TECHNICAL CERTIFICATION RULES OF THE EUROVENT CERTIFIED PERFORMANCE MARK

AIR HANDLING UNITS

Identification: ECP 05

Revision 01-2024 – February
(This version cancels and replaces any previous versions)

Approbation date: 26/02/2024

Comes into effect from 26/02/2024
(The testing procedure is applicable from the 2024 testing campaign; version 01-2023 is applicable for 2023 and previous testing campaigns)

The purpose of the Technical Certification Rules is to prescribe procedures for the operation of the Eurovent Certified Performance (ECP) certification programme for Air Handling Units (AHU), following the Certification Manual.

Modifications as against the last version:

No.	Modifications	Section	Page
1	Clarification on the sister factory definition	II.2.2	12
2	The admission audit can be proposed remotely	III.1.3	16
3	Removal of the special complaint procedure		
4	Removal of the MB surveillance tests		
5	New rule for second test on Real Units	III.1.5.6	21
6	Clarification on recalculation for not on the market anymore components	III.1.5.6	22
7	New testing procedure (selection, conditions, penalty, printout information…)	All document	
8	Clarification on checked requirements for hygienic audits	III.2.1	25
9	Removal of forms (declaration list, test check, TDS)		
10	Clarification on Pairside-ref calculation	F.9 G.9	54 / 68
11	Use of reference city for winter energy class calculation	F.2	50
12	Editorial update and miscellaneous clarifications	All document	

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I. GENERAL INFORMATION

I.1 Scope

I.1.1 General

The programme scope covers Air Handling Units (AHU) that can be selected in software. Each declared range shall at least present one size with a rated air volume flow below 3 m^3/s. For each declared range, all Real Unit sizes available in the software, and up to the maximum stated airflow, and all Model Box configurations shall be declared.

The following AHUs are specifically excluded from the scope:

- AHUs with special casing for only one project
- AHUs without any fans
- AHUs without ventilation functions
- AHUs belonging to a range which presents no size with a rated air volume flow below 3 m^3/s
- AHUs with a rated air volume flow below 250 m^3/h
- AHUs with a rated air volume flow between 250 and 1000 m^3/h and which is exclusively intended for residential applications
- AHUs including only a fan and a non-certified housing or casing (e.g. box fans, roof fans)
- AHUs which are exclusively specified as operating in a potentially explosive atmosphere as defined in Directive 94/9/EC (ATEX design)
- AHUs which are exclusively specified as operating for emergency use, for short periods
- AHUs which are exclusively specified as operating:
  - where operating temperatures of the air being moved exceed 100 °C;
  - where the operating ambient temperature for the motor, if located outside the air stream, driving the fan exceeds 65 °C;
  - where the temperature of the air being moved, or the operating ambient temperature for the motor, if located outside the air stream, is lower than – 40 °C;
  - where the supply voltage exceeds 1 000 V AC or 1 500 V DC;
  - in toxic, highly corrosive or flammable environments or environments with abrasive substances
- Flat-packed units (i.e. not assembled casing and/or CKD (Complete Knocked Down)) unless, due to building limitations the AHU cannot enter the building designated area in sections and the flat-packed unit is being built on-site, under the supervision of on-site directly employed personal of the AHU manufacturer.

I.1.2 Optional Certification for Hygienic Air Handling Units

As an option of the Certification programme for Air Handling Units, an already certified range can also be certified as “hygienic”.

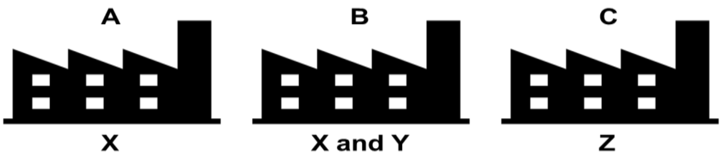
The dedicated process and specific requirements are described in Appendix H.

I.1.3 Certify all principle

Whenever a company participates in the programme for AHU, all AHUs within the scope of the programme and produced in the declared factory must be certified per these Technical Certification Rules. This rule applies to factories worldwide.

If one certified range is produced in different factories, these factories must be declared to ECC and will fall under the scope of the Certify All.

Example: A manufacturer has 3 factories A, B and C all over the world and they produce 3 ranges X, Y and Z.



If the range X produced in factory A is certified, then factory B must be declared and range X produced in factory B must be certified. Then range Y must be certified. However, if the range Z is not certified, then factory C need not be declared.

If a company is certified, the certification does not extend to its affiliates, which shall be individually certified, as the case may be, as independent companies.

List of exclusions: every AHU falling under the list of exclusions below can be excluded from the Certify All principle, the participant can decide whether to declare or not these AHUs.

