amended simplifications and input data are provided for the application to calculate the design heating and design cooling load and (e.g. summer) internal temperatures.

In this way the generic calculation method (ISO 52017-1) is clearly separated from the specific application with all specific assumptions, simplifications and specific input data (ISO 52016-1).

The **hourly** method in ISO 52016-1 produces as additional output the key parameters 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 output, the key monthly parameters for the different cases, the monthly correlation factors can be derived. See flow chart in **Figure 1**.

Input-output relations between ISO 52016-1 and other standards of the set of EPB standards

In a previous REHVA Special on the EPB standards [4] the many links of ISO 52016-1 with other EPB standards were introduced. Special attention in this respect has been paid to testing the link with the procedures to calculate the thermal transmission through the **ground floor**, taking into account the inertia of the ground. These procedures are given in ISO 13370 (see parallel article by Mrs Kosmina) for monthly, but also for hourly calculation methods.

The hourly climatic data are given in ISO 52010-1 and the hourly and daily patterns of the conditions of use (operating schedules) are given in the relevant other EPB standards.

More details on the many inputs from and many interactions with many other EPB standards are given in ISO/TR 52016-2.

Hourly versus monthly calculation method

The hourly and the monthly method in ISO 52016-1 are closely linked: they use as much as possible the same input data and assumptions. And the hourly method can be used to generate the parameters for the monthly calculation method, as shown above (**Figure 1**).

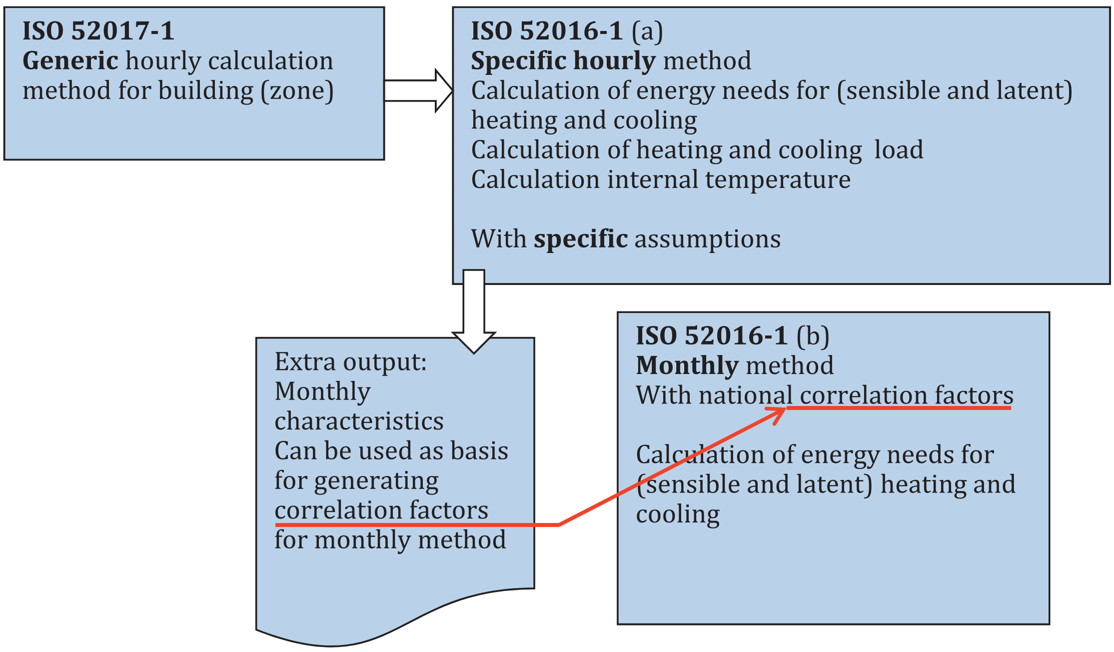

Figure 1. The relation between ISO 52016-1 and ISO 52017-1.

The hourly method in ISO 52016-1 is more advanced than the simplified hourly method given in ISO 13790:2008, to make the method more transparent and more widely usable, without asking more input data from the user. This was already explained in a previous article [5].

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.

Design heating and cooling load in ISO 52016-1

ISO 52016-1 includes specification of the method and the boundary conditions for the calculation of the design heating and cooling load, including latent load, as a basis for the dimensioning of equipment on zone level and on central level for cooling and dehumidification. It specifies also the methods and conditions for the calculation of the humidification load.

The method given for the design **heat** load is intended especially for the cases where the **cooling** load calculation needs to be done (for instance when cooling is necessary) and/or an **hourly** calculation is used for the energy needs calculation. The principle idea is that there is only one method needed for load and energy calculations for heating and cooling in case of an hourly calculation interval.

Flexibility

Options for national choices provided in "Annex A/ Annex B" of ISO 52016-1 comprise:

- References to other EPB or national standards.
- Selection of hourly or monthly method.
- Rules for thermal zoning.
- Simplifications (at various levels).
- Specific details of the hourly calculation method (solution technique, internal modelling of constructions, IR radiation exchange).
- Classification of constructions (e.g. thermal capacity of opaque constructions, solar energy transmittance of solar shading devices).
- (Fixed) values for specific assumed properties.
- Specific solar shading assumptions and simplifications.
- Values for various correlation factors of the monthly calculation method.

Annex C of ISO 52016-1 gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal, solar or daylight properties of (single or multiple) glazings and/or windows.

Accompanying spreadsheet

An extensive spreadsheet was produced on ISO 52016-1, covering both the hourly and the monthly calculation method. Examples of the calculation sheet can be found in ISO/TR 52016-2. The (publicly available) spreadsheet is available since May 2015, based on the draft (prISO/DIS 52016-1). It is intended to update the spreadsheet (symbols, numbering of formulae, minor changes in the calculation method, minor errata) before publication of the standard.

No spreadsheet was produced on ISO 52017-1, because this EPB standard (with reference hourly thermal balance calculation procedures) is not directly used for calculations.

Validation and verification

The hourly calculation procedures have been validated by using relevant cases from the so called BESTEST series. The BESTEST cases are well established since decades, widely used worldwide and well described. In the previous article on ISO 52016-1 we introduced the validation cases and presented the main results [5].

The technical report ISO/TR ISO 52016-2 provides a detailed description of the verification and validation cases. Relevant BESTEST cases are also chosen for the validation of ISO 52010, the overarching EPB standard on external environment conditions, as presented in the parallel article by Mr Plokker on ISO 52010.

A full description of the most relevant validation cases and results are given in the standard itself, as a tool to **verify** if an hourly calculation method based on ISO 52016-1 is in line with the calculation procedures given in the standard. In case at national level it is decided (following the template of "Annex A" to make use of the specifically allowed deviations from the given calculation procedures, then these verification cases are to be used to **validate** the deviating calculation procedures.

Conclusion

ISO 52016-1 presents a coherent set of calculation methods at different levels of detail, for the (sensible) energy needs for the space heating and cooling and (latent) energy needs for (de-)humidification of a building and/or internal temperatures and heating and/or cooling loads. The influence from technical buildings systems, control aspects and boundary conditions can be included where relevant for a "system specific" calculation, in addition to a "basic energy load or need" calculation. Choices are possible at national or regional level to accommodate the specific national or regional situation. The method has been successfully validated using relevant BESTEST cases.

ISO 52017-1 is not needed for the actual calculation of the energy performance of buildings. It contains a generic hourly calculation method, intended as reference method, for instance for ISO 52016-1.

More information is available in the accompanying technical report, ISO/TR 52016-2 [2]. ■

Acknowledgments

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

This paper introduces the subset of EPB standards dealing with thermal, solar and daylight properties of windows and facades. These ISO standards have a long tradition. The changes to make these standards fit into the set of EPB standards were mainly editorial.

Keywords: energy performance of buildings, EPB, EPB standards, EPB regulations, thermal transmission, windows, facades, solar shading, solar transmittance, light transmittance, building components, building elements.

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The EPB standards on thermal, solar and daylight properties of windows and facades concern the following standards mainly under EPB module M2-5 and M2-8 and developed under CEN/TC 89 in collaboration with ISO/TC 163/SC 2: ISO 10077-1[2], ISO 10077-2[3] and ISO 12631[4] as well as ISO 52022-1[5] and ISO 52022-3[6], plus the accompanying technical report on this cluster, ISO/TR 52022-2[1].

History of this suite of standards

The first series of standards on thermal, solar and daylight properties of windows and were prepared by CEN/TC 89 in collaboration with ISO/TC 163 in the 1990s, as a result of growing global concern on future fuel shortages and inadequate health and comfort levels in buildings. Furthermore, the standards served for the determination of product characteristics in accordance with the relevant European product standards. During the following decades, these first standards were revised and new standards (on glazing in combination with solar protection devices, on curtain walls) were added, to cope with new developments and additional needs.

Revision of this suite of standards (2013-2016)

The revisions (2013-2016) to make this suite of standards fit into the set of EPB standards are mainly editorial. This includes editorial changes to make the procedures unambiguous and software proof, to rationalize the choices (via the "Annex A/Annex B" approach) and to ensure consistent interconnections, in particular with all the other standards in EPB module M2 subset of EPB standards.

The two standards on glazing in combination with solar protection devices (ISO 52022-1 and -3) were upgraded from "CEN only" to "CEN & ISO" level.

ISO 100077-2 underwent one technical change, related to the calculation of cavity properties.

Main outputs

The main outputs of these standards are:

- thermal transmittance of windows, doors, curtain walls, shutter boxes and frames;
- solar and daylight characteristics (solar energy transmittance, daylight transmittance) for solar protecting devices combined with glazing.

General description

The standards ISO 100771, ISO 100772 and ISO 12631provide the methodology to obtain the energy losses due to transmission for windows, doors and curtain walls.

The two standards ISO 520221 and ISO 520223 provide the methodology to obtain the energy gains due to solar radiation for transparent elements in combination with solar protection devices needed for the calculation of a potential cooling demand.

Figure 2 in the parallel article by Mrs Kosmina, on the EPB standards on hygrothermal properties of building components and building elements, illustrates the linkages between the various thermal transmission standards, which includes ISO 10077-1, ISO 10077-2 and ISO 12631.

None of the standards under this cluster contain options for national choices provided in "Annex A/Annex B". One should bear in mind that the output from these standards is also used in the context of product declaration according to the European Construction Products Regulation CPR. This requires European wide uniformity.

ISO 10077-1

ISO 10077-1 provides a calculation method to obtain the thermal transmittance of windows and pedestrian doors consisting of glazed and/or or opaque panels fitted in a frame, with and without shutters.

In general, the thermal transmittance or U-value of the window or door product or assembly is calculated as a function of the thermal transmittance of the components and their geometrical characteristics, plus the thermal interactions between the components.

An alternative to calculation according to ISO 10077-1 is testing of the complete window or door according to ISO 125671 or, for roof windows, according to ISO 125672.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal transmission properties of glazing or additional thermal resistance properties of shutters.

ISO 10077-2

ISO 10077-2 specifies the method for numerical calculation of the thermal transmittance of frames U_f and roller shutter boxes U_{sb} and the linear thermal transmittance Ψ.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal transmission properties of glazing.

ISO 12631

ISO 12631 provides a calculation method to obtain the thermal transmittance of curtain walls consisting of glazed and/or or opaque panels fitted in a frame.

In general, the thermal transmittance or U-value of the curtain walling is calculated as a function of the thermal transmittance of the components and their geometrical characteristics, plus the thermal interactions between the components.

Two methods of calculating the thermal transmittance of curtain wall systems are specified:
- the single assessment method and
- the component assessment method.

The single assessment method is based on detailed computer calculations of the heat transfer through a complete construction including mullions, transoms, and filling elements (e.g. glazing unit, opaque panel). This method can be used for any curtain walling system (i.e. unitised systems, stick systems, patent glazing, structural sealant glazing, rain screens, structural glazing).

The component assessment method divides the representative element into areas of different thermal properties, e.g. glazing units, opaque panels and frames. This method can be used for curtain walling systems such as unitised systems, stick systems and patent glazing. Structural silicone glazing, rain screens and structural glazing are excluded from the component assessment method.

Both methods result in the same value for the thermal transmittance of a curtain wall.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal, solar or daylight properties of (single or multiple) glazing.

ISO/TR 52022-2 provides calculation examples.

ISO 52022-1

ISO 52022-1 defines a simplified method for the calculation of
- the total solar energy transmittance,
- the total solar direct transmittance and
- the total light transmittance

  for a glazing in combination with an external or internal or integrated solar protection device

These characteristics are calculated as a function of the "optical" properties of the solar protection device and the glazing, the thermal transmittance of the glazing and the position of the solar protection device.

The formulae given in ISO 52022-1 are based on a simple physical model and the values of the notional parameters G are mathematically fitted to a more precise reference calculation, following the principles of ISO 52022-3.

The results generally tend to lie on the safe side for cooling load estimations. The results are not intended to be used for calculating beneficial solar gains during heating period or thermal comfort criteria.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal transmission or optical properties of glazing.

ISO/TR 52022-2 provides some typical values for the characteristics of glazing and solar protection devices that can be used in the absence of values obtained from measurement or calculation. It also provides calculation examples.

ISO 52022-3

ISO 52022-3 defines a procedure for a detailed calculation of the solar and daylight characteristics for solar protection devices combined with glazing.

The procedure is based on the spectral transmission and reflection data of the materials, comprising the solar protection devices and the glazing, to determine the total solar energy transmittance and other relevant solar-optical data of the combination. If spectral data are not available, the methodology can be adapted to use integrated data. The use of integrated

In the physical model, the glass panes and blinds are considered as parallel, solid layers. In general, the total solar energy transmittance, the total solar direct transmittance and the total light transmittance is calculated as a function of the thermal resistance and spectral "optical" properties (transmittance, reflectance) of the individual layers.

Two sets of boundary conditions are given for the vertical position of the glazing and the blind.

- **Reference conditions**:
  These boundary conditions are consistent with the general assumptions of EN 410 and ISO 10292 to be used for product comparison and average solar gain calculations during the heating period.
- **Summer conditions**:
  These boundary conditions are representative of more extreme condition and to be used for comfort evaluations and cooling load calculations.

Annex C of the standard gives a choice in references to other CEN (for CEN area) or ISO (elsewhere) standards that provide thermal transmission or optical properties of glazing, solar shading devices and gas spaces.

ISO/TR 52022-2 contains a number of calculation examples on this standard.

Accompanying spreadsheets

In agreement with the rules for all EPB standards containing calculation procedures, spreadsheets were prepared during the preparation of the standards to demonstrate and validate the procedures. Spreadsheets are publicly available on (the draft versions of) ISO 10077-1, ISO 12631, ISO 52022-1.

Calculation examples are presented in the technical report ISO/TR 52022-2.

No accompanying calculation spreadsheets (except spreadsheets with only an overview of input and output quantities) were prepared on:

- ISO 10077-2: the standard does not provide a calculation procedure; it provides test cases and performance criteria for calculation procedures.
- ISO 52022-3: the standard provides complex calculation procedures that are not easily put in a spreadsheet. Instead of a spreadsheet, Annex H of ISO/TR 52022-2 contains examples of calculation results obtained by computer programs.

Conclusion

The revisions (2013-2016) to make the suite of standards on thermal, solar and daylight properties of windows and facades fit into the set of EPB standards are mainly editorial. This resulted in a subset that is unambiguous and software proof, with rationalized choices (via the "Annex A/Annex B" approach) and with consistent interconnections, in particular with all the other standards in EPB module M2 subset of EPB standards. ■

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Articles

EPB standards on hygrothermal performance of building components and building elements

This paper introduces the subset of EPB standards dealing with hygrothermal performance of building components and building elements. These ISO standards have a long tradition. The changes to make these standards fit into the set of EPB standards were mainly editorial.

Keywords: energy performance of buildings, EPB, EPB standards, EPB regulations, thermal transmission, building components, building elements.

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The EPB standards on hygrothermal performance of building components and building elements concern the following standards mainly under EPB module M2-5 and developed under ISO/TC 163/SC 2 in collaboration with CEN/TC 89: ISO 6946 [2], ISO 10211 [3], ISO 10456 [4], ISO 13370 [5], ISO 13786 [6], ISO 13789 [7] and ISO 14683 [8], plus accompanying technical report, ISO/TR 52019-2 [1].

History of this suite of standards

The first series of standards on thermal and hygrothermal properties of building components and elements were prepared by ISO Technical Committee TC 163 in the 1980s, as a result of growing global concern on future fuel shortages and inadequate health and comfort levels in buildings. During the following decades, these first standards were revised and new standards were added, to cope with new developments and additional needs. From the 1990s on, these standards were developed in close collaboration with CEN/TC 89.

Revision of this suite of standards (2013-2016)

The revisions (2013-2016) to make this suite of standards fit into the set of EPB standards are mainly editorial. This includes editorial changes to make the procedures unambiguous and software proof, to rationalize the choices (via the "Annex A/Annex B" approach) and to ensure consistent interconnections, in particular with all the other standards in EPB module M2 subset of EPB standards.

Main outputs

The main outputs of these standards are:

- thermal transmission properties of building elements (thermal resistance, thermal transmittance or dynamic thermal characteristics of a wall, floor or roof);
- heat transfer coefficient for the whole building (or part of a building).

General description of the standards

Together with ISO 10077-1, ISO 10077-2 and ISO 12631 (see other article, on the windows related standards); these standards provide the methodology to obtain heat transfer coefficients for a building starting from the properties of materials used for its construction and the size and geometry of the building.

The results provide input for calculation of energy needs for heating and cooling by ISO 52016-1 when one of the simplified (monthly or hourly) calculation methods is being used in ISO 52016-1 (see also [9] and parallel article on ISO 52016). In the case of detailed dynamic simulations, the component (or subcomponent) properties are used directly as inputs for the building simulation.

In applications where individual component properties are needed, the standards provide:

- in the case of minimum component requirements, the U-value or R-value of the construction;
- for multi-zone calculations with assumed thermal interaction between the zones, the thermal transmission properties of the separating construction;

Figure 1 illustrates the linkages between the various standards.

ISO 6946

ISO 6946 provides a calculation method that is valid for most building components (walls, suspended floors and roofs). It is based on calculating the upper limit of thermal resistance of the component (which would apply if the heat flow were unidirectional from warm side to cold side) and the lower limit (in which the plane separating each layer is isothermal). Except for components consisting entirely of homogeneous layers (for which the upper and lower limits are equal), the true thermal resistance of a component is between these two limits. The standard specifies use of the arithmetic mean of the two limits provided that their ratio does not exceed 1,5.

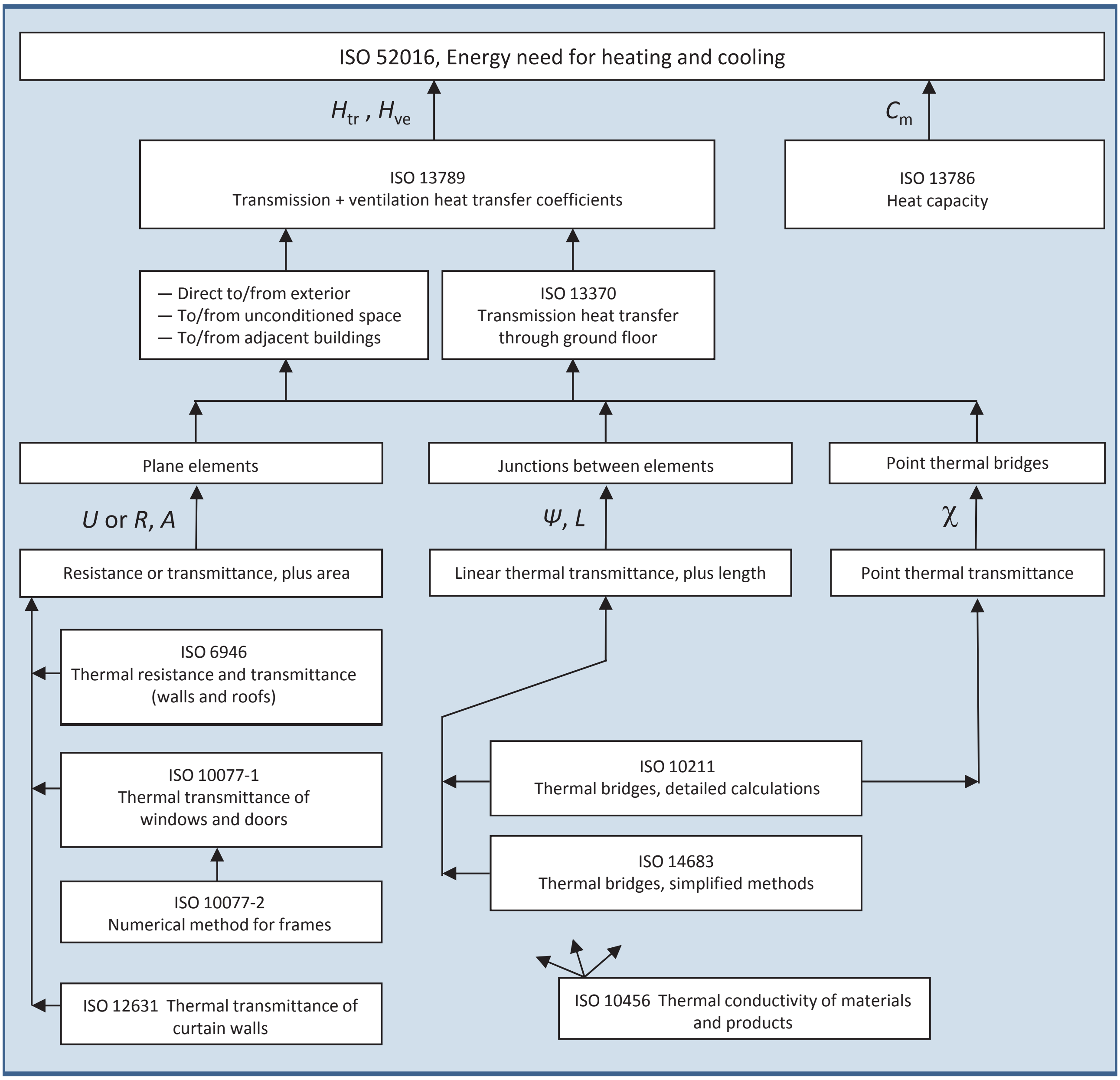

Figure 1. Linkage between the standards.

Options for national choices provided in "Annex A/Annex B" comprise default thermal conductivity or thermal resistance values, criteria to allow specific simplifications and boundary conditions.

ISO/TR 52019-2 provides calculation examples.

ISO 10211

ISO 10211 specifies the method for detailed calculation of thermal bridges. It can be applied to a whole building or part of it, and also to the calculation of linear and point thermal transmittances which are used in ISO 13789.

Options for national choices provided in "Annex A/Annex B" comprise default thermal conductivity values, criteria to allow specific simplifications and the required accuracy of the calculations.

ISO 13370

ISO 13370 is used for calculation of heat transfer via the ground, taking account of its contribution to the total thermal resistance in the case of *U*-value calculations and of its thermal inertia in the case of time-dependent calculations.

ISO 13370 specifies thermal properties for three representative types of ground. Particular values can be provided in ISO 13370 Annex A. Annex F of ISO 13370 contains a procedure for the application to dynamic simulation programs. This procedure is also used in ISO 52016-1 (see other article) for the hourly calculation of the energy needs for heating and cooling, internal temperatures and sensible and latent heat loads. In addition, special care has been taken to ensure that the monthly calculated heat transfer through the ground floor can be used as input for the monthly calculation method in the same ISO 52016-1. Extensive explanation, including validation and examples can be found in ISO/TR 52019-2.

Options for national choices provided in "Annex A/Annex B" of the standard comprise default *U*-values for existing buildings, criteria to allow specific simplifications and environment conditions (incl. ground).

ISO 13786

ISO 13786 defines a method of calculation of the dynamic thermal characteristics of a building component.

Background information, explanation and examples can be found in ISO/TR 52019-2.

Options for national choices provided in "Annex A/Annex B" of the standard are related to restrictions on the use of the simplified method given in the standard.

ISO 13789

ISO 13789 defines the calculation of the transmission heat transfer coefficient of a building, using the heat transmission properties of the building elements and thermal bridge used in its construction. A decision is needed on the system of dimensions to be used – internal, overall internal or external. Annex J of ISO/TR 52019-2 illustrates the three systems and the effect of the systems on the linear thermal transmittance of junctions between elements. This annex is relevant also to ISO 10211 and ISO 14683.

For the ventilation heat, transfer coefficient the airflow rate through conditioned spaces is needed. Annex K of ISO/TR 52019-2 provides a possible method, with associated data. However, for use within CEN, references are given to the CEN EPB standards under EPB module M5-5 (CEN/TC 156) that have been developed for this purpose.

Options for national choices provided in "Annex A/Annex B" of the standard are related to the dimensioning system, choice of method for ventilation heat transfer and criteria for specific simplifications.

ISO 14683

ISO 14683 defines the methodology for determination of linear thermal transmittances and provides default values for when specific information is not available. ISO/TR 52019-2 provides examples of the influence of thermal bridges on the transmission heat loss coefficient.

Options for national choices provided in "Annex A/Annex B" of the standard are related to optional use of an e.g. national/regional thermal bridge catalogues and optional national/regional manual (simplified) calculation method.

Accompanying spreadsheets

In agreement with the rules for all EPB standards containing calculation procedures, spreadsheets were prepared during the preparation of the standards to demonstrate and validate the procedures. Spreadsheets are publicly available on (the draft versions of) ISO 6946, 13370 and 13789. Calculation examples are presented in the technical report ISO/TR 52019-2.

No accompanying calculation spreadsheets were prepared on:

- ISO 10211: this standard does not provide a calculation procedure; it provides test cases and performance criteria for calculation procedures.
- ISO 13786: this standard provides complex matrix calculation procedures. Instead of a spreadsheet, Annex I of ISO/TR 52019-2 contains examples of calculation results obtained by a computer program.
- ISO 14683: this standard does not provide a calculation procedure; it provides choices between procedures provided elsewhere and default tabulated values. Instead of a spreadsheet, Annex L of ISO/TR 52019-2 contains examples of the use of default values.

Conclusion

The revisions (2013-2016) to make the suite of ISO standards on hygrothermal performance of building components and building elements fit into the set of EPB standards are mainly editorial. This resulted in a subset that is unambiguous and software proof, with rationalized choices (via the "Annex A/Annex B" approach) and with consistent interconnections, in particular with all the other standards in EPB module M2 subset of EPB standards. ■

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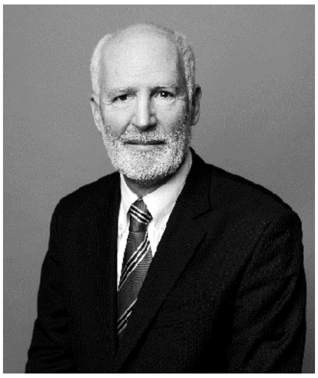

ERICK MELQUIOND
President
Eurovent Certita Certification

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Example of such use can be found in the French Building energy efficiency calculation method which applies a penalty for non-certified heat-pumps and air to air heat exchangers. Consultancies use approved software in order to assess the compliance of a building with the French EPB regulation (RT 2012). This software is linked to database of products which are fed directly with Eurovent certified performance data.

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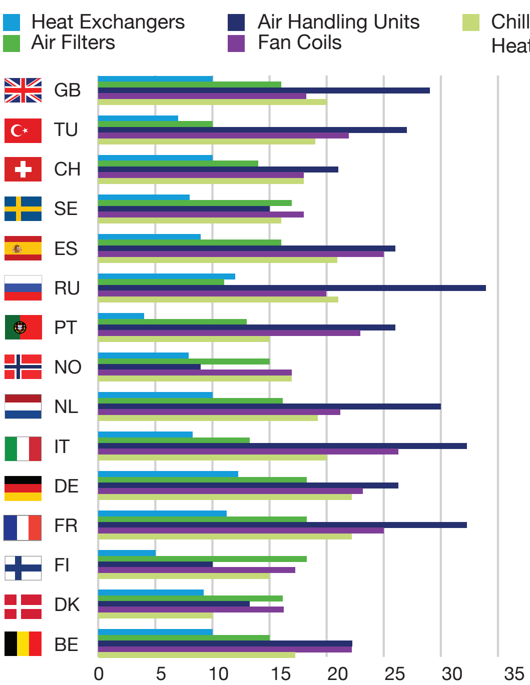

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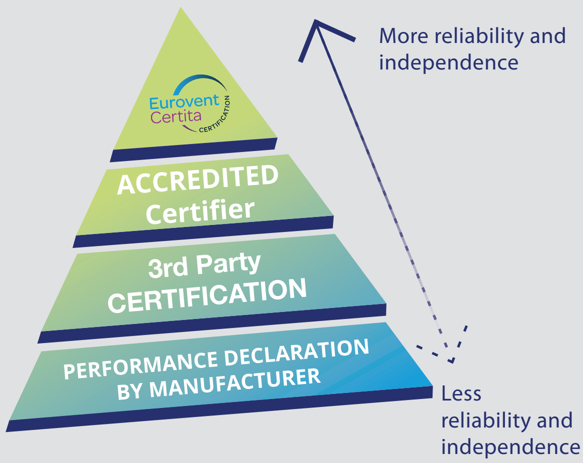
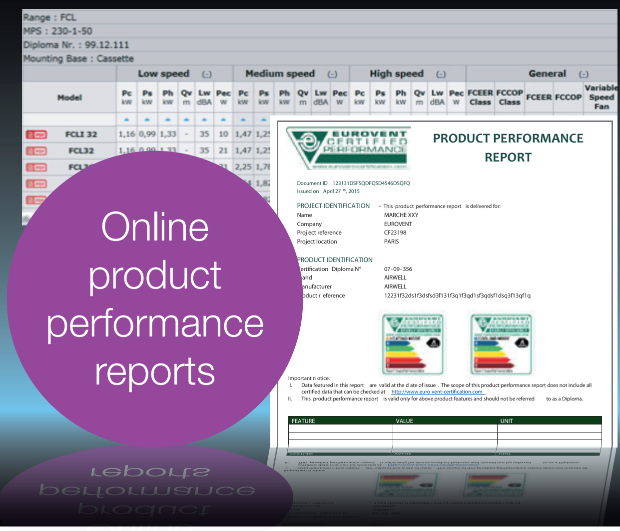


Integrity, Independence and Impartiality

- We operate with the commissions responsible for the harmonisation and the integrity of our certification programmes, including authorities, end-user groups, scientific and technical bodies, and manufacturer associations.
- All 30 laboratories and testing agencies that are a part of the Eurovent Certita Certification process are regularly assessed according to ISO 17025. They are located in 11 countries worldwide.
- Our testing protocols include independent tests, manufacturing audits, selection software checks, product sampling, product purchasing, cross data coherence algorithms per product family, and product dismantling after testing.

By a simple, 24/7 connection to our website **www.eurovent-certification.com** you can download **Product Performance Reports** that provide detailed performance features and values such as the **COP (Coefficient Of Performance)** or the **Sound Power Level**.



Our Events in 2017 – Exhibition and Conferences

15–17 Jan	HVAC-R expo – Saudi	
28 Jan – 1 Feb	ASHRAE 2017 Winter conference – Last Vegas	
17 Jan	Qualicheck – Lyon	
23–25 Feb	Acrex India – New Dehli	Stand C11
5–9 March	Euroshop – Düsseldorf	Stand 15/D25
7–10 March	Harfko – Korea	Stand D0833/834
14–18 March	ISH – Düsseldorf	Stand 11.1.B06 / FOY03
8–10 March	BEPOSITIVE - Lyon	Stand 5 E 22
28 Feb – 7 March	Climatizacione – Madrid	
12–14 April	China Refrigeration Expo – Shanghai	Stand E3G07
10-12 May	Decarb2017 – Brussels	
10–13 May	CLIMAMED – Matera	
12-15 Sept	Febrava - Sao Paulo	
5–10 Nov	Interclima – Paris	

Find all our information on our website: www.eurovent-certification.com

Our commitment in adding value along the renewable energy decision chain goes one step further and extends to **installers, household buyers or contractors** for whom we are implementing on-line tools to support them at every stage of their projects, from the quotation to the filing for local incentives or tax rebates.

Conclusion

The challenging normative and regulatory background in the fields of HVAC&R induces a complex environment. Assessing the quality and compliance of products is therefore more and more difficult for end-users. In this context, the Eurovent Certified Performance online directory provides an easy and straightforward way to get up to date, trustful and exhaustive data. Such information can be (and are already) used in various voluntary and regulatory compliance schemes.

With this special issue of the REHVA journal, we welcome the opportunity to present 20 years of Third-Party performance certification expertise and know-how. ■

EUROVENT CERTIFIED PERFORMANCE
www.eurovent-certification.com

CERTIFICATION PROGRAMMES

FOR DOMESTIC, COMMERCIAL AND INDUSTRIAL FACILITIES

Indoor Climate	Ventilation & Air Quality	Process Cooling & Food Cold Chain
European Heat Pumps	Air to Air Plate Heat Exchangers *	Cooling Towers
Chilled Beams *	Air to Air Regenerative Heat Exchangers *	Cooling & Heating Coils
Close Control Air Conditioners *	Air Handling Units *	Drift Eliminators
Comfort Air Conditioners *	Air Filters Class M5-F9 *	Liquid Chilling Package & Heat Pumps *
Rooftop (RT) *	Residential Air Handling Units (RAHU)	Heat Exchangers *
Fan Coils Units *	Ventilation Ducts (DUCT)	Remote Refrigerated Display Cabinets
Variable Refrigerant Flow (VRF) *	Hygienic Air Handling Units (HAHU)	Heat Recovery Systems with Intermediate Heat Transfer Medium (HRS-coils)

* All models in the production have to be certified

Indoor Climate

European Heat Pumps

Scope of certification

- Electrically driven heat pumps for space heating (incl. cooling function)
- Electrically driven heat pumps used for heating swimming pool water (outdoors or inside)
- Dual-mode heat pumps, i.e. designed for space heating and domestic hot water production,
- Gas absorption heat pumps (incl. cooling function)
- Engine-driven gas heat pumps (incl. cooling function).

Certification requirements

- Qualification campaign: 1 audit/factory + tests depending on products declared
- Repetition campaign: 2 machines/year + 1 audit/year/factory

Main certified characteristics and tolerances

- Heating and/or Cooling capacities *Ph* and/or *Pc* [kW], Electrical Power inputs *Pe* [kW] and Coefficient of performance *COP*
- Design capacity *Pdesignh*, Seasonal Coefficients of Performance *SCOP*, $SCOP_{net}$ and Seasonal efficiency η_s
- Minimum continuous operation Load Ratio *LRcontmin* [%], *COP* at LRcontmin and Performance correction coefficient at LRcontmin *CcpLRcontmin*
- Temperature stabilisation time *th* [hh:mm], Spare capacity *Pes* [W], Energy efficiency for water heating [COP_{DHW} & WH] or Global performance coefficient for a given tapping cycle COP_{global}, Reference hot water temperature θ'_{WH} and Maximum effective hot water volume V_{MAX} [l]
- Daily consumption for the draw-off cycle in question (Qelec)
- Annual consumption (AEC)
- Sound power levels *Lw* [dB(A)]

ECC Reference documents

- Certification manual
- Operational manual OM-17
- Rating standard RS 9/C/010

Main testing standards

Thermal performance:

- Heat pumps with electrically driven compressors
- Space heating & cooling: EN 14511-1 to 4; Seasonal performance: EN 14825
- Domestic hot water: EN 16147
- Direct exchange ground coupled heat pumps: EN 15879-1
- Gas-fired heat pump: EN 12309-1 to 5

Acoustics:

- Heat pumps and dehumidifiers with electrically driven compressors: EN 12102
- ISO 3741: Reverberant rooms or ISO 9614-1: Sound intensity, measurements by points

▼ Indoor Climate

Chilled Beams

CERTIFY ALL

Scope of certification

This Certification Programme applies to all Active and Passive Chilled Beams. Chilled Beams are presented by ranges but all ranges must be certified. This applies to all product ranges which have either catalogue leaflets with product details including technical data or similar product information in electronic format.

Certification requirements

For the qualification procedure (yearly): 3 units are selected from regular production and tested in the independent Laboratory selected by Eurovent Certita Certification.