- AHUs with external pressure higher than 2000 Pa
- AHUs for cooling data centres with evaporative cooling
- Ceiling units with a height less than 0.6m
- Range with AHUs with a heat pump integrated

I.2 Certified performances

I.2.1 Mechanical, thermal and acoustical performance

The following mechanical and acoustical performance following EN 1886:2007 shall be specified and verified by tests:

- **Casing air leakage (CAL)** class for one Real Unit size
- **Casing strength (CS)** class for one Real Unit size
- **Filter bypass leakage (FBL)** class for one Real Unit size

Construction variation	Casing strength	Casing air leakage	Filter bypass leakage	Thermal transmittance	Thermal bridging	Acoustic insulation
Corner post	x	x	x	x	x	x
Mullion	x	x		x	x	x
Filter holding system (N/A in case of pre-filtration only)			x			
Type of access		Doors	Doors			Doors
Panel structure/geometry	x	x	x	x	x	x
Panel thickness	the thinnest	the thinnest		the thinnest	the thinnest	the thinnest
Sheet metal thickness	the thinnest			the thickest	the thickest	the thinnest
Insulation material (wool vs foam): - density out of - 25% - conductivity out of + 15%	x (density)			x (conductivity)	x (conductivity)	x (density)
Way of insulation mounting (fixed vs loose)	x					x
Metal sheet of panel (*aluminium* vs galvanized vs stainless steel)				*worst case: aluminium otherwise galvanized*	*worst case: aluminium otherwise galvanized*	
External finishing (galvanized vs coated)						
Door handle, Hinge and /or latch		x		x		x
Gaskets (e.g. on doors, casing)		x	x			

Table 1: MB Construction variations

The following mechanical and acoustical performances following EN 1886:2007 shall be specified and verified by tests:

- **Casing strength class** for each variation of corner post, mullion, panel structure/geometry, variation of density of the insulation material out of -25 %, way of insulation mounting (fixed vs loose), for the thinnest panel and the thinnest metal sheet.
- **Casing air leakage class** for each variation of corner post, mullion, panel structure/geometry, hinge and/or latch, gaskets, and for the thinnest panel.
- **Filter bypass leakage class** for each variation of corner post, filter construction and panel structure/geometry and gaskets.
- **Thermal transmittance class** for each variation of corner post, mullion, panel structure/geometry, hinge and/or latch, variation of conductivity of the insulation material out of +15 %, for aluminium sheet if available, galvanized otherwise, for the thinnest panel and the thickest metal sheet.
- **Thermal bridging factor class** for each variation of corner post, mullion, and panel structure/geometry, for each variation of conductivity of the insulation material out of +15 %, for aluminium sheet if available, galvanized otherwise, and the thinnest panel and the thickest metal sheet.
- **Acoustical insulation** for each variation of corner post, mullion, panel structure/geometry, hinge and/or latch, for each variation of density of the insulation material out of -25 %, for each way of insulation mounting (fixed vs loose), for the thinnest panel and the thinnest metal sheet.

To claim a better class on one performance data, another MB with the construction parameter variation must be tested too.

I.2.2 Other performances

On each Real Unit, the following performances shall be specified and verified by tests:

- **Air flow rate**, external static pressure, absorbed motor power *(“wire to air” including the speed control)* at 3 conditions + 1 “secret” operating point
- **Octave band in-duct sound power level**, at the inlet and outlet, with only the supply air fan running
- **Airborne sound power level**, only with the supply air fan running
- **Cooling capacity** at 2 conditions, if a standard feature of the range
- **Heat recovery *temperature* dry efficiency** at one condition, at equal mass flow rates
- ***Heat recovery humidity efficiency*** *at one condition, at equal mass flow rates*
- Heat recovery pressure drop on both air sides
- For run-around coils, **fluid side pressure drop**, glycol percentage and absorbed motor power of the circulation pump (if pump rated in output)
- **Pressure drop on the waterside** at two conditions for the cooling coil
- ***EATR*** *according to EN 308:2022*
- ***OACF*** *according to EN 308:2022*

I.2.3 Performance items not covered by the programme

The following performances shall not be considered: filtration efficiency, humidification, heating/cooling by other means than water coils, sound attenuator characteristics, vibration level, hygienic aspects (only covered in the hygienic option of the AHU certification programme), weather protection, mixing efficiency, drain facilities.

I.3 Definitions

In addition to the definitions specified in the Certification Manual, the following definitions apply:

Air Handling Unit: A factory-made encased assembly, or flat-packed unit, that consists of a fan or fans and other necessary equipment to perform one or more of the following functions: circulating, filtration, heating, cooling, heat recovery, humidifying, dehumidifying and mixing of air. The AHU should be suitable to be used with ductwork.

Range: A family of Air Handling Units of different sizes, grouped under the same designation and using the same selection procedure.

Model Box: Construction envelope built according to specifications presented in the manufacturer's literature, used to establish mechanical, thermal, and acoustical performance according to the relevant EN standards.

Sub-range: Part of a range using the same Model Box(es) and grouped under the same designation.

Real Unit: Unit from the range of a specific size, used to establish complete performance for all the available functions of the Air Handing Unit range, according to the relevant EN standards.