For the repetition procedures: the number of units selected is limited to 1 unit/range.

Obtained performances shall be compared with the values presented in the catalogues or electronic selection from manufacturer's website.

Certified characteristics & tolerances

Cooling capacity: 3 conditions are required.

- Active: 80 – 100 – 120% of the nominal air flow rate (for 8°C temperature difference)
- Passive: 6 – 8 – 10°C temperature difference

Tolerance = 12% and +24% for the 3 single values; –6% for the average value.
Water pressure drop: tolerance = maximum (2 kPa; 10%)

ECC Reference documents

- Certification manual
- Operational Manual OM-12
- Rating Standard RS 2/C/007

Testing standards

- EN 14518: "Testing and rating of Passive Chilled Beams"
- EN 15116: "Testing and rating of Active Chilled Beams"

Comfort Air Conditioners

CERTIFY ALL

Scope of certification

This certification programme includes:

- AC1: comfort air cooled AC and air to air HP with cooling capacity up to 12 kW, except double duct and single duct units.
- AC2: comfort units with cooling capacity from 12 to 45 kW
- AC3: comfort units with cooling capacity from 45 to 100 kW

This programme applies to factory-made units intended to produce cooled air for comfort air conditioning (AC1, AC2, AC3). It also applies to units intended for both cooling and heating by reversing the cycle. For the AC1 programme units out of Regulation 206/2012 are excluded.

Participating Companies must certify all production models within the scope of the programme they enter. However concerning multi-split air conditioners, only systems with maximum two indoor units are included, same mounting type, capacity ratio 1+/- 0.05.

Certification requirements

For the qualification & yearly repetition procedures: AC1: 8% of the units declared are selected and tested by an independent laboratory, and 30% of the selected units are tested at part load conditions. AC2 & AC3: 10% of the units declared are selected and tested by an independent laboratory.

Certified characteristics & tolerances

- Capacity (cooling and heating) –5%
- Efficiency (EER and COP) –8%
- Seasonal Efficiency (SEER and SCOP): –0% (the product is downgraded (or rerated) as soon as partload efficiency is out of tolerance
- A-weighted sound power level +0 dB (A)
- Auxiliary power +10%

Minimum continuous operation Load Ratio: LRcontmin [%], COP/EER at LRcontmin and Performance correction coefficient at LRcontmin CcpLRcontmin.

ECC Reference documents

- Certification manual
- Operational Manual OM-1
- Rating Standard RS 6/C/001 - RS 6/C/001A - RS 6/C/006

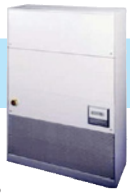
Testing standards

- EN 14511 • EN 14825 • EN 12102

Indoor Climate

Close Control Air Conditioners

CERTIFY ALL



Scope of certification

This Certification Programme applies to factory-made units intended for Close Control Air Conditioning. This programme includes units with cooling capacities up to 100 kW under the specified test conditions.

Participating companies must certify all production models within the scope of the programme.

Certification requirements

For the qualification & repetition procedures: 10% of the units declared will be selected and tested by an independent laboratory.

Certified characteristics & tolerances

Air-Cooled and Water-Cooled Close Control Air Conditioners

- Total cooling capacity: –8%
- Sensible cooling capacity:–8%
- EER: –8%
- A-weighted sound power level: +0 dB

Chilled-Water Close Controls Air Conditioners

- Total cooling capacity: –8%
- Sensible cooling capacity: –8%
- Effective power input: +8%
- A weighted sound power level: +0 dB
- Water pressure drop:+10%

ECC Reference documents

- Certification manual
- Operational Manual OM-1
- Rating Standard RS 6/C/001
- Rating Standard RS 6/C/004
- Rating Standard RS 6/C/006

Testing standards

- EN 14511
- EN 12102 - EUROVENT 8/1

Rooftop (RT)

CERTIFY ALL

EUROVENT CERTIFIED PERFORMANCE ENERGY EFFICIENCY CHECK ENERGY CLASS ON www.eurovent-certification.com

The Eurovent rooftop certification (RT) program covers air-cooled packaged rooftop units below 100 kW in cooling mode, with an option to certify units from 100 kW to 200 kW and water cooled rooftops.

Eurovent certifies indoor and outdoor sound levels, cooling and heating capacity and efficiency. Certified performances provide transparency and fair comparison between manufacturers. It is also the basis for the reliable study of HVAC system energy performance.

In 2018 the program will evolve towards part load efficiency (SEER, SCOP). Current work done on EN 14825 aims to address rooftops in the calculation hypothesis.

The software certification will be a key item to comply with existing and coming certification of building energy calculations in the EU countries.

Mr Arnaud Lacourt
Head of Thermodynamics Department
Eurovent Certita Certification

Scope of certification

- This certification program applies to air-cooled rooftops rated below 100 kW.

Can be certified as an option:

- Models with cooling or heating capacity ranging from 100 kW to 200 kW
- Rooftops with 3 & 4 dampers
- Water cooled rooftops

Certification requirements

- For the qualification and repetition procedures (yearly) between 1 & 3 units are selected and tested by Eurovent Certification, depending on the number of products declared.

Certified characteristics & tolerances

- Capacity (Cooling or Heating): –5%
- EER or COP: -8%
- Condenser water pressure drop: +15%
- A-weighted Sound Power Level: +3 dBA.
- Eurovent Energy Efficiency class (cooling and heating)

ECC Reference documents

- Certification manual
- Operational Manual OM -13
- Rating Standard RS 6/C/007

Testing standards

- EN 14511 for Performance Testing
- EN 12102 for Acoustical Testing

Fan Coils Units

CERTIFY ALL

Scope of certification

This Certification Programme applies to Fan Coil Units using hot or chilled water. It concerns both non ducted and ducted fan coils:

- Non ducted units: Fan Coil Units with air flow less than 0.7 m³/s and a published external static duct pressure at 40 Pa maximum.
- Ducted units: Fan Coil Units up to 1 m³/s airflow and 300 Pa available pressure.
- District cooling units and 60 Hz units can be certified as an option

Participating companies must certify all production models within the scope of the programme. Selection tools (software) are checked.

Certification requirements

Repetition procedure: the number of units to be tested each year will be proportional to the number of his basic models listed in the Directory, in an amount equal to 17% for Fan Coil Units with a minimum of one test.

Certified characteristics & tolerances

- Sensible capacity* ** : −8%
- Total cooling & heating capacity * ** : −7%
- Water pressure drop* **: +15%
- Fan power input*: +10%
- A-weighted sound power **: +2 dB(A)
- Air flow rate: −10%
- Available static pressure 0 Pa for medium speed and −5 Pa for other speeds
- FCEER & FCCOP
- Eurovent energy efficiency class

(*) At standard and non-standard conditions

(**) Tolerances for capacities are increased by 2% for variable speed units.

ECC Reference documents

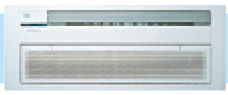
- Certification manual
- Operational Manual OM-1A
- Rating Standard RS 6/C/002
- Rating Standard RS 6/C/002A

Testing standards

- Performance testing: EN 1397:2015
- Acoustic testing: EN 16583:2015

Variable Refrigerant Flow (VRF)

CERTIFY ALL



VRF systems have shown the highest growth amongst cooling systems during the past 10 years and indeed the highest potential for the next 10 years.

Until recently, VRF systems were the only type of direct expansion cooling system that was not covered by a dedicated Certification programme.

The Eurovent Certification scheme was therefore critical.

It was my privilege to Chair the Launching committee from the first meeting to its introduction. Whilst it took 2 years to complete, I believe it was worth the time and effort.

We at Toshiba are pleased as a manufacturer to work with Eurovent Certification Company as they guarantee the consistency of thermal testing and they increase the integrity of the products on the market.

Nick Ball
Toshiba EMEA
Engineer Director

Scope of certification

The certification programme for Variable Refrigerant Flow (VRF) applies to:

- Outdoor units used in Variable Refrigerant Flow systems with the following characteristics:
- Air or water source, reversible, heating-only and cooling-only.

VRF systems with data declared and published as combinations are excluded from the scope.

Heat recovery units are included in the scope but the heat recovery function is not certified.

High ambient systems are included in the scope but tested under standard conditions as specified in RS 6/C/008.

Certification requirements

- Qualification: units selected by ECC shall be tested in an independent laboratory selected by ECC.
- Repetition procedure: units selected from regular production shall be tested on a yearly basis.
- A factory visit is organized every year in order to check the production

Certified characteristics & tolerances

- Outdoor Capacity (cooling and heating): −8%
- Outdoor Efficiency (EER, COP): −10%
- A-weighted sound power level: 2 dB

ECC Reference documents

- Certification manual
- Operation manual OM-15
- Rating Standard RS 6/C/008

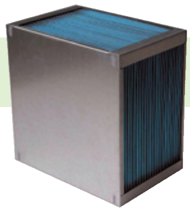
Testing standards

- EN 14511 - EN 12102

▼ Ventilation & Air Quality

Air to Air Plate Heat Exchangers

CERTIFY ALL



Scope of certification

This Certification programme applies to selected ranges of Air to Air Plate Heat Exchangers. Participants shall certify all models in the selected range, including:

- cross flow, counter-flow and parallel flow units
- all sizes
- all materials
- all airflow rates
- all edge lengths
- plate heat exchanger with humidity transfer

Heat Exchangers with accessories such as bypass and dampers shall not be included.

Manufacturers shall declare production places and provenance of products is randomly chosen. The programme does not cover other types of Air to Air Heat Exchangers like Rotary Heat Exchangers or Heat Pipes. Combination of units (twin exchangers) are also included in the scope of the program.

Certification requirements

For each range to be certified, 3 units for qualification and 1 for yearly repetition will be selected by Eurovent Certita Certification and tested in an independent Laboratory.

Certified characteristics & tolerances

- Dimensions: ± 2 mm
- Plate spacing: ± 1% or ± 1 plate
- Temperature efficiency Dry: –3 percentage points
- Temperature efficiency Wet: –5 percentage points
- Humidity efficiency: -5%
- Pressure drop: +10%, minimum 15 Pa

ECC Reference documents

- Certification manual
- Operational Manual OM-8
- Rating Standard RS 8/C/001

Testing standards

- EN 308

Air to Air Regenerative Heat Exchangers

CERTIFY ALL

Scope of certification

This Certification Programme applies to all ranges of Air to Air Regenerative Heat Exchangers (RHE) including sealing systems. Units sold without casing and sealing systems are also included. Participants shall certify all models in the ranges, including:

- all classes: condensation (non hygroscopic, non enthalpy) RHE, hygroscopic enthalpy RHE, hygroscopic sorption RHE
- all RHE geometry (wave height, foil thickness)
- all sizes (rotor diameters and rotor depths and surface areas of Alternating Storage Matrices - ASM)
- all materials
- all airflow rates
- all different types of sealing (if available)

Certification requirements

For the qualification procedures 1 unit per class of rotor will be selected and tested by an independent laboratory. For yearly repetition, 1 unit will be selected.

Certified characteristics & tolerances

- Temperature Efficiency: –3% points
- Humidity Efficiency: –5% points (min. tolerance 0.2 g/kg in absolute humidity of leaving supply air)
- Pressure Drop: +10% (min 10 Pa)
- Outdoor Air Corrrection Factor (OACF): 0.05
- Exhaust Air Transfer Ratio (EATR): +1% point

ECC Reference documents

- Certification manual
- Operational Manual OM-10
- Rating Standard RS 8/C/002

Testing standards

- EN 308
- ARI 1060

▼ Ventilation & Air Quality

Air Handling Units

CERTIFY ALL

Swegon has participated in the program for Air Handling Units from the start. The first priority at that time, and still is, was to find a way for fair competition. This is a long term struggle were we try to cover all aspects from manufacturing to software performance predictions and its agreement with tests. We discuss and take decisions about mandatory performance in software printout, rules for the energy labelling, how to test and what to apply in the, on site, auditor check. Customers should go for Eurovent certified products, to get reliable data, and then they can cut the main cost and take care of the environment by minimising the use of energy.

Committee chair:
Mr Gunnar Berg
Development Engineer, Swegon

Scope of certification

This Certification Programme applies to ranges of Air Handling Units that can be selected in a software. Each declared range shall at least present one size with a rated air volume flow below 3 m³/s. For each declared range, all Real Unit Sizes available in the software and up to the maximum stated air flow and all Model Box configurations shall be declared.

Participants shall certify all models in the selected product range up to the maximum stated air flow.

A range to be certified shall include at least one size with a rated air volume flow up to 3 m³/s.

Certification requirements

For the qualification procedure: the selection software will be verified by our internal auditor. A visit on production site will be organized. During that visit, the auditor will select one real unit per range, as well as several model boxes that will cover all mechanical variations.

The selected units will be tested and performances delivered by the selection software will be compared to the performances measured in an independent laboratory.

For the repetition procedures, the auditor will annually check the software conformity against the production data, and tests will be repeated every 3 to 6 years.

Certified characteristics & tolerances

- External Pressure: 4% or 15 Pa
- Absorbed motor power: 3%
- Heat recovery efficiency: 3%-points
- Heat recovery pressure drop (air side): max. of 10% or 15 Pa
- Water coil performances (heating/cooling): 2%
- Water coil pressure drop (water side): max. of 10% or 2 kPa
- Radiated sound power level casing: 3 dB(A)
- Sound power level unit openings:
  - 5 dB @ 125 Hz
  - 3 dB @ 250 – 8 000 Hz
- Casing Air Leakage: same class or higher

ECC Reference documents

- Certification manual
- Operational Manual OM-5
- Rating Standard RS 6/C/005

Testing standards

- EN 1886: “Ventilation for buildings – Air handling units – Mechanical performance”
- EN 13053: “Ventilation for buildings – Air handling units – Rating & performance for units components and sections”

▼ Ventilation & Air Quality

Air Filters Class M5-F9

CERTIFY ALL

Today, people spend most of the time inside of buildings. Hence, indoor air quality is a key factor to human health. Air filters removing fine dust from the air stream are the key component in building heating, ventilation and air conditioning systems to supply air of the required cleanliness and to ensure a high level of indoor air quality. With the air filter certification program, reliable and transparent filter data are ensured to customers. On a yearly base, four different filters are selected out of the product range of each participant for testing at independent laboratories according to EN 779:2012, verifying the initial pressure drop, the filter class and the initial and minimum efficiency, as well as the energy efficiency class to Eurovent document 4/11. Additionally, with the new energy efficiency label, Eurovent provides valuable data to enable users to select the most energy efficient air filters.

Committee chair:
Dr. Thomas Caesar
Head of Filter Engineering Industrial Filtration Europe
Freudenberg Filtration Technologies SE & Co. KG

Scope of certification

- This Certification Programme applies to air filters elements rated and sold as "Medium or Fine Air Filters M5-F9" as defined in EN 779:2012 and with a front frame size of 592 x 592 mm according to standard EN 15805.
- When a company joins the programme, all relevant air filter elements shall be certified.

Certification requirements

- For the qualification procedures: 6 units will be selected and tested by an independent Laboratory selected by Eurovent Certification.
  Then each year 4 units will be selected & tested

Certified characteristics & tolerances

- Filter class: no tolerance.
- Initial pressure drop: +10% + 5 Pa (minimum 15 Pa)
- Initial efficiency for F7 to F9: 10% – point
- Discharge efficiency for F7 to F9: 10% – point
- Annual energy consumption +10% +60 kWh/a

ECC Reference documents

- Certification manual
- Operational Manual OM-11
- Rating Standard RS 4/C/001

Testing standards

- EN 779:2012
- Eurovent 4/21

Ventilation Ducts (DUCT)

Scope of certification

The programme scope covers rigid and semi-rigid ventilation ductwork systems divided into the following sub-programmes:

- Rigid metallic ductwork systems with circular cross-section (DUCT-MC);
- Rigid metallic ductwork systems with rectangular cross-section (DUCT-MR);
- Semi-rigid non-metallic ductwork systems predominantly made of plastics (DUCT-P);

Each sub-programme applies to ductwork systems fitted with integrated sealing solution as described in relevant Rating Standard.

Certification requirements

The certification programme is based on product performance testing by independent testing laboratories as well as production sites auditing.

Certification characteristics & tolerances

The product performance testing will enable the verification of the following ratings accuracy:

- Air tightness class (all sub-programmes)
- Positive and negative pressure limits (all sub-programmes)
- Dimensions (DUCT-MC and DUCT-MR)
- Minimum and maximum service temperatures (DUCT-P)
- Resistance to external pressure (DUCT-P)

ECC reference documents

- OM-19-2016
- RS/2/C/002MC-2016
- RS/2/C/003MR-2016
- RS/2/C/004P-2016

Testing standards

- Air leakage and strength testing:
  – EN 12237:2003 (DUCT-MC and DUCT-P)
  – EN 1507:2006 (DUCT-MR)
- Service temperature and resistance to external pressure (DUCT-P):
  – RS 2/C/004P-2016

Hygienic Air Handling Units (HAHU)

Scope of certification

This programme applies to hygienic ranges of Air Handling Units. As an option of the Certification programme for Air Handling Units, only an already ECP certified range is eligible for the hygienic option. The hygienic aspect of the AHU is certified based on a 3 levels classification, each level declaring an AHU suitable for different application:

- Level 1: Offices, commercial buildings, schools, hotels
- Level 2: Hospitals
- Level 3: Pharmaceutical, food processes, white rooms

The previous list is not exhaustive and must be used as a reference only. Final customer/user who has complete and detailed knowledge of the building application shall decide which Hygienic rating level is appropriate

Certification requirements

Same as in the Air Handling Unit programme.