Deflection [mm/m]: The largest deformation of the sides of the AHU under pressure, positive or negative, given as a difference in distance from a reference plane outside the AHU to the external AHU surface with and without test pressure. The deflection, related to the span, defines the casing strength.

Air leakage factor [$l.s^{-1}.m^{-2}$]: The air leakage in volume per unit of time, related to the external casing area.

Thermal transmittance [$W.m^{-2}.K^{-1}$]: The heat flow per area and temperature difference through the casing of the air handling unit.

Thermal bridging factor [-]: The ratio between the lowest temperature difference between any point on the external surface and the mean internal air temperature and the mean air-to-air temperature difference.

Filter bypass leakage [%]: Air bypass around filter cells as a percentage of rated air volume flow.

Acoustical insulation [dB]: Sound insertion loss value of the Air Handling Unit.

Heating capacity [kW]: Thermal energy supplied into the air per unit of time.

Cooling capacity [kW]: Thermal energy removed from the air per unit of time.

Heat recovery [%]: Heat transferred from extract air into supply air or reverse.

In-duct sound power level [dB]: Sound power level per octave band, radiated in the duct.

Airborne sound power level [dB(A)]: Sound power level radiated through the envelope of the Air Handling Unit.

Critical non-conformity: A non-conformity is classified as critical by Eurovent Certita when based on objective evidence:

- there is a significant risk to the product's conformity to specified requirements, or
- there is a significant risk to the management system's ability to control the product's conformity to specified requirements, or
- there is systematic or repeated non-conformity to a specified requirement.

Non-critical non-conformity: A non-conformity is classified as non-critical by Eurovent Certita when based on objective evidence:

- there is no significant risk to the product's conformity to specified requirements, or
- there is no significant risk to the management system's ability to control the product's conformity to specified requirements, or
- there is no systematic or repeated non-conformity to a specified requirement.

Temperature efficiency [%]: Temperature efficiencies mentioned in this document are temperature gross efficiencies as described in EN308:2022.

I.4 Contributors

The lists of contributors are given for information and may be modified by EUROVENT CERTITA CERTIFICATION whenever necessary.

I.4.1 Audit body

The audit functions are performed by the following body(ies), called audit body:

EUROVENT CERTITA CERTIFICATION SAS
34 Rue Laffitte
FR- 75009 PARIS
Tel : + 33 1 75 44 71 71
www.eurovent-certification.com

EUROVENT CERTITA CERTIFICATION Ltd
Kemp House 152-160 City Road London,
EC1V 2NX United Kingdom
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AENOR
Génova, 6
ES- 28004 MADRID

TÜV NORD Systems GMBH & Co. KG
Buildings Testing, Am TÜV 1
DE- 45307 – ESSEN

I.4.2 Independent laboratory/test body

When the checks carried out involve product tests, these are performed at the request of EUROVENT CERTITA CERTIFICATION by the following laboratories, known as independent laboratories, it being specified that EUROVENT CERTITA CERTIFICATION is free to select one of these laboratories:

TÜV NORD Systems GMBH & Co. KG
Buildings Testing, Am TÜV 1
DE- 45307 – ESSEN

DTI - DANISH TECHNOLOGICAL INSTITUTE
Gregersenvej
DK- 2630, TAASTRUP

TÜV SÜD Industrie Service GmbH
Klima- und Lufttechnik - IS-TAK03-MUC, Geiselbullacherstraße 2
DE- 82140, OLCHING

II. REQUIREMENTS OF THE REFERENCE DOCUMENT

II.1 Reference documents

II.1.1 Product and test standards

The test procedure is detailed in the technical appendix and the product and test standards.

The applicable standards are as follows (non-exhaustive list):

- EN 1886:2007: “Ventilation for buildings – Air Handling Units – Mechanical performance
- EN 13053:2019: Ventilation for buildings – Air Handling Units – Rating and performance for unit’s components and sections.

II.1.2 Software specific technical requirements

An English version of the software selection is necessary. Each quotation of a certified AHU shall include the date/code/number of the software version used for the selection of the AHU. From the version code key, it shall be possible to check what the latest technical software version is by splitting up the code into more characters. An example of a suitable code is given below:

Version: XY / Z

Z: characters indicating a version serial number, not affecting the selection results

XY: characters to indicate the technical version serial number

The participant is obliged to send the most recent technical software version to Eurovent Certita Certification. *The participant guarantees that the software is free from any intellectual third parties rights and is free from virus and malwares.*

The selection software shall be operative as an entity with all AHU components integrated into one software. Components in an AHU that are selected with different software or any other means of selection cannot be certified. The AHUs of the applied range shall be built with components specified in the selection software. If some components, not present in the certified software, performing a certified performance item are included in the technical specification of a particular order, the following statement shall be provided in the quotation: “This component is not included in the Eurovent certified software”. This statement is not required for components serving for non-certified performance items.

At least four sections must be included: fan, filter, heating and cooling. When a heat recovery section is available, it shall be declared and included in the selected AHU for certification test.