Certification characteristics & tolerances

Services characteristics:

The following services characteristics are certified:

1. Manufacturing
2. Maintenance
3. Quality Managemement System
4. IOM (Installation and Operational Manual)
5. Shipment

Hygienic characteristics:

The following hygienic characteristics are certified:

1. Materials
2. Casing performance
3. Components arrangement and performances (filters, coils, heat recovery systems, fans, humidifiers, dehumidifiers and silencers)

ECC reference documents

- OM-5-2016-rev1
- RS/6/C/011-2016 Hygienic AHU

Testing standards

- RS 6/C/005-2016
- EN ISO 846:1997
- EN ISO 2896:2001
- EN 10088-3:2014
- EN 1993-1-2:2005
- DIN 1946/4-6.5.1:2008
- EN 779:2012
- EN 1822:2010
- EN ISO 12944-2:1998

Residential Air Handling Units (RAHU)

CERTIFY ALL

The objective of the Eurovent RAHU certification programme is, through tests performed by a third-party, to verify the performance of a unit bought somewhere on the open European market. It is important for the RAHU certification to use a unit out of the serial production – no special samples. For us, as a manufacturer, it pays to develop good products that deliver what we promise. By utilizing certified products, the designers' task is easier as they do not need to make detailed comparisons or perform advanced tests. Consultants, engineers and users can select a product and be assured that the catalogue data is accurate.

Certification is important for a designer/consultant/end user:

- No unnecessary risks – they can only use products that deliver what they promise "Eurovent certified"
- Well-functioning systems – the product delivers the promised capacity and performance
- Safer calculations on energy consumption is expected

Mr. Tobias Sagström
Global Product Manager Residential at Systemair AB

Scope of certification

This programme applies to balanced residential AHUs (supply and exhaust) with heat recovery systems such as:

- Air-to-air **plate** heat exchangers
- Air-to-air **rotary** heat exchangers
- **Heat-pumps** with a nominal airflow below 1 000 m^3/h.

Certification requirement

- Qualification test campaign: 1 test per heat recovery type.
- Repetition test campaign: 1 test every 2 years for each heat recovery type.
- Units are sampled directly from selling points.

Certified performances

- Leakage class
- Aeraulic performances:
- Airflow/pressure curves
- Maximum airflow [m^3/h]
- Electrical consumption [W]
- Specific Power Input SPI [$W/(m^3/h)$]
- Temperature efficiency / COP
- Performances at cold climate conditions
- SEC (Specific Energy Consumption) in [$kWh/(m^2.an)$]
- A-weighted global sound power levels [dB(A)]

Tolerances

- Leakage class 0
- Airflow –10%
- Temperature efficiency –3%-point
- Temperature efficiency at cold climate –6%-point
- COP / EER –8%
- A-weighted global sound power levels +2dB(A)
- Electrical consumption +7%
- Specific Power Input SPI +7%
- Disbalance ratio 0

ECC Reference documents

- Certification manual
- Operation manual OM-16
- Rating standard RS 15/C/001

Testing standards

- European standard EN 13141-7:2010

Cooling Towers

The importance of air conditioning and industrial cooling is constantly increasing in modern architecture and industrial process cooling. The human perception of comfort and the new challenges to reduce the electrical power consumption and CO_2 footprint have designers striving for optimal system performances with the highest possible efficiencies. Reliable thermal performances are crucial to ensure these best efficiencies which are typical for cooling circuits driven by evaporative cooling equipment. On a yearly basis, one random picked cooling tower of each Eurovent-CTI certified product line will be full scale thermal tested by applying the CTI standard 201.

Eurovent Certita Certification guarantees the consistency of thermal testing and manufacturing of European and non-European companies that subscribe to the program.

Committee chair:
Mr Rob Vandenboer
Product Manager, Quality Manager
Evapco Europe, BVBA

The first ECC / CTI collaborative certification program for Cooling Towers

The Eurovent Certification Company (ECC, Brussels, Belgium) is pleased to announce the Certification programme for cooling tower thermal performance developed in cooperation with the Cooling Technology Institute Est.1950 (CTI, Houston, Texas, USA). The scope of the program includes standardized model lines for open circuit cooling towers, typically factory assembled. Standardized model lines are composed of individual models that are required to have published thermal rating capacities at corresponding input fan power levels.

Thermal performance certification via this program offers a tower buyer assurance that the capacity published for the product has been confirmed by the initial and ongoing performance testing per the requirements of the program using CTI STD-201. It also offers for regulators of energy consumption related to cooling towers, that the capacity of the towers has been validated. Minimum energy efficiency standards such as the Eurovent Industry Recommendation / Code of Good Practice Eurovent 9/12-2016 and ASHRAE 90.1, which requires cooling tower energy efficiency validation by the CTI certification process, are used by governments and by green building certification programs such as LEED™.

Scope of certification

This Certification Programme for Cooling Towers applies to product ranges (or product lines) of Open-Circuit series and Closed Circuit Cooling Towers that:

- Are manufactured by a company whose headquarter or main facility are located in Europe, Middle-East, Africa or India. After getting the Eurovent Certification, the CTI certificate could be requested.
- Have already achieved and hold current certification by the Cooling Technology Institute (CTI) according to CTI STD-201.

Certification requirements

For the qualification & yearly repetition procedures our internal auditor visits the production place and reviews the conformity of Data of Records. One unit per range is selected and tested by an independent test agency.

Certified characteristics & tolerances

- Certified characteristic shall be per CTI STD-201
- Entering wet bulb temperature: 10°C to 32.2°C (50°F to 90°F)
- Cooling range > 2.2°C (4°F)
- Cooling approach > 2.8°C (5°F)
- Process fluid temperature < 51.7°C (125°F)
- Barometric pressure: –91.4 to 105.0 kPa (27" to 31" Hg)

ECC Reference documents

- Certification manual
- Operational Manual OM-4-2016
- Rating Standard RS 9/C/001-2014

Testing standards

- CTI STD-201 RS
- ECC OM-4-2016

▼ Process Cooling & Food Cold Chain

Cooling & Heating Coils

Heating Cooling Coils (HCCs) which enable the conditioning of different zones and flexibility in application in buildings are generally employed in compact and central station AHU. To meet the required extra capacity in various processes, they are also used as heating or cooling devices.

With the application of these coils to high energy efficient heat recovery systems, the entire system becomes more compact as well as it avoids occupation of large spaces. Besides, they can be applied to Variable Air Volume (VAV) systems used for conditioning of hospitals, shopping centers and convention facilities.

The Certification programme for the HCCs has increased integrity and accuracy of the industrial performance ratings which provides clear benefits for end users who can be confident that the product will operate in accordance with design specifications. Also, by means of this certification programme users can collect reference data on the fundamental characteristics of the HCCs, such as capacity, pressure drop, mass flow complying with the standard of EN 1216.

Engin Söylemez, R&D
Test Engineer, Friterm A.Ş

Scope of certification

The rating standard applies to coils operating:
– with water or with a 0-50% ethylene-glycol mixture, acting as cooling or heating fluid.
– and without fans.

Certification requirements

- Qualification and repetition procedures: units declared will be selected and tested by an independent laboratory.
- The number of units will depend on the variety of coil material configurations and their applications for the applied range.
- The selection software will be verified in comparison with the test results.
- On-site audits (checking of software)

Certified characteristics & tolerances

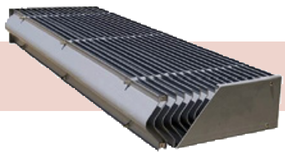
- Capacity: –7%
- Air side pressure drop: +20%
- Liquid side pressure drop: +20%

ECC Reference documents

- OM-9-2016
- RS 7/C/005

Testing standards

- EN 1216:1998+A1/2002



Drift Eliminators

Scope of certification

The Certification Programme for Drift Eliminators applies to Drift Eliminators used for evaporative water-cooling equipment.

Certified characteristics & tolerances

The following characteristics shall be certified by tests:

- For counter-flow and cross-flow film fill, the average drift losses of the two tests at 3.5 m/s are less than 0.007% of circulating water flow rate.
- For cross-flow splash fill, the average drift losses of the two tests at 3 m/s are less than 0.007% of circulating water flow rate.

No tolerance will be applied on the average drift losses.

ECC Reference documents

- Certification manual
- Operational Manual OM-14-2016
- Rating Standard RS 9/C/003

Testing standards

- CTI ATC-140

Liquid Chilling Package & Heat Pumps

Certification is a strong way to supply safe information in the right language

Offering guaranteed performances to customers has always been a fundamental benefit thanks to the accredited independency of this certification program. Today the need for certified performances is emphasized by several directives and it is essential for customers to:

- demonstrate the high performance efficiency of their buildings,
- compare safety performances of the products selected with the requirements of the regulations implementing ERP Ecodesign & labelling directives,
- be sure of the return of their investment or energy savings,
- have the ability to compare fairly between chillers, heat pumps or other type of heaters.

In addition to being certified, performances must be seasonal, in line with the new regulations, and assessed according to the new harmonized standards as soon as they apply.

This program is also a great opportunity for fruitful exchanges between independent laboratories, certification body and manufacturers. It also facilitates the understanding and application of new regulations or standards in a regulatory context in perpetual evolution.

A certification is a guarantee of fair competition (for customers/manufacturers). It also helps increase the number of applications using RES, and represents a commitment in the reduction of consumption and emissions.

Didier Perales
Manager of Technical Relations & Concept Projects
CIAT Group France

ECC Reference documents

- Certification manual
- Operational Manual OM-3
- Rating Standard RS 6/C003 - RS 6/C/003A

According to New Regulations for Space heaters Eco Labelling No 811/2013 - ErP No 813/2013.

Seasonal efficiency for heating (η_s) for Chillers & Heatpumps with a design capacity below 70kW is certified since 26 September 2015. (For units above 70kW it is optional).

Scope of certification

- This programme applies to standard chillers and hydronic heat pumps used for heating, air conditioning and refrigeration.
- They may operate with any type of compressor (hermetic, semi-hermetic and open) but only electrically driven chillers are included.
- Only refrigerants authorised in EU are considered. Chillers may be air cooled, liquid cooled or evaporative cooled.
- Heating-only hydronic heat pumps, 60 Hz units and Higher capacities (between 600 kW and 1500 kW) units can be certified as an option.

Certification requirements

Qualification and repetition: a certain number of units will be selected by Eurovent Certita Certification and tested every year, based on the number of ranges and products declared.

Certified characteristics & tolerances

- Cooling & heating capacity and EER & COP at full load: < –5%
- Performance SCOP & Seasonal Efficiency for Heating η_s: automatically rerated when Part Load efficiency criteria fails
- Seasonal Efficiency ESEERfor cooling: automatically rerated when Part Load efficiency criteria fails
- A-weighted sound power level: > +3 dB(A) (> +2 dB(A) for units with Pdesignh below 70kW)
- Water pressure drop: +15%

Testing standards

- Performance testing: EN 14511
- Seasonal Performance testing: EN 14825
- Sound testing: EN 12102

Heat Exchangers

CERTIFY ALL

EUROVENT CERTIFIED PERFORMANCE ENERGY EFFICIENCY CHECK ENERGY CLASS ON www.eurovent-certification.com

Air coolers for refrigeration

Dry coolers

Air cooled condensers

The purpose of the Eurovent "Certify-All" certification programme for heat exchangers is to encourage honest competition and to assure customers that equipment is correctly rated.

The programme covers 3 product groups:
- Unit Air Coolers
- Air Cooled Condensers
- Dry Coolers

The "Certify-All" principle ensures that, for heat exchangers, all models in the three product categories are submitted for certification, not just some models chosen by the manufacturer.

A product energy class scheme has been incorporated into the certification programme, based on 7 classes from "A++" to "E" in order to provide a guide to the best choice of product: this enables the user to minimize life-cycle costs, including running costs which account for a much superior sum than the initial investment cost.

Committee chair:
Stefano Filippini
Technicalmanager - LUVE

Scope of certification

The Eurovent Certification Programme for Heat Exchangers applies to products using axial flow fans. The following products are excluded from the Eurovent Certification Programme for Heat Exchangers:

- Products units using centrifugal type fans.
- Units working at 60 Hz

In particular, the following products are also excluded from the Eurovent Certification programme for Dx Air Coolers and Air Cooled Condensers:
- Products using R717 refrigerant (ammonia), CO_2, and refrigerants with high glide like R407C or without correction factors
- Product ranges of Dx Air Coolers where maximum standard SC2 is below 1.5 kW.
- Product ranges of Air Cooled Condensers where maximum standard capacity under DT1 15K is below 2.0 kW

Certification requirements

- Qualification: units selected by Eurovent Certita Certification shall be tested in an Independent Laboratory selected by ECC
- Repetition procedure: units selected from regular production shall be tested on a yearly basis.

Certified characteristics & tolerances

- Standard capacity –8%
- Fan power input +10%
- Air volume flow ±10%
- External surface area ±4%
- Energy ratio R
- Energy class

For Dry Coolers:
- Liquid side pressure drop +20%

For Air Cooled Condensers and Dry Coolers:
- A-weighted sound pressure level: +2 dB(A)
- A-weighted sound power level: +2 dB(A)

ECC Reference documents

- Certification manual
- Operational Manual OM-2
- Rating Standard RS 7/C/005

Testing standards

- Thermal Performance EN 328
- Thermal Performance EN 327
- Thermal Performance EN1048
- Acoustics EN 13487

Remote Refrigerated Display Cabinets

CERTIFY ALL

Remote refrigerated display cabinets (RRDC) are the appliances for selling and displaying chilled and/or frozen foodstuff to be maintained within prescribed temperature limits.

Typically, food and beverage retailers are the direct customers of the refrigeration industry while the supermarket's customers are the end users of food and beverage retailers.

Food and beverage retailers ask for food safety and also for appliances with high-energy efficiency, supermarket's customers ask for food safety. Refrigeration industry has to face the hard challenge of satisfying both needs.

How is it possible to assure that the refrigeration appliances perform accurately and consistently to the reference standards? How is it possible to assure that what is rated by the manufacturer is properly rated?

There is only one way: It is necessary to join a globally recognized and industry respected certification program.

Eurovent Certita Certification program for RRDC is the only certification program in Europe that can assure that performance claims have been independently measured and verified. The factory audits and the product's performances tested in an independent and third-party laboratory make the difference!

Since 2011, Eurovent Certita Certification has also launched a voluntary energy label certification scheme, anticipating what only nowadays EC DG Energy is doing in the framework of Ecodesign and Energy Label Regulations. What better way to rate RRDC's energy consumption and to promote their energy efficiency?

What would you trust more: a self-declaration by the Manufacturer or what an independent, globally recognized and forerunner certification program is able to assure? Which one is better?

Maurizio Dell'Eva
Project manager
EPTA S.p.A. – MILANO (ITALY)

Scope of certification

- 100 basic model groups divided in 5 categories of remote units: semi-verticals and verticals (with doors); multi-deckers; islands; service counters; combi freezers.
- At least two references per basic model group representing 80% of sales shall be declared.
- One Bill of Material for each declared reference.

Certification requirements

- Qualification: sampling and test of one unit & Audit of one factory.
- Repetition test of one unit per brand every 6 months & Annual audit of each factory.

Certified characteristics & tolerances

- Warmest and coldest product temp. ±0.5°C
- Refrigeration duty (kW) 10%
- Evaporating temperature –1°C
- Direct elec. Energy Consumption (DEC) +5%
- Refrigeration elec. Energy Cons (REC) +10%
- M-Package Tclass: ±0.5°C
- Total Display Area (TDA) –3%

ECC Reference documents

- Certification manual
- Operational Manual OM-7
- Rating Standard RS 14/C/001

Testing standards

- EN ISO 29953 and amendments

Process Cooling & Food Cold Chain

Heat Recovery Systems with Intermediate Heat Transfer Medium (HRS-COIL)

Scope of certification

This certification programme covers the heat recovery exchangers with intermediate heat transfer medium corresponding to the category IIa ("without phase change") of the EN 308:1997 standard, that is Run Around Coils systems.

Certification requirements

The certification programme is based on product performance testing by independent testing laboratories according to the European standard EN 308:1997 as well as manufacturing facility auditing and operating software checking.

Certification characteristics & tolerances

When tested in the laboratory the obtained performance data shall not differ from the recalculated values ("test-check") by more than the following tolerance values:

- Dry heat recovery efficiency: −3 percentage points (abs. deviation)
- Air side pressure drop: Maximum [+10%; +15 Pa]
- Fluid side pressure drop: Maximum [+10%; +2 kPa]

ECC reference documents

- OM-18-2016
- RS 7/C/009 – 2016

Testing standards

- EN 308:1997

Opening of collection 2017

On 4th of January, Eurovent Market Intelligence (EMI), the European statistics office for the HVAC&R market, launched its new annual data collections for 2017. The aim is to collect sales data from manufacturers in the sector in order to provide them with a reliable and precise market map for HVAC&R in Europe, the Middle East and Africa (EMEA).

YANNICK LU-COTRELLE
Manager
Eurovent Market Intelligence

Last year, more than 300 manufacturers had joined EMI, providing the most comprehensive and reliable ever overview of the market, and thus become the largest collection of data on the HVAC&R market in terms of number of market players.

In 2016, EMI brought also two major innovations to the information provided to its participants.

The first one is the delivery of customised reports. These individual market reports, packed with between 50 and 250 pages, compare market characteristics for each country in the EMEA area (size, segmentation, main players, growth, etc.) and the position of the manufacturer in the market (market share, rank, progress, etc.). The aim is to offer each participant a full overview of his situation so that in a glance he can see his strong points and areas where he needs to improve.

The second one is a new online marketing tool. All the market figures are available – under private access only – on the Eurovent Market Intelligence website, and the new marketing tool allows users to carry out all possible market analyses in a single click, as simple as using a flight comparison tool, and export the results to an Excel file. Participants can see, in detail for each selection – even very accurate – their market share, their rank, the market size and evolution, and the 5 main competitors for this selection.

From January to March 2017, Eurovent Market Intelligence is launching its 24th annual data collections

- Adiabatic coolers
- Air curtains
- Air filters
- Air handling units
- Chilled beams
- Chillers and heat pumps
- Cooling towers
- Fan coil units
- Heat exchangers
- Heat recovery systems
- IT cooling
- Pool dehumidifiers
- Residential air handling units
- Rooftop units

This year, EMI gives priority to the "freshness" of the information and will release all the results during the month of March. As usual, EMI will be attending Acrex in India (Stand C-11) and ISH in Germany (HALL 11.1 – stand B06). ■

For additional information or to receive these reports:
https://www.eurovent-marketintelligence.eu & statistics@eurovent-marketintelligence.eu

Hygienic Air Handling Units – an option for cleaner air

Eurovent Certita Certification has recently announced launching a three-level hygienic certification option for the Eurovent Certified Performance programme under the existing air-handling units' programme, with an avowed objective of improving air quality. The aim of this option is to guarantee a hygienic aspect of an Air Handling Unit (**AHU**) by checking the quality of the material used, the components selected as well as the level of maintenance of the casing and the components.