Consistency of the software shall be verified by the auditor appointed by Eurovent Certita Certification. In case inconsistency of the software is observed, failure treatment shall be applied.

Anytime, Eurovent Certita Certification has the right to collect data directly from customers and perform extra checking of software.

Additional requirements for the Hygienic option:

The selection software shall be designed to propose the hygienic option as well as the selection of the required level.

According to the level selected, the software shall be designed in such a way that it doesn’t allow the selection of non-applicable components (e.g. If level 3 is selected the supply side shall include at least an ePM 1 70% filter) and alert the user if the arrangement of the AHU is not following the hygienic requirements (e.g. alert the user if the dehumidifier is arranged before filters or silencers).

II.2 Specific requirements and quality management

II.2.1 Use of ECP not certified heat recovery system (HRS)

Additional testing of non-certified HRS is requested in the laboratory of the regular certification campaign, of the different models, once every year. Surveillance would only be necessary in case of a change in the structure of the HRS. When an HRS is tested in the RU for one year, this additional testing is not necessary for that year.

Compare the efficiency and pressure drop data in the AHU quotation or software with results obtained from the test result. Deviation shall be equal or lower than the acceptable acceptance criteria defined in the certification programme for the HRS (ECP-08-2023 for Air-to-Air Plates and Tubes Heat

Exchangers, ECP-10-2023 for Air-to-Air Regenerative Heat Exchangers). In case a RU is tested every year, this additional testing is not necessary. *Penalty tests are not applied to these tests.*

II.2.2 Ranges produced in several production places

When a manufacturer presents several production places, each place will be considered independently so each factory must be audited every year by the auditor appointed by Eurovent Certita Certification (selection or annual on-site checking). Assembly places shall be considered the same way as manufacturing places.

*Regarding the selection of units to be tested, the production places for an **identical product** must be considered as one collective production place.*

<u>Identical product means:</u>

- *Identical software*
- *Identical components (designation) and suppliers for HRS, fans, coils, and filters selectable in the software.*
- *Same casing (same drawings and materials)*
- *Same assembly (same mounting instructions)*

In that case, each time a different production location will be randomly chosen for the selection of the unit to be tested. The different production places are thus called "sister factories".

In case several manufacturing places have a different ISO 9001 certification status (one is certified and the other is not), the timetables described in Table *2*: RU selection for factories with different ISO9001 certification status shall be applied:

Campaign year	ISO9001	Not ISO9001
Y	Selection	AOC
Y+1	AOC	Selection
Y+2	AOC	Selection
Y+3	Selection	AOC
Y+4	AOC	Selection
Y+5	AOC	Selection
Y+6	Selection	AOC
And so on…		

Table 2: RU selection for factories with different ISO9001 certification status

During the annual on-site checking, if there is any suspicion that the production place cannot ensure the same performances as its sister production places, then the auditor may ask that a Real Unit and/or Model Box be tested.

II.2.3 Management of non-certified ranges

When a manufacturer also produces units out of scope, they shall have a significantly different range name from the certified ranges (including at least 4 or 5 different characters). If the range out of scope can be selected in the same selection tool, it shall be clear that this range is not certified.

Participant shall not create any possible confusion in its commercial and marketing communication, especially on its Web sites.

II.2.4 Brand Name

This covers the case of models submitted by a company presenting on the market AHUs, under its own brand, manufactured by a certified company.

II.2.5 Traceability

To ensure the traceability of the products each certified product shall be marked to ensure traceability to the plant (e.g. serial number).

II.3 Marking and published information

It is highly recommended that the participating company indicates participation in the Air Handling Unit EUROVENT CERTIFIED PERFORMANCE (ECP) programme by the following means.

II.3.1 Marking information

II.3.1.1 Eurovent Certified Performance mark (ECP)

See relevant specifications in the Certification Manual.

In addition, the mark shall also include the name of the certified range and the certificate number provided by Eurovent Certita Certification when certification is granted, during the validity period of said certification.