QUENTIN LIEBENS
Project Development Manager
Eurovent Certita Certification

Context and origin of the hygienic option

The air quality within a building, whether it is a commercial building, a school, an office or a hospital, is a key element in nowadays building's design. Air handling units are at the beginning of the air movement within a building, it is therefore essential to ensure a good air quality from this point. Hygienic air is already vital for few types of buildings such as hospitals, food processes, pharmaceutical environments and white rooms. The concept of hygienic air can be extended to more applications, such as an office, a commercial building or a school.

Though several environmental labels advocate a good air quality for commercial buildings and work towards achieving it is unusual to see requirements on the air handling units for this kind of label. This is rather a shame when we know that an AHU is the first step in the process of the air treatment in a building. This lacuna is mostly due to the current image of "hygienic" for an AHU which is for the most of us typically reserved to the hospitals and pharmaceutical area. This is a direct consequence of the existing hygienic standards which don't fit for commercial buildings because there were written for hospitals. However, some manufacturers will tell that several Air handling units manufactured for commercial buildings answered to hygienic criteria but are not recognised as such, mostly because there are no needs for it.

General presentation of the new AHU Hygienic option

It's within this context that Eurovent Certita Certification decided to launch the hygienic option for its existing AHU programme. The aim of this option is to certify the hygienic aspect of an AHU and to ensure a good air quality for a large range of buildings.

The AHU hygienic option has been developed with the help of a Compliance Committee made of AHU manufacturers, all already participant of the Eurovent Certification AHU programme and from different nationalities. The proposed programme has been checked and validated by a group of expert called the Certification Programmes and Policy Commission which consists of four colleges: end user representatives, manufacturers, technical and scientific experts and finally national authorities.

This certification programme proposes a hygienic rating, from level 1 to level 3 (represented by a number of stars), the higher the rating, the more hygienic the AHU unit. The goal of this certification programme is to declare an AHU suitable for different applications, easy to identify thanks to an easy classification (**Figure 1**).

This certification programme provides a simple but reliable guidance to end users willing to get the benefits of a good air quality whether it is for an office, a school, a commercial building or a hospital.

★ star for Offices, commercial buildings, schools, hotels:

★★ stars for Hospitals:

★★★ stars for Pharmaceutical, food processes, white rooms:

Figure 1. Our easy classification for identifying AHU suitable for different applications.

The hygienic option includes 60 requirements

This new hygienic option consists of several requirements related to manufacturing, shipment, materials, maintenance, casing performance, components arrangement and performances.

Manufacturing properly an AHU is vital to ensure a good quality of the product at the very beginning of

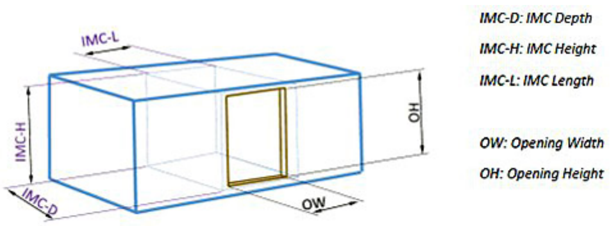
General	Unit Housing	Air treatment
• Planning • Manufacturing • Shipment	• Metallic materials • Non-metallic materials • General AHU arrangement • Inner casing surface • Inspection, maintenance and cleaning • Filter maintenance	• Filter • Cooling and heating coil • Humidifier • Dehumidifier • Heat recovery system • Fans • Silencer

the process. Checking the quality of the product after manufacturing to guarantee smooth and clean surfaces in order to allow an easy maintenance, an easy cleaning of the casing and a harmless surface is necessary.

Shipment can be a source of damaging for the product, a good protection must be ensured when stored and shipped from the factory to the building site. Installation and Operational Manual (IOM) of the products and quality management systems of the manufacturers must be written to ensure a good protection of the AHU after manufacturing.

Materials used is one of the key element for a hygienic air handling unit. It must prevent any microorganisms, resist to corrosion, being stainless in case of metallic materials and be sustainable to ensure a long lifespan to the AHU. Standards are already in place for such application, the aim of the hygienic programme is to ensure the quality of the materials selected and used by the manufacturer and their compliance with these standards.

Ensuring an easy maintenance is essential to guaranty the durability of the AHU. It is therefore important to ensure an easy access to the components in order to clean and to change them quickly and easily. The accessibility of all components within an AHU as well as the maintenance and cleaning of the casing and the components must be ensured.



<table>
<tr><td colspan="2">AHU section size (+/- 1%)</td><td colspan="2">All levels</td><td>Level 1</td><td>Level 2</td><td>Level 3</td></tr>
<tr><td>Internal unit Depth (= IMC-D) per air steam</td><td>Internal unit Height (=IMC-H) per air stream</td><td colspan="2">Designed type of IMC (after entering the unit, all relevant inner surfaces shall be reached with the hand)</td><td colspan="3">Minimum IMC Length IMC-L (for quickly removable components: including free space when component is removed)</td></tr>
<tr><td><800 mm</td><td>>300 mm and <1900 mm</td><td rowspan="2">Standing outside and entering the unit with the arm or with the arm plus the shoulder</td><td rowspan="2"></td><td>250 mm</td><td>400 mm</td><td>550 mm</td></tr>
<tr><td>≤1000 mm</td><td>>400 mm and <1900 mm</td><td>400 mm</td><td>400 mm</td><td>550 mm</td></tr>
</table>

The Eurovent Certified Performance (ECP) AHU programme tests and certifies the casing performance of an AHU. The hygienic option includes minimum criteria to achieve in order to comply with hygienic standards.

It is well known that to ensure a good quality of the AHU it is important to ensure a good performance and quality of the components. The hygienic option proposes a list of requirements to check the quality of the components selected end then ensure the hygienic aspect of the AHU. It includes requirements on the filters, heating and cooling coils, heat recovery systems, fans, humidifiers, dehumidifiers and silencers. The aim of those requirements is to guarantee the hygienic aspect of the components, set up minimum performances and minimum criteria.


	Offices, Schools, Hotels, Retail ...	Hospitals	Pharmaceutical, Food processes, White rooms
	Level 1 - Star	Level 2 - Stars	Level 3 - Stars
Corrosivity class for metallic materials	At least C3		At least C4
Thermal Bridging class	At least TB3		At least TB2
Casing Air leakage Class	At least L2 (M) & L2(R)		At least L1 (M) & L1(R)
Casing Strength class	At least D2		At least D1
Water Drainage from pans, condense trays and water tanks	95%		
Filters class (supply side)	F7		F9
Number of filter on supply side	1	2	
Fin thickness	0.10 mm	0.12 mm	
Minimum distance between fins (cooler)	2.5 mm		3.0 mm
Minimum distance between fins (heating)	2.0 mm		2.5 mm

Specifications are subject to change without notice.

In this hygienic option, it is proposed to have different requirements from a level to another (level 1 to level 3), meaning that for the same criterion the requirement to achieve might differ. Some criteria are common to every level (e.g. the criteria for level 3 is the same than the level 1 and 2), but for some technical aspects different thresholds to achieve or characteristics to meet are defined. This is to maintain the rule of the higher the rating, the more hygienic the AHU unit. **Table** above summarises some criteria which are different from a level to another (non-exhaustive list).

Certification process to get the option

In terms of qualification this hygienic option consists of a desk study and an audit which come along with the AHU audit (existing AHU programme).

The desk study is a review of technical document such as technical specifications, IOM (Installation and Operational Manual), drawings, quality management system, etc. but also of the selection software. Indeed, the selection software is an important part of the AHU design and the requirements shall be met at the earliest stage. A checking of the software is therefore crucial to avoid a design which wouldn't meet hygienic criteria.

The audit, on the other hand, will allow a visual check of the hygienic units. In order to ensure a good quality of the product it's important to not base the certification only on a review of technical documents, a combination of the two (audit and documents review) is necessary. Through a visual check the auditor can verify the relevance of a product in terms of maintainability and clean ability, key criteria in today's demand.

In terms of repetition procedure, the verification is spread over a three-year period. It means that all the requirements listed in the rating standard of the hygienic option will be rechecked over three years, with a frequency of one audit per year.

Tests in laboratory are made under the existing AHU certification programme, the hygienic doesn't require any specific tests. ■

For more information related to the Eurovent hygienic option of the AHU programme: we invite you to contact Eurovent Certita Certification by sending an email to apply@eurovent-certification.com.

Certified performances for air cleaners

Air cleaning devices: a growing market polluted by confusing communication

According to an industry study published in March 2016 by the Freedonia Group[1], global demand for consumer air treatment systems is projected to increase to over $10 billion in 2019.

Indeed, the growing public awareness about indoor air pollution coming from furniture, construction materials and sometimes poor quality ventilation has conducted the consumers to care more and more about the effect that these pollutants can have on their health. In some countries, such as Japan, where air cleaning systems are used to capture tobacco smoke when smoking indoor, the air cleaning devices have even become part of "standard" domestic appliances. Besides, the rising diagnosis of asthma and allergic rhinitis, as well as peak pollution incidents in urban areas are contributing to increase the air cleaning devices market demand. This phenomenon has become worldwide and air cleaning devices are appearing everywhere on the market.

In this growing market the manufacturers are all claiming that their product is "efficient against all air pollutants" and will "ensure a purified air in the house where children will be safer and parents happier". Still, few manufacturers quantify their product performance and when they provide figures these are difficult to compare (different units, no information about operating conditions…). The consumer is therefore forced to base his choice on marketing criteria without any clear commitment from the manufacturer.

A need for a harmonized evaluation method

To enable and encourage manufacturers to communicate about quantified performances on a levelled ground, the first step is to provide them a standard to refer to. Indeed, there is no international product standard available for air cleaners except for electrical

MARIE-CLÉMENCE DEGALLAIX
Project Development Engineer
Eurovent Certita Certification

safety aspects[2]. Several testing methods are coexisting (ANSI/AHAM AC-1:2006[3], JEM 1467:2013[4], GB/T 18801:2015[5]…) and used by some manufacturers to evaluate their products. However, these methods are not recognized on a global scale and the valorisation is limited to the local market.

Among these testing standards exist the NF-B44-200:2016[6] and prNF EN 16846-1:2015[7], respectively derived from experimental testing standards XP-B44-200:2011[8] and XP-B44-013:2009[9]. These are candidates as testing standards on the international stage. The specificity of NF-B44-200:2016 is

1 World Consumer Air Treatment Systems, Industry study 3370, The Freedonia Group Inc., March 2016.

2 IEC 60335-2-65:2002 Household and similar electrical appliances – Safety – Part 2-65: Particular requirements for air-cleaning appliances, International Electrotechnical Commission, 2002.

3 ANSI/AHAM AC-1:2006 Method for measuring performance of portable household electric room air cleaners, Association of Home Appliance Manufacturers, 2006.

4 JEM 1467:2013 Air Cleaners of Household and Similar Use, Japan Electrical Manufacturers' Association, 2013.

5 GB/T 18801:2015 Air Cleaner, Standardization Administration of the People's Republic of China, 2015.

6 NF-B44-200:2016 Independent air purification devices for tertiary sector and residential applications - Test methods - Intrinsic performances, AFNOR, 2016.

7 prNF EN 16846-1:2015: Photocatalysis - Batch mode test methods - Part 1: measurement of efficiency of photocatalytic devices used for the elimination of VOC and odour in indoor air in active mode, AFNOR, 2015.

8 XP-B44-200:2011 (OBSOLETE) Independent air purification devices for tertiary sector and residential applications-Test methods - Intrinsic performances, AFNOR, 2011.

9 XP-B44-013:2009 Photocatalysis -Test and analysis method for determining the efficiency of photocatalytic systems for eliminating volatile organic compounds/odours in recirculating interior air -Confined chamber test, AFNOR, 2009.

the consideration of 11 indoor air pollutants[10] divided into 4 categories (Particulate Matters, Volatile Organic Compounds, Micro-organisms and Allergens). Besides, the NF-B44-200:2016 comprises a measurement of reaction intermediates (ozone, carbon monoxide, nitrogen monoxide, nitrogen dioxide) to verify that no dangerous products are emitted by the device.

The NF-Air Cleaners mark

Eurovent Certita Certification has developed a new NF mark certification for Air Cleaners under a mandate from AFNOR Certification. A dedicated working group gathered four times between May and November 2015 to establish the certification requirements and the draft document was approved by AFNOR Certification in January 2016. The NF-Air Cleaners certification scheme[11] entered into force on 2016, March 1st.

This NF mark aims at certifying models of air cleaning devices (i.e. device basically built of a fan and a set of components possessing the ability to capture and/or partially or totally destroy air pollutants[6]) for residential (domestic) and tertiary (stores, offices, classrooms, waiting rooms…) sector applications. This definition covers all types of technology: mechanical filtration, electrostatic filtration, plasma, ionization, UV-A or UV-C lamp, etc.

The Air Cleaners certification scheme enables to verify the accuracy of the performance ratings claimed by manufacturers in terms of effectiveness with respect to several pollutants[10], but also regarding the power consumption and the sound power level of the device.

This verification is performed through product performance testing conducted by independent laboratories selected by Eurovent Certita Certification. As the testing standard NF-B44-200:2016 was chosen as product performance testing method reference, the test enables to verify not only the ratings but also that no dangerous products are emitted. Testing standard XP-B44-013:2009[9] may be used as a supplement in some particular cases identified in the reference document[11].

The purification efficiency is tested at maximum operating speed for one or several pollutants category. It is understood that a manufacturer has to declare ratings for all the pollutants that belong to the category. For example, if the manufacturer wants to claim that his product can remove formaldehyde from the air then he must declare ratings for the 4 remaining gases too[10] and the air cleaner is tested for the whole gas mixture as foreseen in the testing standard[6]. Eurovent Certita Certification will proceed to careful examination of technical and sales documentation (paper and/or website content) to verify the consistency between the declaration and the communications to the public.

The air volume flow rate, the sound power level and the electrical power consumption are tested at the maximum operating speed but also at minimum and intermediate speeds whenever applicable[11]. This enables the end-user to verify the device sound power level at low speed operation ("night mode" for example).

The testing requirements do not stop there. To pass the test, there shall be no generation of reaction/emission by-products and the sound power level at maximum speed shall not exceed 60 dB[A] (when maximum purified air flow rate ≤ 250 m^3/h; 65 dB[A] otherwise[11]).

In addition to product performance testing, the certification scheme comprises factory audits to check that the quality management system in place ensures the manufacturing process reliability and consistency. This guarantees that the tested products, sampled from the manufacturing facility or directly from the market, are representative of the whole production.

If the manufacturer has passed the tests and audits and that he complies with the specified requirements in terms of clarity and transparency of published ratings, then he is granted the right to use the NF-Air Cleaners labelling on the certified air cleaner model(s) and the documentation for a given period mentioned on the certification diploma. Once an air cleaner model is certified, a surveillance procedure is initiated, comprising annual product performance testing and annual factory audits to verify that the requirements continue to be fulfilled throughout the years. This surveillance procedure is mandatory to renew the authorization to use the NF-Air Cleaners labelling.

BY EUROVENT CERTITA CERTIFICATION

NF

AIR CLEANERS

www.marque-nf.com

NF-Air Cleaners certification mark labelling

10 Particulate matter (PM) in the 0.3 µm to 0.5 µm size range, PM in the 1.0 µm to 2.0 µm size range, PM in the 3.0 µm to 5.0 µm size range, Acetone, Acetaldehyde, Heptane, Toluene, Formaldehyde, Staphylococcus epidermidis (bacteria), Aspergillus Niger (fungi) and Fel D1 (cat allergen).

11 NF-536 Certification rules for NF-Air Cleaners, Eurovent Certita Certification, 2016.

No room for ambiguity in the NF-Air Cleaners mark

The NF-Air Cleaners mark aims at guaranteeing clarity, transparency and comparability of the information related to the product use. Thus, to avoid any ambiguity in relation to the room size where the device use can be recommended, the NF-Air Cleaners reference document[11] establishes a consistency principle between the purified air volume flow rate delivered by the device and the surface area of the room through a minimum ratio criteria. For further details about this consistency principle please refer to the reference document[11] which is available on-line[12].

For example, when a manufacturer claims that the air cleaner can be used to remove VOCs in a room of 50 m^2, the related purified air volume flow rate measured by the laboratory shall be higher than or equal to 250 m^3/h. If this is not the case, the manufacturer shall no longer communicate about 50 m^2 and update his documentation with the surface area that corresponds to the measured purified air volume flow rate and complies with the minimum ratio defined in the NF-Air Cleaners reference document[11].

Another measure to eliminate any risk of misunderstanding consists in specifying clearly in which measure units the manufacturer has to communicate data. For instance sound pressure levels shall be replaced by sound power levels and the values shall be displayed in dB[A]. Besides whenever the manufacturer displays a performance value the corresponding operation speed must appear.

Foreseen evolutions of the NF-Air Cleaners mark

In the near future, the NF-Air Cleaners mark will most certainly evolve to cover industrial applications and duct mounted installations. A dedicated committee gathering manufacturers, laboratories as well as consumers' associations is in charge of these future developments which will be managed by Eurovent Certita Certification.

As a matter of fact, the first update of the reference document is being reviewed by the NF-Air Cleaners mark committee. This revision aims notably at implementing the minor changes in the testing standard. Indeed, the NF-B44-200:2016[6], which replaces the XP-B44-200:2011[8] standard referred to in the original NF-Air Cleaners document[11], changes the composition of the tested mixture of gaseous pollutants with the introduction of formaldehyde and the decrease of the gases concentration towards more realistic values. The proposal of revision also provides some clarifications regarding product sampling rules and tests to be conducted in the surveillance procedure.

The revision of the reference document is expected to be published in February 2017.

A European certification scheme

As for the Euro-HP certification scheme, which enables participants to the NF-Heat pumps mark to be eligible to the Eurovent Certified Performance (ECP) mark (see dedicated article in REHVA Journal of March 2016[13]), it is foreseen to offer a European-Air Cleaners (Euro-ACL) mark for companies participating to the NF-Air Cleaners scheme.