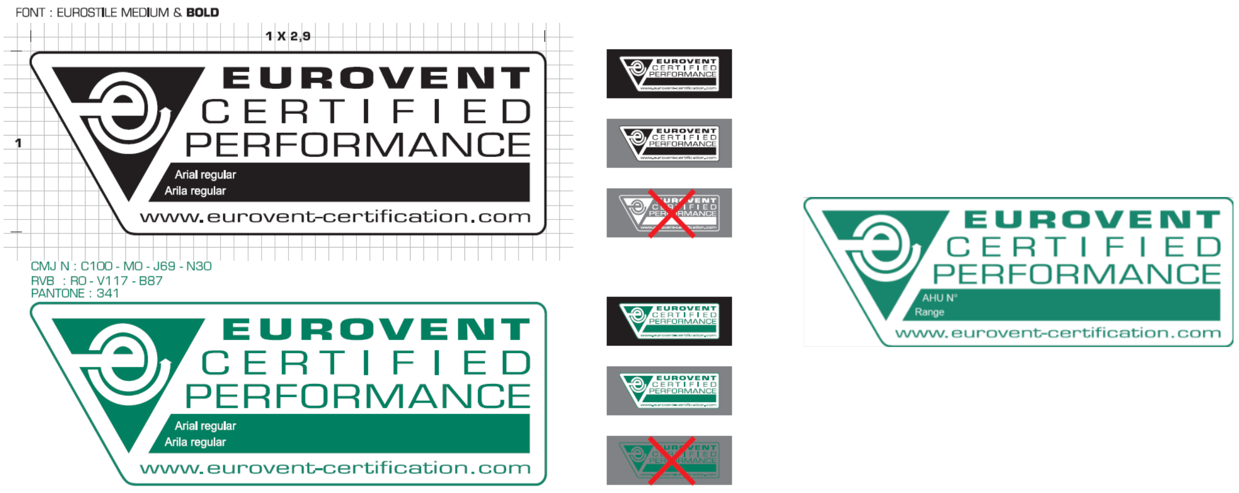


Figure 1: Eurovent Certified Performance mark specifications and Eurovent Certified Performance mark for Air Handling Units

II.3.1.2 Eurovent Certified Performance Energy Efficiency Label

Rules for the use of Eurovent Certified Performance energy labels are given in the Certification Manual.

It is not mandatory to use Eurovent Certified Performance energy labels. However, it is highly recommended to do so. If an energy label is used by the participant, it is mandatory to use the layout described on our website.

High-resolution files of these labels, as well as specifications for the layout, are available on the website in the manufacturer’s restricted area.

https://www.eurovent-certification.com/en/member-area

For units (eventually on printouts)

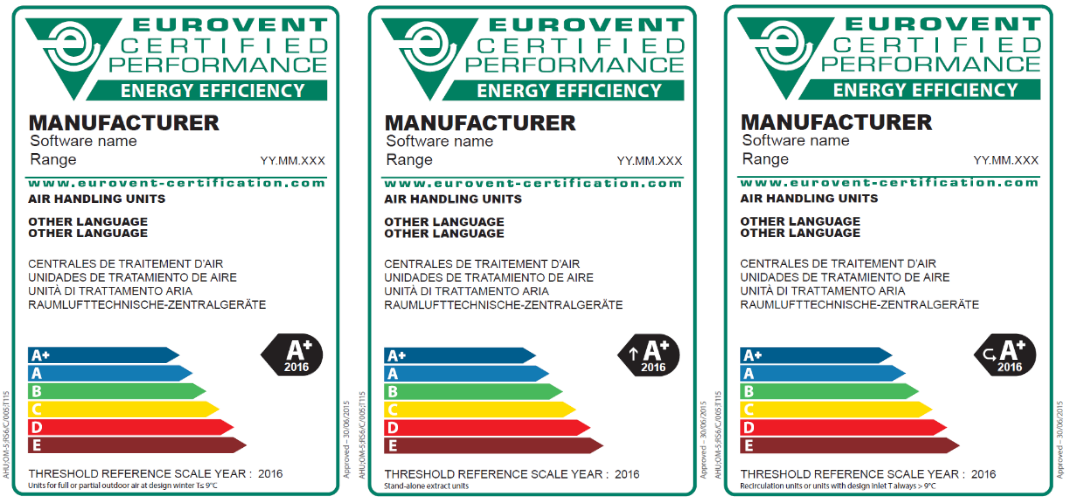


Figure 2: Examples of Eurovent Certified Performance Energy Efficiency Label – for units

For printouts

The label shall be at least 40 mm wide and 40 mm high. The diploma number shall be displayed on the label.

Conditions of use: can only be used in printed/web documents:

- if the product shown is certified
- if no other product is shown
- if all certified performances of the product are displayed next to the label (in the same technical specification).

Files can be found on the restricted part of the Eurovent Certified Performance website.
https://www.eurovent-certification.com/en/member-area

Figure 3: Eurovent Certified Performance Energy Efficiency Label – for printouts

II.3.2 By Eurovent Certita Certification

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

The following information shall be published for each certified range on the Eurovent Certified Performance website www.eurovent-certification.com:

- Name of Company
- Trade or brand name
- Certificate number (format: YY.MM.NNN)
- Designation(s) of the range
- Software name and version
- Designation of certified sizes of the real units
- Heights and widths of the real units

- Designation of certified model boxes
- Panel thickness, insulation material, and insulation material conductivity of certified model boxes
- The certified mechanical, thermal and acoustical performance data of the model boxes: casing strength (deflection) identified with a "(M)", casing air leakage at -400 Pa and +700 Pa identified with a "(M)", filter bypass leakage identified with a "(M)", thermal transmittance, thermal bridging factor and sound level at different frequencies.
- Production sites (city, country)

II.3.3 By the Participant

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

II.3.3.1 Display of Eurovent Certified Performance logo on production units

Each Participant is entitled to display the Eurovent Certified Performance mark on units of ranges which have been certified, in strict compliance with the following rules:

- By using the relevant Eurovent Certified Performance mark
- By application of the relevant Eurovent Certified Performance mark directly on the nameplate
- By using the relevant Eurovent Certified Performance energy efficiency label if applicable. In case the Participant has chosen to display the Eurovent Certified Performance Energy Efficiency label on units, each unit shall be marked, even the one with class E.

II.3.3.2 Display of Eurovent Certified Performance logo on technical documentation

The following shall be applied:

Heat recovery systems: Plate and Rotary Heat Exchangers

Component in Eurovent certified software AHU	Component not in Eurovent certified software AHU but Eurovent certified component	Component not in Eurovent certified software AHU and no Eurovent certified component
AHU energy efficiency label mandatory Specify at least dry efficiency at equal mass flow and design pressure drops for extract and supply airside	AHU energy efficiency label mandatory Component identification shall be enabled Specify the brand and type (product key) of the component Specify at least dry efficiency at equal mass flow and design pressure drops	AHU energy efficiency label not allowed Specify at least dry efficiency at equal mass flow and design pressure drops for extract and supply airside

Fan and electric motor

Component in Eurovent certified software AHU	Component not in Eurovent certified software AHU
AHU energy efficiency label mandatory Specify at least all data, required to check the energy efficiency class (as described in "Requirements for quotations / technical specifications")	AHU energy efficiency label not allowed if fan out AHU energy efficiency label mandatory if motor out only Fan and motor identification shall be enabled Specify the brand and type (product key) of components (fan and/or motor) that are not in the certified software Specify at least the fan and motor date, required to check the energy label: -for the fan: volume flow, fan speed and useful static pressure -for the motor: rated shaft power, synchronic speed, absorbed power

III. CERTIFICATION PROCESS

III.1 Admission procedure

III.1.1 Declaration of data

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

The Applicant, after signing the Certification Agreement, shall send to EUROVENT CERTITA CERTIFICATION all information required for the qualification: the name(s) of the range(s), the list of names and versions of the corresponding selection software, the software itself, the list of factories where the range is produced, declaration file with all Real Unit (RU) sizes and Model Box (MB) configurations, with all the required characteristics and performance data, and relevant literature.

Assembly places of flat-packed units shall be considered the same way as manufacturing places. When a manufacturer presents several manufacturing places, each place shall be considered independently.

The file "declaration list of products" shall be completed and sent to Eurovent Certita Certification as .xlsx files. This file is sent by Eurovent Certita Certification.

III.1.2 Pre-check of selection software

A pre-check of the selection software must be conducted by ECC for each applicant. The selection software must meet all the requirements listed in Appendix E. Once passed, the admission audit can be scheduled and carried out.

III.1.3 Initial admission audit

Once the pre-check of the selection software is passed, an initial admission audit (1 day, audit duration can be adapted in case of combined audits) including the selection of the Real Unit for testing must be scheduled and carried out. *The admission audit can be proposed remotely to the manufacturer (not applicable for the hygienic option).*

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

The auditor shall verify that AHUs are manufactured there and selected with the software.

Before each audit, the auditor appointed by Eurovent Certita Certification shall collect and study the construction details and claimed performance of the relevant AHU range to make a proper selection of suitable unit(s) for testing.

During each audit, the appointed auditor shall verify that the factory makes all necessary arrangements for the recording and investigation of complaints regarding certified performances.

During selection audits, a selection of a Real Unit will be performed by the auditor with the technical expert for each declared range via the selection software. The manufacturer will then be asked to build and ship the unit to the allocated independent laboratory, within the required delays and at its costs.

The entire composition and technical specifications of the selected units shall then be checked onsite. The manufacturer's technical expert shall fully inform the auditor by submitting all relevant assembly drawings, specifications and technical data sheets of the selected units. An agreement shall be reached between the manufacturer and the auditor on the final selection of the Real Unit for testing.

Observations of rotor arrangements in the AHUs shall be made. If it appears that (sometimes) parts of the actual heat exchanger surface of the rotor are blanked/obstructed it shall be verified in the manufacturer's software if this unfavourable assembly has been considered. The software shall predict a (small) reduction in efficiency and (substantial) pressure drop increase, compared to a selection with a completely open rotor surface.

At least one unit, selected by the auditor, shall be verified with the methodologies detailed in the following paragraphs:

Pressure drop consistency

The auditor will proceed to check the total static pressure of the fans (supply and extract) by doing the sum of every pressure drop of each component section.

Fan acoustic performance consistency check

The auditor will proceed to check the acoustic performance of a standalone fan "Alpha" with the acoustic performance of several fans "Alpha" for the same duty point of the single fan. The airborne sound power level and the octave band in-duct sound power level shall be higher for several fans Alpha than for the standalone fan Alpha.

Checking of the face air velocity

The auditor will check that the face air velocity (filter section, or fan section if no filter section) is properly calculated. Cf section A.3.1 for further details.