This ECP certification will rely upon the completion of the NF-Air Cleaners process and the verification that the general requirements of the ECP mark, as detailed in related Certification Manual[14], are fulfilled.

The manufacturer will therefore be able to benefit from the ECP mark notoriety while capitalizing on existing efforts.

The draft documents will be submitted for approval to the Certification Programmes and Policy Commission, independent body in charge of guaranteeing the consistency between ECP programmes. The Euro-ACL mark is expected to enter into force in March 2017.

How to get further information?

Anyone willing to get further information about the NF-Air Cleaners certification can visit the dedicated webpage where the applicable reference document is available in English[12].

For specific questions or to apply for the certification scheme please contact apply@eurovent-certification.com specifying "NF-Air Cleaners" in the e-mail object. There is no deadline as this is a voluntary registration. ■

12 http://www.certita.fr/en/certita-mark/nf-air-cleaners.

13 New challenges for heat pump Certification, Eurovent Certita Certification, REHVA Journal Volume 53 p.31-35, March 2016.

14 Certification Manual of the Eurovent Certified Performance Mark 13th edition, Eurovent Certita Certification, November 2016.

Cooling Tower Certification Programme – "Peace of Mind, Reliability, Performance and good investment"

IAN BUTLER
Msc, Project manager
Eurovent Certita Certification
&
TOMMASO FONTANA
Subgroup marketing strategy team
Cooling Tower Compliance Committee

Evaporative cooling is the most efficient way to remove the excess heat from modern air conditioning systems and industrial processes and, as such, most suited to address the increasing of ambient temperatures due to the warming up of the atmosphere as well as the restrictions in energy usage and efficiency constraints.

The demand for energy efficient buildings and more stringent environmental sustainability requirements in the process industry have increased in recent years. As a consequence, the comfort and industrial cooling industry needed to be extremely dynamic in replying to the changing market demand. More specifically, cooling tower manufacturers have been challenged to select and size their products in a more accurate and reliable way and to develop new technologies and solutions, with the aim of saving electricity and, more recently, also water.

In order to better understand the extent of this change, it is useful to consider how it was in the past. The data provided to the end-users, designers or contractors to select evaporative heat rejection and cooling equipment (inlet/outlet/wet bulb temperatures and waterflow) were most of the time overestimated, as the exact total heat load to be removed from the system was approximate. Moreover, the cooling equipment, after having been sized on the basis of the yearly highest ambient temperatures (in Europe, only a few days in July), were operated well below full capacity throughout the year. The first consequence of this approach was obviously a significant oversizing of the evaporative cooling equipment. The second consideration was the unawareness of how the equipment actually performed at specified climate conditions, again providing good reason for conservative oversizing and in some cases risk taking by undersizing the cooling tower.

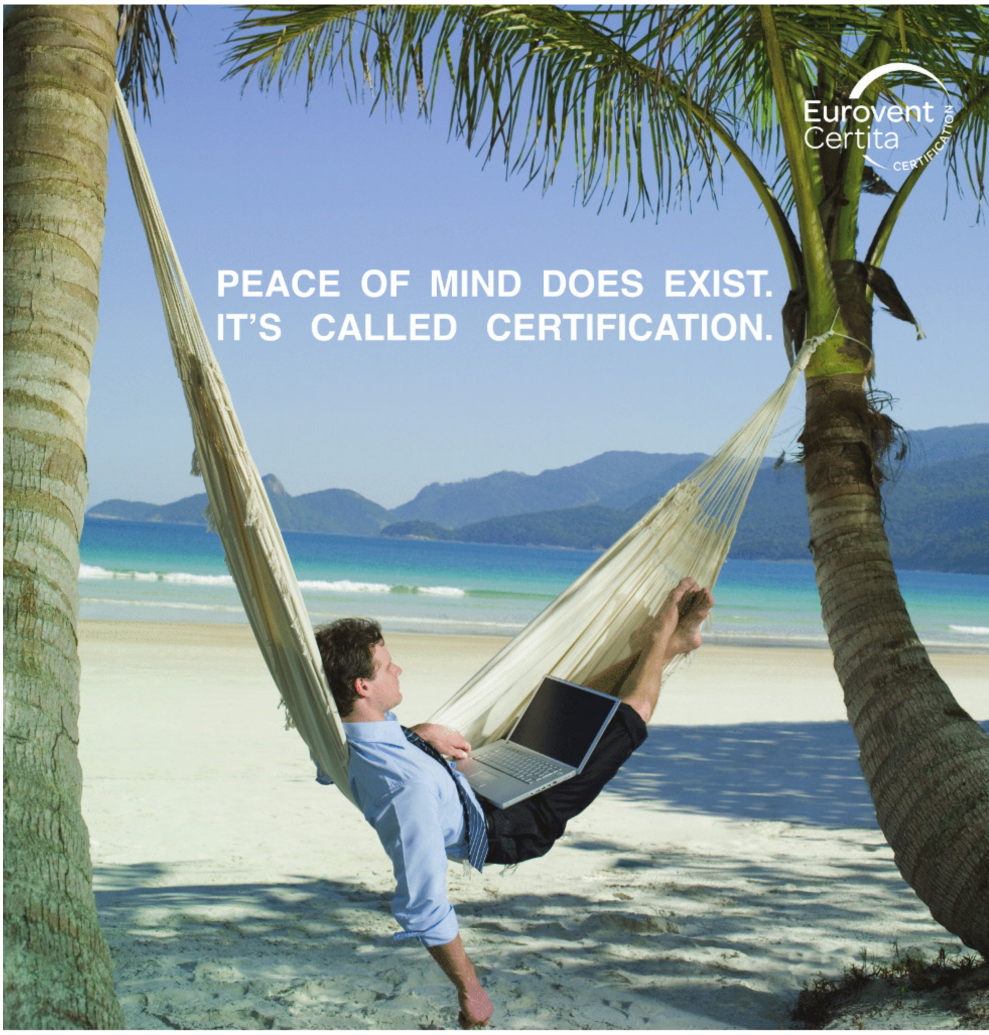
Nowadays the scenario is very different, with regulations setting minimum energy efficiency requirements and even more challenging future thresholds. End-users are much more aware of the possibilities offered by the modern technologies in terms of energy and water savings (high efficiency motors and fans, inverters, software to manage the cooling systems, etc.). The designers are much more skilled in the correct sizing of the plants and its optimization on the basis of the temperatures conditions variation and the partial loads. The contractor more often has to guarantee the energy efficiency performance of the plant and they must manage them for several years at their own risk (not only as far as the maintenance is concerned, but also with regards to the operation costs).

In this environment, the manufacturers are expected to be reliable in terms of sizing and performance of their products, updated in terms of applied technologies, and transparent in terms of technical information to be provided.

With these premises, the introduction of the Eurovent Certita Certification (ECC) Cooling Tower voluntary product certification programme can clearly play an important role within the evaporative cooling sector, increasing its reliability and confirming its image as the most efficient and economical technology for heat removal.

A product certification programme can bring important advantages, both to the users and the manufacturers:

- It represents a valid support for a customer in the choice of a product
- It creates a "standard" benchmark to which the operators can refer for a fair comparison of different products (also between certified and non-certified ones)
- It assures a correct sizing of the machine and its performance, avoiding excessive system operating costs
- It assures that the product meets the customer's needs
- It increases the customer's confidence
- It eliminates expensive customer paid verification tests
- It brings the manufacturers of non-certified products to follow honest rules
- It increases the competition and drives towards more efficient products
- It reduces the competitive pressure based mainly on the price versus the one based on the quality of the products



Enjoy certified quality in your evaporative cooling system.

The COOLING TOWER certification programme "Eurovent Certified Performance" is new within the Eurovent HVAC&R industry. It responds to the Ecodesign regulations by adopting an energy efficient design to the building systems using Eurovent Rating Standard 9C-001. This certification programme is offered by Eurovent Certita Certification (ECC), a leading Third-Party certification body in Indoor climate – Ventilation & Air quality – Process cooling & Food cold chain.

The COOLING TOWER certification programme ensures regular performance sample testing of cooling tower models of the product lines submitted for certification by a manufacturer. An independent third party expert appointed by ECC will survey the performance claims of a participant and challenge any discovered inconsistency. In addition, a factory audit to each facility building the certified product shall be conducted by an appointed ECC auditor to validate the declaration of build, this value-added activity provides additional assurances and trust that the manufacturer is actually providing what it said it would.

In addition, the programme provides the opportunity of self-control by the participants who have the opportunity of optimizing their products with preliminary private tests. ECC, in case of failures by participants, furthermore assures the programme integrity with a strict handling of the non-conformity.

The cooling tower customer can feel comfortable about the performance of the certified tower model prior to his purchase decision and long before the tower is delivered and installed. Expensive field testing is no longer required.

The Eurovent Certita Certification COOLING TOWER certification programme will be a major driving force towards better products with higher efficiency to meet the requirements of tomorrow's environment. ■

Definition of filtration performance – from EN 779 to ISO 16890

SYLVAIN COURTEY
Head of Ventilation Department
Eurovent Certita Certification

A new ISO standard is about to replace the current EN 779 standard used to characterize the filtration efficiency of filters now classified from G1 to F9. This new standard incorporates a different approach from the current standard in terms of classification methodology and will therefore have a significant impact on the market. It is proposed here to present the main changes, to detail the future benefits provided by this standard and to consider the impact on the certification of the filters.

New ISO 16890 - A new way to classify filters

Over the past five years, a new approach has been developed within the ISO standardization working groups to characterize filter filtration efficiency. This new approach is to look at filtration efficiency not only for particles with a diameter of 0.4 µm but to consider the entire spectrum of particle sizes.

The EN779:2012 standard used today in Europe to characterize the filtration efficiency of the filters for the ventilation of buildings defines the filtration classes according to the average filtration efficiency of the particles with a diameter of 0.4 µm (see **Table 1** below).

Table 1. Filter classification according to EN 779:2012.

Group	Class	Average efficiency (Em) at 0,4 µm	Minimum efficiency at 0,4 µm
Medium	M5	40≤ E_m<60	–
	M6	60≤ Em<80	–
Fine	F7	80≤ Em<90	35
	F8	90≤ Em<95	55
	F9	95≤ Em	70

The convention of using only the filtration efficiency of particles with a diameter of 0.4 µm is due to the fact that particles of this size are the most difficult to filter. Indeed, for particles with a smaller diameter, the phenomenon of diffusion predominates, whereas for particles with a larger diameter, the phenomenon of interception is predominant (see **Figure 1** below).

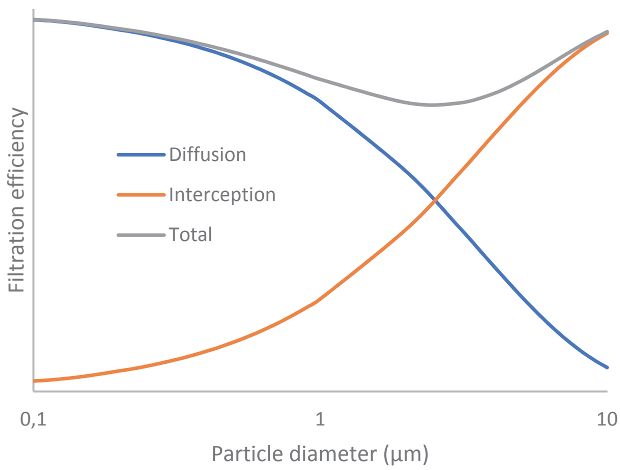


Figure 1. Particle filtration efficiency according to size.

For most media filtering the minimum efficiency is around 0.4 µm.

The current system therefore makes it possible to compare filters between them, but it is not easy to evaluate the effectiveness of a filter with regards to its impact on air quality.

From this observation, it has been suggested to characterize the filters in relation to indicators that have been used for several years in the field of air quality: particulate matter (PM): PM_{10}, $PM_{2.5}$ and PM_1 which respectively define the air concentrations in liquid or solid particles whose diameter is below 10, 2.5 and 1 µm.

These indicators are used in many health and toxicological studies. They make it possible to classify the particles according to their dangerousness:

- Particles with a diameter greater than 10 µm are retained by the upper airway and are not breathed.
- Particles with a diameter of less than 10 µm (PM_{10}) can penetrate the bronchi.
- Particles with a diameter below 2.5 µm ($PM_{2.5}$) can penetrate the pulmonary alveoli.
- Particles with a diameter below 1 µm (PM_1) can penetrate the alveolo-capillary barrier.

The new standard therefore classifies filters relative to their filtration efficiency for these different particle sizes according to **Table 2** below.

With respect to PM_1 the efficiency of a filter classified as ePM_1[80%] will be above 80% and below 85%.

a. Other changes from EN 779:2012.

Table 2. Filter classification according to ISO/DIS 16890-1.

Group	Initial efficiency in PM_x	Discharged efficiency PM_x
ePM_{10}	≥ 50% (PM_{10})	≥ 50% (PM_{10})
$ePM_{2.5}$	≥ 50% ($PM_{2.5}$)	≥ 50% ($PM_{2.5}$)
ePM_1	≥ 50% (PM_1)	≥ 50% (PM_1)

The new ISO 16890 standard will be divided into four parts covering all the chapters currently covered by EN 779:2012 according to **Table 3** below.

Table 3. Filter classification according to ISO/DIS 16890-1.

Object	ISO/DIS 16890	EN 779:2012
Technical specifications, requirements and classification	Part 1	Chapters 5 - 6
Efficiency measurements	Part 2	Chapters 7, 8 and 9
Definition of the gravimetric efficiency	Part 3	Chapter 10.4
Packaging method to determine the minimum spectral efficiency of the test	Part 4	Chapter 11

Beyond the new approach of classification of the filters certain evolutions are to be noted:

- requirements have been introduced with respect to the test conditions in terms of temperature and relative humidity.
- the conditioning method for determining the minimum efficiency makes it possible to test a complete filter and not only the filter media as with the EN 779:2012.
- "Fine AC" dust is used to determine gravimetric efficiency as a replacement for standardized dust such as "ASHRAE".

Publication schedule

The four parts of ISO 16890 are currently undergoing the validation process of ISO standards and are likely to be published by the end of 2016. It will also take several months for this standard to be adopted by the CEN and will replace the Standard EN 779:2012 (in 2017).

1. Benefits for the end user

a. Towards a universal method?

The adoption of this new Standard may perhaps make it possible to harmonize worldwide the method of characterizing the efficiency of filters. Today two systems predominate:

- In Europe, the method EN 779:2012 is the only one
- In North America, the ASHRAE 52.2 method is used exclusively
- In Asia the European and American systems coexist.

In the future, the new ISO Standard is intended to be the universally used method. However, there is no indication that this will be the case, a Standard being of a voluntary nature. However, we can say that this Standard will be the future reference in Europe as it has already been decided that it will replace the current EN779:2012 Standard (which will eventually be removed from the CEN Standards catalog). Similarly, in Asia there is a good chance that they will become the benchmark except in the markets where US players are predominant.

However, in North America doubts remain about the possible use of the future ISO standard. Indeed, the ASHRAE methods have been established for a long time and the United States has shown some reluctance throughout the validation process of this ISO standard.

A clearer link between filter efficiency and indoor air quality

As indicated earlier, concentrations of PM_{10} and to a lesser extent $PM_{2.5}$ and PM_1 are now widely used for assessing air quality. The European "Airbase" project gathers data from more than 8 000 continuous PM_{10} measurement stations in Europe (see **Figure 2** below). WHO defines guidelines for maximum levels of concentrations not to be exceeded for PM_{10} and $PM_{2.5}$.

The use of efficiency referring to these indicators will enable end-users to more easily assess their needs based on outdoor air quality and their objectives in terms of indoor air quality.

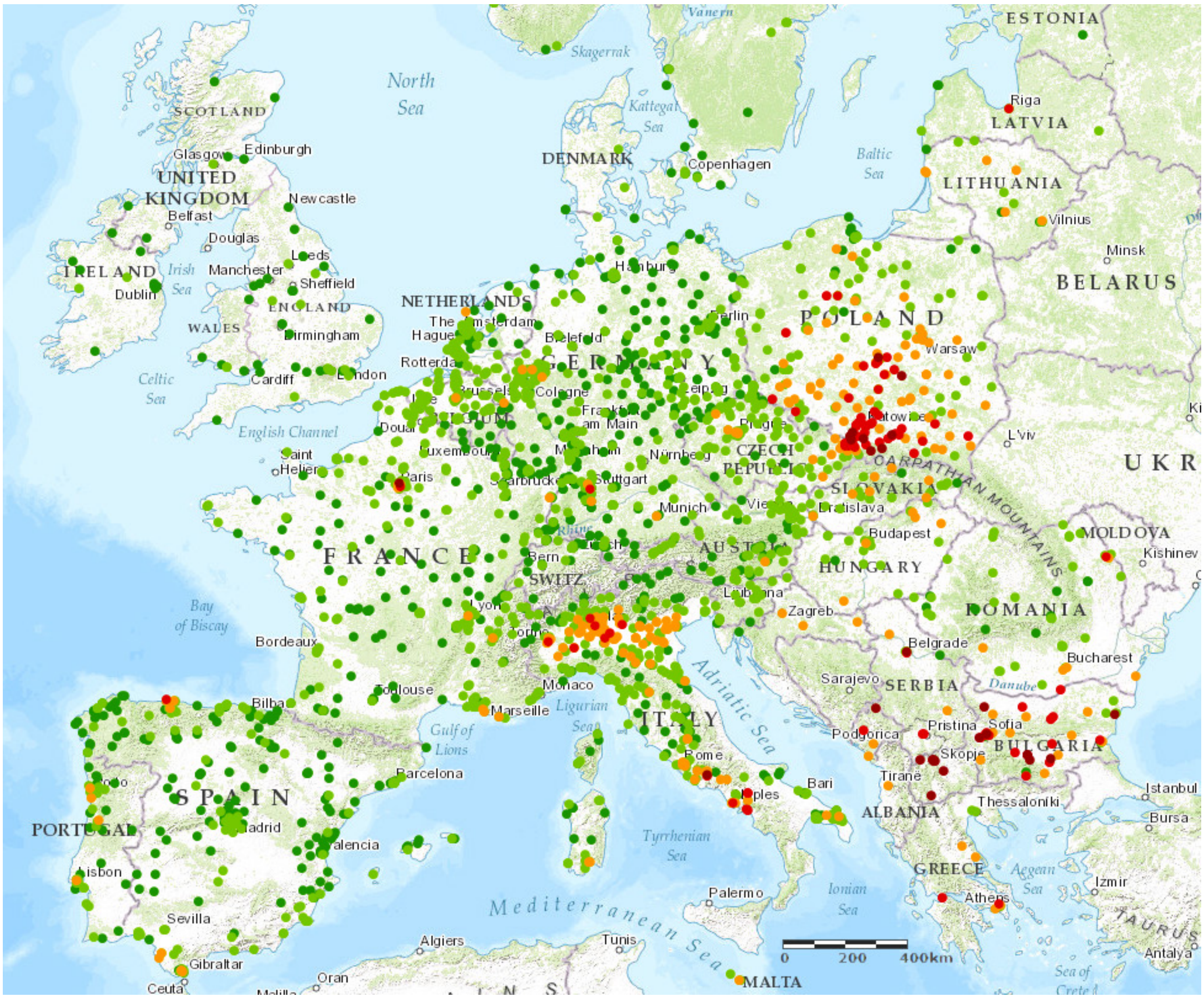


Figure 2. Location of continuous PM_{10} measurements in Europe (Source: Airbase).

2. What impact on the certification of filters for ventilation?

a. The Eurovent certification for filters:

i. The certification programme « Eurovent Certified Performance » for Air Filters M5 – F9 was launched in 2006. This certification is based on tests carried out by independent ISO 17025 laboratories, according to EN 779:2012 (which replaced EN 779:2002). This programme covers the certification of all relevant performances of filters used for general ventilation, namely:

- The filtration class
- The initial pressure drop
- The initial efficiency
- The minimum efficiency

These performances related to the Standard EN 779:2012 add up to the performances related to the energy efficiency as defined in the Standard Eurovent 4/21.

- Annual energy consumption
- Energy efficiency class

All certified data are available on www.eurovent-certification.com.

ii. In 2016 this certification programme covers 25 manufacturers representing 25 brands and more than 2300 references. According to the latest figures from Eurovent Market Intelligence, this programme covers 87% of the French market and 75% of the European market.

Evolution and next steps

The first four parts of the new ISO 16890 standard cover all the chapters covered today by the European standard EN 779. Thus it does not define a method for calculating the average annual energy consumption as defined in document Eurovent 4 / 21. A revision of the latter must therefore be carried out in order to integrate the new provisions of ISO 16890. A Eurovent working group dedicated to this project was recently set up, and met for the first time in December 2015. A first revision project is planned for February 2016.

The Eurovent certification of filters will then be able to evolve towards the new standard once it has replaced the standard EN 779.

Conclusion

The new ISO 16890 Standard will have a significant impact on all the actors of filtration. In the first place manufacturers will have to characterize all their products according to this new method. Knowing that standardized dust will also change this implies a significant effort on their part, the old standardized dust being used for decades.

Secondly, buyers will have to completely revise their current requirements based on the well-known filtration classes M5, M6, F7, F8 and F9. It is expected that a transition period will be required (with dual labeling of products) before the new efficiency classes are integrated by buyers. A major effort will have to be made by all the players (notably the manufacturers) to communicate effectively on these changes. The fact that the vast majority of products available on the market are certified will facilitate this transition by providing clear and controlled information. ■

References

ISO/DIS 16890-1, Air filters for general ventilation – Part 1: Technical specifications, requirements and classification system based upon particular matter efficiency (ePM).

ISO/DIS 16890-2, Air filters for general ventilation – Part 2: Measurement of fractional efficiency and air flow resistance.

ISO/DIS 16890-3, Air filters for general ventilation – Part 3: Determination of the gravimetric efficiency and the air flow resistance versus the mass of test dust captured.

ISO/DIS 16890-4, Air filters for general ventilation – Part 4: Conditioning method to determine the minimum fractional test efficiency.

EN 779:2012, Particulate air filters for general ventilation – Determination of the filtration performance.

Eurovent 4/21 – 2014: Calculation method for the energy use related to air filters in general ventilation systems.

ANSI/ASHRAE 52.2 – 2007, Method of testing general ventilation air-cleaning devices for removal efficiency by particle sizeProjet.

Airbase – The European Air Quality Database, http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-8.

OMS guidelines for air quality: particulate matter, ozone, nitrogen dioxide and sulfur dioxide, Global update 2005. http://www.euro.who.int/__data/assets/pdf_file/0005/78638/E90038.pdf.

ASHRAE Announces Delhi, India as site for 2017 Developing Economies Conference

ATLANTA – ASHRAE has announced that its second Developing Economies Conference will take place Nov. 10–11, 2017, in Delhi, India.

The conference addresses the challenges developing countries face in infrastructure and urbanization as well as air pollution, refrigerant phasedown and lack of trained manpower.

"Developing economy countries are in many ways leapfrogging technologies while simultaneously handicapped due to inadequate education and regulations," Ashish Rakheja, conference chair, said. "At the same time, there is increasingly more new construction and demand on energy sources and a corresponding demand for excellent technical information to cope with these demands."

The conference theme is titled "Trends, Opportunities and Challenges for the Built Environment in Developing Economies."

The conference is focused on trends that are affecting the built environment in developing economies and the opportunities and challenges presented by these trends.

"This conference seeks to provide consulting engineers, building professionals and policymakers with guidance that will help them successfully meet the challenges in their countries," he said.

The conference attempts to bring together experts from all over the world. A call for conference presenters is now open. Presentations are sought on the following topics:

- Technologies that are game changers in building design
- Solutions to challenges, such as outdoor and indoor pollution, refrigerant phasedown, lack of trained manpower and expensive technologies
- Standards, measurement and rating standards being developed and adopted to bring a common language for built environment evaluation, such as ASHRAE's Building EQ, local standards, etc.
- Regulatory changes and direction affecting the building industry, such as energy codes
- Evolving economic models and their impact on building planning and use.

The presentations and sessions cover aspects of energy efficiency, comfort, indoor air quality, wellness and environmental impact of buildings in developing economy countries as affected by the air-conditioning, heating and ventilating systems for the buildings. Abstracts (400 or less words in length) are due July 7, 2017. For more information or to submit a presentation proposal, visit www.ashrae.org/Developing2017.

The conference is co-organized by ASHRAE, the ASHRAE India Chapter and ISHRAE.

iStockphoto.com

REHVA Annual Meeting 2017

REHVA is pleased to invite its Members and Supporters to the 2017 REHVA Annual Meeting hosted by CISBE in London, United Kingdom. The 2017 Annual Meeting is held on Sunday April 2nd to Tuesday April 4th, 2017 with some major changes in the agenda compared to previous years. The REHVA Board would like to present and discuss a new strategy of cooperation with Member and Supporters, so the schedule of this year's Annual Meeting was planned to provide fora for more interactive discussions.

REHVA strategic meetings and General Assembly (2-3 April, CIBSE Headquarters)

The first day (2nd April) will be dedicated to committee meetings, a REHVA Members Plenary meeting and an Advisory meeting between REHVA Board and past REHVA Presidents, closed by the usual welcome cocktail. The 61st REHVA General Assembly will be held after these strategic discussions in the afternoon on the 2nd day (3rd April). In the morning, our sister organizations SCANVAC and BALTVAC will have a meeting. The General Assembly will be followed by the usual REHVA Gala Dinner and Awards Ceremony. The venue of the first 2 days will be the CIBSE Headquarter, 222 Balham High Road, London SW12 9BS.

REHVA Supporters Day with REHVA seminar and the Student Competition (April 4th, University College London)

The 3rd Day will be dedicated to REHVA supporters and features the Supporters Committee discussing about the new REHVA strategy for Supporters, a REHVA Seminar on future HVAC sector challenges and the REHVA Student Competition. The REHVA Seminar will give updates on the EPBD review and upcoming key policy changes and presentations from industry representatives about technology challenges of the near future followed by a moderated interactive discussion between speakers and participants. REHA would like to provide forum to exchange knowledge and experience between their members and supporters, practitioners, engineers, and HVAC manufacturers.

The sessions of the last day are held at the University College London, (UCL), Gower St, Kings Cross, London WC1E 6BT in Central London. The UCL is close to the St. Pancras train station, so participants have easy connections to continue to the CIBSE-ASHRAE Technical Symposium "Delivering Resilient High Performance Buildings" held on April 5th and 6th, 2017 at the Loughborough University.

See below an overview table of the schedule and more information about the 2017 REHVA Annual Meeting.

REHVA looks forward to meeting you in London in April!

Schedule

Sunday 2 April 2017

Venue: CIBSE Headquarter, 222 Balham High Road, London SW12 9BS, UNITED KINGDOM

09.00 – 10.15	Education and Training Committee Meeting	Publishing and Marketing Committee Meeting and REHVA Journal Editorial Board Meeting
10.15 – 10.30	*Coffee break*	
10.30 – 12.00	External Relations Committee Meeting	Publishing and Marketing Committee Meeting and REHVA Journal Editorial Board Meeting
12.00 – 13.00	*Lunch*	
13.00 – 14.00	Technology and Research Committee Meeting	Awards Committee Meeting
14.00 – 15.00		
15.00 – 15.30	*Coffee break*	
15.30 – 17.30	REHVA and Member Associations Plenary Meeting (Presidents, Directors and delegates)	
17.30 – 18.30	Advisory meeting between Board of Directors and Past Presidents	
19.30	*REHVA Welcome Cocktail (location in Balham - TBC)*	

Monday 3 April 2017

Venue: CIBSE Headquarter,222 Balham High Road, London SW12 9BS, UNITED KINGDOM

09.00 – 10.45	REHVA Board Meeting	COP Meeting	SCANVAC/BALTVAC meeting
11.00 – 12.00			
12.00 – 13.00	*Lunch*		
13.00 – 15.30	General Assembly		
15.30 – 16.00	*Coffee break*		
16.00 – 18.00	General Assembly		
19.30	*REHVA Dinner and professional awards (location in Balham - TBC)*		

Tuesday 4 April 2017 - REHVA SUPPORTERS DAY

Venue: University College London (UCL), Gower St, Kings Cross, London WC1E 6BT, UNITED KINGDOM

9.00 – 10.00		REHVA Student Competition
9.30 – 11.30	Supporters Committee Meeting – Strategic Plan	
11.30 – 13.00	*Supporters' Lunch (upon invitation)*	
13.00 – 17.00	REHVA Seminar - HVAC sector challenges ahead us	

BELIMO ZoneTight™

BELIMO

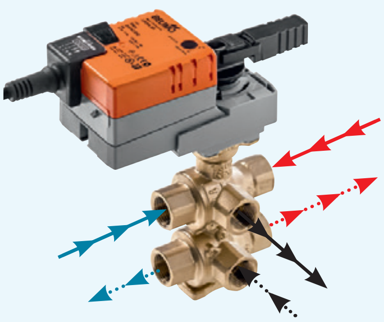
The original: 6-way zone valves from Belimo

From the invention to the "all-in-one" solution

Controlling combined heating/cooling elements in 4-pipe systems has long been an elaborate, bulky and complicated process. But since 2008 there has been an impressive alternative: the 6-way zone valve invented by Belimo. The world market leader has now further developed this revolutionary concept into an electronic, pressure-independent «all-in-one» control unit and therefore taken another further pioneering step towards simplification.

The 6-way zone valve invented by Belimo makes control of combined heating/cooling elements simpler, more cost-effective and safer.

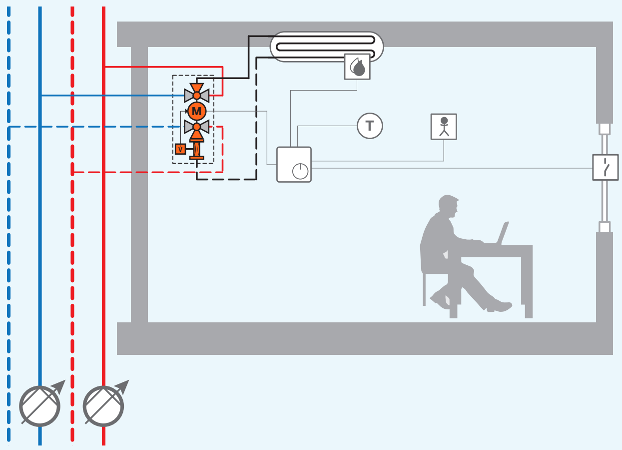
The ingenious functional principle of the 6-way zone valve means that more can be achieved with less these days. Only one valve is required instead of four, one actuator instead of four and one data point instead of four. This reduces planning work and procurement costs, installation requires less space and there is less probability of mistakes during mounting.



The revolutionary functional principle of the 6-way zone valve from Belimo.

The tried and tested 6-way zone valve

The numerous advantages of the pressure-dependent 6-way zone valve have been proven time and time again in practical applications. Customers and installers value this solution because they need less material and mounting in tight spaces in false ceilings is much simpler and faster. Plant operators achieve greater efficiency because the different k_{vs} values which can be selected for heating and cooling permit precise and effective control of both circuits with one valve. Reliably decoupling the cooling and heating circuit ensures high operating safety and the integrated pressure relief function ensures maximum protection for the plant. Because the valve closes completely air bubble-tight when closed, energy consumption and life cycle costs fall significantly.



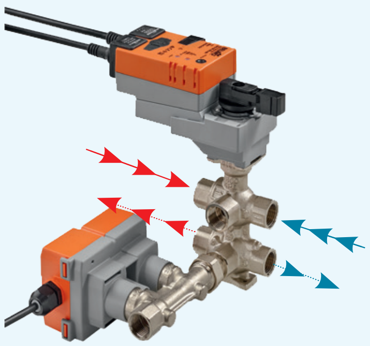
Example: Functional diagram showing integrated use of the 6-way zone valve with decoupled heating and cooling circuit.

Further development towards electronic pressure independence

The age of digitalisation has entered building technology. In the interests of optimum transparency and efficiency, it makes sense to make use of the possibilities of modern electronics at the level of individual control components.

By further developing the 6-way zone valve into an intelligent «all-in-one» control unit, Belimo is now enabling it to be used to control combined heating/cooling elements too.

As well as the described benefits of the mechanical version, the electronically controlled 6-way zone valve can do even more. The integrated flow measurement and control automatically ensures permanent dynamic balancing and, if there are changes in differential pressure during partial load operations, ensures that the amount of water is correct at all times. This allows plant operators to save on elaborate, manual hydronic balancing and any adjustments needed. They also have peace of mind that the plant is running perfectly at all times.



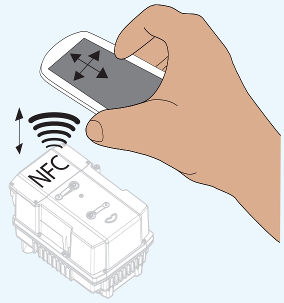
The functional principle of the further developed electronic, pressure-independent 6-way zone valve from Belimo.

Flexible and transparent communication

The integral control and monitoring of heating and cooling requires components, which orientate themselves towards the bus systems used – and not the other way round. This applies particularly in complex, large-sized buildings, but also in the "Smart Homes" of the near future.

The complete product range of the 6-way zone valves from Belimo communicate with MP-Bus® and Modbus. Depending on the application a communication is also possible with LonWorks®, BACnet® or KNX®. The MP-Bus® actuators can also be used to bring together up to eight valves in lines. This permits maximum flexibility in plant planning and when integrating the 6-way zone valves into the overall HVAC system of each house.

The central element in an optimised operating concept is transparent communication between technicians and system. This helps with commissioning and provides data for the analysis and evaluation of valve settings. To make the whole process simpler and faster, the bus actuators of the pressure-independent 6-way zone valves from Belimo have an NFC interface (Near Field Communication). This allows wireless on-site communication with the actuator via a smartphone app. Data can be accessed and the setting configured if necessary.



The built-in NFC interface permits wireless communication with the bus actuators of the 6-way zone valves from Belimo.

Optimised economic efficiency

Economic efficiency is not defined solely by price. It is far more the case that it is dependent on whether each plant is equipped with the exact-fitting and optimally coordinated components. By offering the biggest choice of 6-way zone valves, Belimo makes this possible. Whether the customer is looking for pressure-dependent or pressure-independent – the wide product range is unique and includes various k_{vs} combinations and a huge number of motor variants. Because very particular special requirements also sometimes have to be met, further customised solutions can be implemented with various combinations of zone valves from the Belimo ZoneTight™ family.

Consulting engineers, plant manufacturers, system integrators and operators can rely on the world market leader's sound technical application knowledge both when selecting and using the 6-way zone valves. This gives them additional peace of mind during planning and the operating phase. ■

More information: **www.belimo.eu**

The Belimo Group is a leading global manufacturer of innovative electrical actuator and valve solutions for heating, ventilation and air conditioning technology. The Group achieved sales of CHF 493 million in 2015 and employs around 1,470 people. For information on the company and its products, visit www.belimo.com/investorrelations.

The shares of BELIMO Holding AG have been traded on the SIX Swiss Exchange since 1995 (BEAN).

Sensor maintenance for optimal energy savings in HVAC

LARS STORMBOM
MSc, Product manager,
Vaisala Oyj

VAISALA

Keywords: CO_2, Humidity, Enthalpy, DCV

Advanced control regimes such as Demand Controlled Ventilation (DCV) and free cooling are gaining popularity as the pressure to reduce energy consumption in HVAC is mounting. However, no amount of intelligence in the building automation system will help you if the sensor measuring the actual conditions has drifted. It is also not enough that accuracy requirements are met out of the box, the requirements should be maintained during the lifetime of the building.

Indoor air conditions are considered benign for sensors. On the other hand, sensors used in building automation are rarely calibrated or serviced once the system has been commissioned. Miswired or faulty sensors are common, so at least one comparison measurement should be done during the system commissioning. It is advisable to check the installed sensors after a couple of years against a reliable handheld instrument.

Some measurements demand extra care. I will now discuss outdoor humidity and CO_2-sensors in more detail.

Outdoor humidity measurement

Economizers can save energy in some climates by using free cooling from outdoor air. In humid climates, the most important factor is the amount of humidity in the outdoor air, not the temperature. At 30°C the enthalpy changes from 30 kJ/kg to 96 kJ/kg when the relative humidity changes from dry to 95%RH. According to ASHRAE standard 90.1, differential enthalpy control or fixed enthalpy control is recommended in economizers for hot and humid climates. The RH accuracy for control sensors should be <±5%RH. While most sensors are specified to ±5%RH or better, this specification is out of the box. The ±5%RH should be maintained over lifetime of the system.