In case of force majeure (e.g. accidents, labour disputes, natural events, acts of war) which would not allow Eurovent Certita Certification to perform a factory audit, Eurovent Certita Certification can decide to replace it by another means of verification, to postpone it within a reasonable deadline or to cancel it. The Programme Committee will be informed regarding these cases.

The audit is considered as passed if no Critical non-conformities have been found by the auditor. The following penalties can be applied during the audit:

- Any Non-critical non-conformity identified during an on-site checking will be escalated to Critical non-conformity if not solved before or during the next follow-up audit.
- Any Critical non-conformity identified during an on-site checking shall be solved within 30 days after the factory audit (or within the deadline defined by the auditor during the audit). Non-resolution of a Critical non-conformity after this deadline can lead to an immediate suspension until the non-compliance is solved, at EUROVENT CERTITA CERTIFICATION sole option.

The classification of non-conformities is performed by the auditor (audit team leader in agreement with the members of the audit team when applicable). NC resolution report shall be issued by the auditor.

Use of components not in the certified software shall remain exceptional. Energy class calculation shall be consistent with the unit delivered to the customer. Eurovent Certita Certification is entitled to ask a manufacturer to include a component in the software if it is observed that this component is used regularly.

Handling several ranges

Case 1: 2 ranges with different names, Range A is certified, but Range B is not certified

ARE ENERGY COMPONENTS THE SAME?	IS MECHANICAL CONSTRUCTION THE SAME?	MANDATORY	FORBIDDEN	COMMENTS
YES	NO	Energy efficiency label for A	ECP mark and Eurovent Energy Efficiency label for B	Range A and B shall have significantly different names.

Case 2: 2 ranges with different names, Range A is certified, but Range B is not certified

ARE ENERGY COMPONENTS THE SAME?	IS MECHANICAL CONSTRUCTION THE SAME?	MANDATORY	FORBIDDEN	COMMENTS
NO	YES	Energy efficiency label for A	ECP mark and Eurovent Energy Efficiency label for B	Range A and B shall have significantly different names. MB shall have different names

Case 3: 2 ranges with different names, Range A is certified, but Range B is not certified

ARE ENERGY COMPONENTS THE SAME?	IS MECHANICAL CONSTRUCTION THE SAME?	MANDATORY	FORBIDDEN	COMMENTS
YES	YES	Energy efficiency label for A	ECP mark and Eurovent Energy Efficiency label for B	Range A and B shall have significantly different names.

Case 4: 2 products A and B from the same Eurovent-certified range: they include only components available in the certified software, except product B includes a Eurovent-certified HRS not included in the certified software.

ARE ENERGY COMPONENTS THE SAME?	IS MECHANICAL CONSTRUCTION THE SAME?	MANDATORY	FORBIDDEN	COMMENTS
YES except Eurovent certified HRS	YES	Energy efficiency label for A and B		

Case 5: 2 products A and B from the same Eurovent-certified range: they include only components available in the certified software, except product B includes a non-Eurovent certified HRS not included in the certified software.

ARE ENERGY COMPONENTS THE SAME?	IS MECHANICAL CONSTRUCTION THE SAME?	MANDATORY	FORBIDDEN	COMMENTS
YES except non-Eurovent certified HRS	YES	Energy efficiency label for A and ECP mark for B	Energy efficiency class and label for B	

Case 6: 2 products A and B from the same Eurovent-certified range: they include only components available in the certified software, except product B includes a fan (or fans) not included in the software.

ARE ENERGY COMPONENTS THE SAME?	IS MECHANICAL CONSTRUCTION THE SAME?	MANDATORY	FORBIDDEN	COMMENTS
YES except fan(s)	YES	Energy efficiency label for A and ECP mark for B	Energy efficiency class and label for B	

Case 7: 2 products A and B from the same Eurovent-certified range: they include only components available in the certified software, except product B includes a motor (or motors) not included in the software.

ARE ENERGY COMPONENTS THE SAME?	IS MECHANICAL CONSTRUCTION THE SAME?	MANDATORY	FORBIDDEN	COMMENTS
YES except motor(s)	YES	Energy efficiency label for A and B		

Case 8: 2 products A and B from the same Eurovent-certified range: they include only components available in the certified software, except product B has a mechanical construction not included in the software.

ARE ENERGY COMPONENTS THE SAME?	IS MECHANICAL CONSTRUCTION THE SAME?	MANDATORY	FORBIDDEN	COMMENTS
YES	NO	This case is not allowed as all mechanical constructions for a certified range shall be certified and available in the certified software. Products with non-certified mechanical construction shall carry a significantly different range name from the certified range name		

Additional requirements for the Hygienic option:

For the hygienic option, the manufacturer will have to validate 100% of the requirements listed in Appendix H through a documentation audit (applicable only for the qualifying campaign) and an audit.

Once the documentation audit is done the auditor will perform an additional on-site audit (1 day, audit duration can be adapted in case of combined audits) focused on the quality of the hygienic range.