Outdoor humidity measurements are more demanding. The sensors are subjected to high humidity, high winds, solar heating and pollution. It makes sense to use one properly maintained, high-quality outdoor humidity sensor instead of multiple low quality sensors.

Maintenance includes, in addition to periodic checking of the measurement, also regular cleaning of the radiation shield. Failure to do so may lead to temperature readings several °C higher and relative humidity values more than 10%RH lower than actual values.

The most important consideration is to use a sensor designed for outdoor use. Some sensors that look good on the data sheet can drift so much in outdoor conditions as to be unusable after a few months. In **Figure 1** you can see the test results for 3 Vaisala HUMICAP® sensors used outdoors for more than 12 years at the Vaisala outdoor test site in Vantaa, Finland. Even with these impressive results, we still recommend periodic checking against a reliable handheld instrument at least every second year as conditions outdoors vary dramatically.

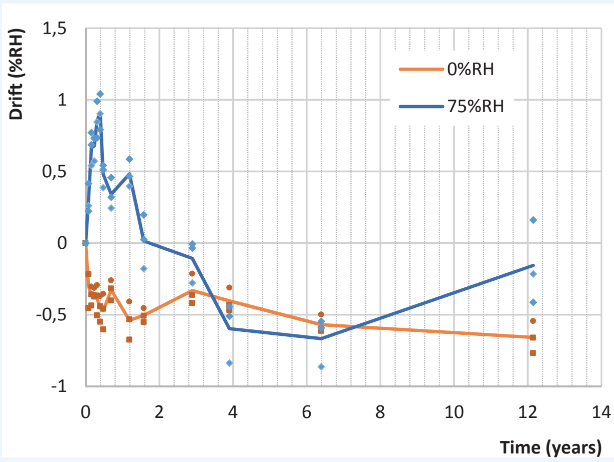


Figure 1. Vaisala HUMICAP® sensors' outdoor stability test data.

CO_2 sensors

CO_2-sensors are central in reducing energy consumption using DCV. As the measurement directly controls the amount of fresh air used accuracy requirements are tightening. The Californian regulation CEC-400-2008-001-CMF requires a ±75 ppm accuracy at 600 ppm and 1 000 ppm including 5 years stability. ASHRAE standard 90.1 for green buildings requires a ±50 ppm accuracy at 1 000 ppm. This kind of accuracy will not be achieved with simple instruments relying on 400 ppm background concentration compensation algorithms. The 1 000 ppm control CO_2-concentration is too far from the supposed 400 pm background CO_2-concentration as sensitivity drift is also likely to build up over time. Especially the ±50 ppm requirement can be achieved only with dual beam or single beam-dual wavelength instruments (like the Vaisala CARBOCAP®) that are regularly calibrated using calibration gases. A calibration interval of 2 years is probably enough depending on the instrument type.

For slightly lower requirements a five-year service or replacement regime may be enough as demonstrated in **Figure 2**, which shows the stability of 23 tested Vaisala CARBOCAP® GM10 measurement modules.

Where outdoor CO_2-sensors are used in order to control a 600 ppm difference between indoor and outdoor CO_2-concentrations, this single sensor becomes one of the most important sensors in the whole building. Drift in this sensor will affect all the independent zones in the building.

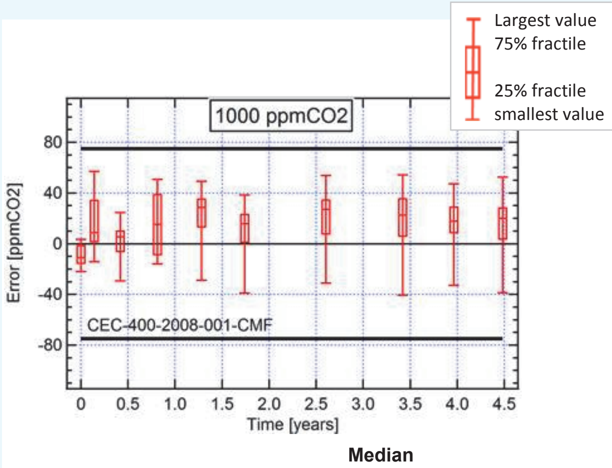


Figure 2. Indoors stability test results for 23 GM10 CO_2-modules at 1 000 ppm. Black lines represent California standard CEC-400-2008-001-CMF requirements.

Conclusion

Many HVAC instruments are used in order to save energy. To achieve projected energy savings, the measurements have to perform properly during their whole lifetime. If something is worth measuring, it is worth measuring right! ■

Eurovent Certita Certification – Call for Launching Committees

As part of the launch of new certification programmes under the European brand "Eurovent Certified Performance", Eurovent Certita Certification is making **Calls for Launching Committees**.

The mission of the Launching Committee is to:

- Establish the specific requirements and rules that will allow the evaluation of the products.
- Prepare all relevant reference documents and guidance on the choice of laboratory/test agency/audit agency when applicable.
- The latest European and National regulations will be considered.

Products involved:

- **Thermodynamic Water heaters**

The scope of this programme will cover **all types of thermodynamic water heaters technologies for both domestic and tertiary use.**

Each manufacturer of **Thermodynamic Water heaters** is eligible to be part of the Launching Committee group.

If you are interested in participating in this Launching Committee, or wish to get more information, please contact Arnaud Miraton:
a.miraton@eurovent-certification.com

- **Liquid to Liquid Plate Heat Exchangers**

The scope of this programme will cover Liquid to Liquid Plate Heat Exchangers designed for **HVAC-R applications** such as **Brazed plate heat exchangers, Fusion-bonded plate heat exchangers** or **Gasketed plate-and-frame heat exchangers** for instance.

Each manufacturer of **Liquid to Liquid Plate Heat Exchangers** is eligible to be part of the Launching Committee group.

If you are interested in participating in this Launching Committee, or wish to get more information, please contact Marie-Clémence Degallaix:
mc.degallaix@eurovent-certification.com

- **Air Curtains**

The scope of this programme will cover **all type of Air curtain technologies for tertiary use.**

Each manufacturer of **Air Curtains** is eligible to be part of the Launching Committee group.

If you are interested in participating in this Launching Committee, or wish to get more information, please contact Quentin Liebens:
q.liebens@eurovent-certification.com ■

Send information of your event to Ms Chiara Girardi cg@rehva.eu

Events in 2017

Conferences and seminars

February 14–17	Aquatherm Novosibirsk	Novosibirsk, Russia	https://goo.gl/D6tLnM
March 1–3	World Sustainable Energy Days 2017	Wels, Austria	http://www.wsed.at/en/world-sustainable-energy-days/
March 14–15	Is ventilation the answer to indoor air quality control in buildings? Do we need performance-based approaches?	Brussels, Belgium	https://goo.gl/U9Tg5F
March 29–31	5th International Congress Mechanical Engineers Days	Vodice, Croatia	http://www.hkis.hr/
April 2–4	REHVA Annual Meeting	London, UK	https://goo.gl/EJoSKQ
April 5-6	CIBSE ASHRAE Technical Symposium 2017	Loughborough, United Kingdom	https://goo.gl/VKqWEW
April 19–22	Teskon+Sodex	Izmir, Turkey	http://www.teskonsodex.com/
April 19–21	Aquatherm St. Petersburg	St. Petersburg, Russia	https://goo.gl/p26L85
May 10–11	50th International Congress "Beyond NZEB retrofit of existing buildings"	Matera, Italy	https://goo.gl/Ctg2I7
May 10–12	1st Buildings India 2017 Exhibition and Conference	New Delhi, India	http://www.smartcitiesindia.com/
May 10–13	Sodex Ankara	Ankara, Turkey	http://www.sodexankara.com/
May 12–13	Climamed 2017 Conference "Historical buildings retrofit in the Mediterranean area"	Matera, Italy	http://www.climamed17.eu/
May 14–17	38th Euroheat & Power Congress	Glasgow, United Kingdom	www.ehpcongress.org
August 7–9	Building Simulation 2017	San Francisco, California, USA	www.buildingsimulation2017.org
August 23–25	43rd International Symposium of CIB W062 Water Supply and Drainage for Buildings 2017	Haarlem, The Netherlands	http://www.tvvl.nl/cib-w062-2017
September 5–7	ISH Shanghai & CIHE 2017	Shanghai, China	www.ishs-cihe.hk.messefrankfurt.com
September 13–14	Ventilating healthy low-energy buildings	Nottingham, United Kingdom	http://www.aivc2017conference.org/
September 28–29	7th International Conference on Solar Air-Conditioning - PV Driven/Solar Thermal	Tarragona, Spain	http://www.solaircon.com/
November 10–11	Second ASHRAE Developing Economies Conference	Delhi, India	https://ashraem.confex.com/ashraem/de17/cfp.cgi

Exhibitions

February 15–17	HVAC R EXPO Saudi	Jeddah, Saudi Arabia	https://www.hvacrexposaudi.com/
February 23–25	ACREX 2017	Delhi, India	www.acrex.in
March 14–18	ISH	Frankfurt am Main, Germany	http://www.ish2017.com/
May 18–20	ISH China & CIHE 2017	Beijing, China	www.ishc-cihe.hk.messefrankfurt.com
September 5–7	ISH Shanghai & CIHE 2017	Shanghai, China	www.ishs-cihe.hk.messefrankfurt.com
September 19–23	FOR ARCH	Prague, Czech Republic	www.forarch.cz/en/

REHVA Workshop on Indoor Environmental Quality

Sunflower, Hall 2 C, 2nd Floor, India Exposition Centre, Greater Noida, Thursday February 23rd, 2017 From 14:30 to 17:00

REHVA Workshop, in collaboration with ISHRAE, deals with IAQ measurement and ventilation system audit practices in Europe, user satisfaction survey as a tool and how the IEQ impacts the financial side such as productivity, health, sick leaves, rents and building value.

REHVA

Federation of European Heating, Ventilation and Air Conditioning Associations

INDIAN SOCIETY OF HEATING REFRIGERATING & AIR CONDITIONING ENGINEERS

AGENDA Thursday 23 February 2017

14.30–14:45 REHVA Representatives and ISHRAE President-elect, **Vishal Kapur**, welcome speech

14:45–15:05 Air pollution in India and how it impacts the occupant health, **Dr. Radha Goyal**, Indian Pollution Control Association (IPCA)

15:05–15:25 International IEQ standard development (ISO, CEN, ASHRAE), **Jaap Hogeling**, REHVA

15:25–15:45 Indoor Air Quality and User Satisfaction measurements in practice – European experience, **Dr. Atze Boerstra**, REHVA

15:45–16:05 European solutions and technologies for Better IAQ – what can India learn? **Maija Virta**, Santrupti engineers

16:05–16:25 Why investment for better IAQ is a good business case? **Frank Hovorka**, REHVA

16:25–16:45 Does the client, developer or architect see a benefit of good IAQ in India? **Prof. Ashok Lall**, Ashok B Lall Architects

16:45–17:00 Q&A

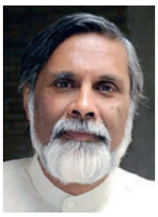
Dr. Radha Goyal is currently working as Deputy Director, Indian Pollution Control Association (IPCA) and associated with IPCA as a member since its origin in year 2001. Her work responsibilities are to handle all research related activities of organization, writing and submission of proposals, research papers, DPRs etc. in areas of waste management, air quality and health assessment. Her PhD research was on Indoor air quality monitoring. Dr. Radha has published more than 35 research articles in international and national journals of repute and in conference proceedings, also contributing to many chapters in international books.

Jaap Hogeling is Manager international projects and standards of ISSO: the Dutch Building Services Knowledge Centre. For the last 20 years, active in the international standardisation work in CEN (the European Standard Organisation) and ISO (the International Standard Organisation) in the area of energy, energy-efficiency and performance and thermal performance of buildings, their indoor environmental conditions and impact on the environment. Since 2003 chairperson of CEN/TC371 "Program Committee on EPBD" on basis of a mandate from the EU-Commission to CEN regarding the implementation of the EPBD (Energy Performance Buildings Directive) in the building regulations in the EU-member States.

Dr. Atze Boerstra is founder and managing director of BBA Indoor Environmental Consultancy, a Dutch consultancy company specialized in indoor air quality, thermal comfort and healthy building. He has a background in Mechanical Engineering and had a PhD degree in building science from the Eindhoven University of Technology. Atze has over 20 years of experience with the investigation of 'sick' buildings and has been involved in the design of >100 above average comfortable & healthy buildings. He is REHVA fellow and honorary member of the Dutch chapter of ISIAQ (International Society of Indoor Air Quality and Climate) and as vice-president of REHVA.

Maija Virta is the Founder and Director of Santrupti engineers Private Limited. She has 25 years of experience in construction and HVAC-industry. Her chief areas of expertise are indoor environmental quality, energy efficiency of buildings as well as sustainable building policies and technologies. During her career, she has been involved in developing many technologies for sustainable buildings as well as user-centric IEQ measurement, verification and post-occupancy evaluation processes. She has over 5 years of experience of onsite work to improve IAQ both in Europe and in India. Before moving to India, Maija was CEO of the Green Building Council Finland.

Frank Hovorka, in 2005, he achieved the first office building certified as a 'green building' by Certivea (French Green Building Council). In Munich, he completed an office building of 20,000sq m that was awarded a gold certification by DGNB (German green building council). Frank also contributes to research projects on net zero energy buildings and on financial indicators of buildings' 'green value' (RICS UNEP FI, IISBE and REHVA). Since September 2010, Frank has worked for the French group Caisse des Dépots, where he's in charge of real estate sustainability policy development at the headquarters' strategy department.



Prof. Ashok Lall, in 1948, graduated from the University of Cambridge U.K. in Architecture Fine Arts and obtained the Architectural Association Diploma in 1970. His architectural firm (estd. 1981) is committed to an architectural practice based on the principles of environmental sustainability and social responsibility. It has won a number of awards and its work has been published widely. Engaged in architectural education since 1990, he has developed curricula and teaching methods to address. He is e.g. a member of RICS in India.

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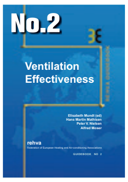
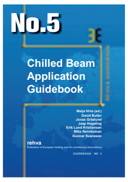
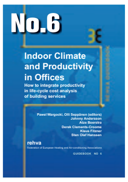


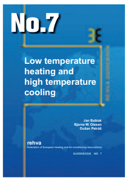
Ventilation Effectiveness. Improving the ventilation effectiveness allows the indoor air quality to be significantly enhanced without the need for higher air changes in the building, thereby avoiding the higher costs and energy consumption associated with increasing the ventilation rates. This Guidebook 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.



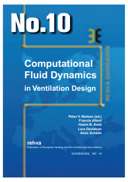
Chilled Beam Cooling. Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature 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.



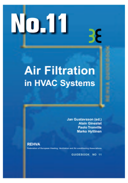
Indoor Climate and Productivity in Offices. This Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available.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



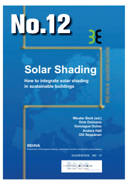
Low Temperature Heating And High Temperature Cooling. This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in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



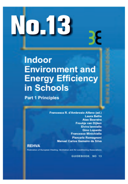
Computational Fluid Dynamics in Ventilation Design. CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary 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.



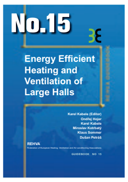
Air Filtration in HVAC Systems. This Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on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



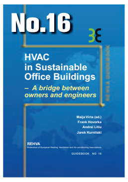
Solar Shading – ***How to integrate solar shading in sustainable buildings.*** Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy 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.



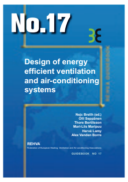
Indoor Environment and Energy Efficiency in Schools – ***Part 1 Principles.*** School buildings represent a significant part of the building stock and also a noteworthy part of the total energy use. Indoor and Energy Efficiency in Schools Guidebook describes the optimal design and operation of schools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



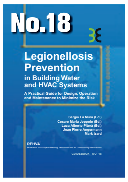
Energy Efficient Heating and Ventilation of Large Halls. This Guidebook is focused on modern methods for design, control and operation of energy efficient heating systems in large spaces and industrial halls. The book deals with thermal comfort, light and dark gas radiant heaters, panel radiant heating, 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.



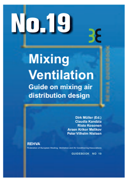
HVAC in Sustainable Office Buildings – ***A bridge between owners and engineers.*** This Guidebook discusses the interaction of sustainability and heating, ventilation and air–conditioning. HVAC technologies used in sustainable buildings are described. This book also provides a list of questions to be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



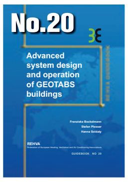
Design of energy efficient ventilation and air-conditioning systems. This Guidebook covers numerous system components of ventilation and air-conditioning systems and shows how they can be improved by applying the latest technology products. Special attention is paid to details, which are often overlooked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



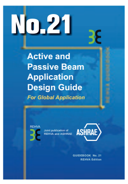
Legionellosis Prevention in Building Water and HVAC Systems. This Guidebook is a practical guide for design, operation and maintenance to minimize the risk of legionellosis in building water and HVAC systems. It is divided into several themes such as: Air conditioning of the air (by water – humidification),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



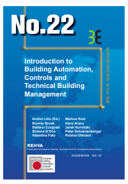
Mixing Ventilation. In this Guidebook most of the known and used in practice methods for achieving mixing air distribution are discussed. Mixing ventilation has been applied to many different spaces providing fresh air and thermal comfort to the occupants. Today, a design engineer can choose from large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



Active and Passive Beam Application Design Guide is the result of collaboration by worldwide experts. It provides 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 and maintain. 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.



Introduction to Building Automation, Controls and Technical Building Management. This guidebook aims to provide an overview on the different aspects of building automation, controls and technical building management and steer the direction to further in depth information on specific issues, thus increasing the readers' awareness and knowledge on this essential piece of the construction sector puzzle. It avoids reinventing the wheel and rather focuses on collecting and complementing existing resources on this topic in the attempt of offering a one-stop guide.

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