Additionally, it is required that at least 40% of the requirements be visually checked (on an actual unit, component, model box, etc. and not on a document or software) by the auditor during the factory audit.

For the documentation audit, the manufacturer will have to fill out the document checklist provided by Eurovent Certita Certification and issue it to Eurovent Certitia Certification. This list will have to be completed carefully and accurately to assist Eurovent Certita Certification during its work. The reference of the document as well as the relevant paragraph or the location of the information shall be indicated in this document checklist.

III.1.4 Selection of units to be tested

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

The following number of units per factory producing the range (except the case of “sister factories”, see II.2.1) are then required for test in an independent laboratory for each range.

Regarding **Model Boxes**, Eurovent Certita Certification shall select the minimum number of units from the declaration list file to cover the construction variations available on the software and catalogue. All variations (marked by an X) and worst cases are mandatory to be tested according to Table 1, and worst-case performances can be transferred from the tested Model Box (MB) to other constructions. If several ranges use the same construction, the corresponding unit will be tested only once.

If a model box is partly tested (not on all mechanical characteristics); it shall have the same dimensions as the already tested model box (on other characteristics) from which not tested characteristics will be adapted to declare all claimed model box values.

Selection of one **Real Unit** suitable for testing shall be made during selection audits as described above. The size of the units, air volume performance, and cooling capacity shall be within the limits of the measuring facilities of the laboratory. An up-scaled or down-scaled unit can be selected if no suitable size is available.

For models selected for the test, a “TDS” file must be completed with the technical description of all components along with characteristics and performance data. This file is sent by Eurovent Certita Certification.

In case no unit with heat recovery or cooling/heating coils can be provided by the factory, these components and the associated performance shall be non-certified. Because it is a significant parameter for the energy efficiency classification, in case the software proposes heat recovery, then the selected unit shall include heat recovery.

For the sake of aerodynamic tests (airflow - pressure – absorbed motor power):

- *Design filter pressure drop needs to be selected according to EN 13053:2019.*
- *The cooling coil and the HRS have to be selected for dry conditions.*

If no Eurovent-certified filters are selectable in the software, an additional test is required to test the filter ISO efficiency of the selected filter (applicable from the 2025 campaign). This filter test is not required if a filter efficiency laboratory test report according to EN ISO 16890:2016 is supplied to ECC.

For the sake of the recalculation, and in the case of a release of a new software version before the recalculation, the manufacturer shall keep an archived version of the software on which the selection has been made for at least 1 year, or make sure that every component remains selectable in the new software for 1 year.

III.1.5 Tests at the independent laboratory

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

Before testing, the laboratory shall check the product against the information declared in the technical datasheet to ensure that the unit corresponds to the selection.

The laboratory shall not perform the test and contact EUROVENT CERTITA CERTIFICATION when:

- one or more pieces of provided information is not compliant with the technical datasheet (see technical appendix),
- one of the units appears damaged.

EUROVENT CERTITA CERTIFICATION will contact the applicant to give instructions regarding further actions.

The test on the Real Unit of a range can be carried out after the test results on the Model Box(es) is/are available.

III.1.5.1 Time limitation of acquisition and recovery of units

The provisions of the Certification Manual apply.

Model Box(es) for testing shall be supplied to the laboratory within 6 weeks for factories in Europe and within 8 weeks for factories outside Europe.

Real Units for testing shall be supplied to the laboratory within 10 weeks for factories in Europe and within 14 weeks for factories outside Europe upon receipt of testing notification from Eurovent Certita Certification.

When the manufacturer does not meet the corresponding time limits for the supply of units, this will be considered as a non-application of procedures and 3 points are removed from the contract.

Selected units shall be sent to the independent laboratory within a maximum of 6 months. If this deadline is not fulfilled, another on-site checking with selection shall be scheduled within a maximum of one year from the previous on-site checking.

The manufacturer shall be liable of any additional fees and costs caused by its failure to meet the prescribed deadlines.

The manufacturer shall inform the laboratory and the Eurovent Certita Certification team (preferably before the test) if he wants the unit to be scrapped after the test results are available.

Manufacturers must collect their products one month after receiving and accepting the test results. After this delay, the laboratory will destroy the units if not collected and the manufacturer will be invoiced through Eurovent Certita Certification.

III.1.5.2 Test procedure

Only independent laboratory personnel shall be permitted to handle test units. If the manufacturer's installation and handling instructions are shared by the manufacturer, it shall be followed. The laboratory shall be responsible for unpacking, handling, testing and packing the unit for shipment. The laboratory personnel shall make repairs to the test unit only in agreement with the manufacturer. No manufacturer's personnel shall be present in the test facility during the test.

The units shall be tested at the conditions as stated in Appendix A.

Independent laboratories shall test units at the conditions as close as possible to the selected rating conditions.

III.1.5.3 Test Results on Real Unit

For each unit, upon completion of all the measurements, the laboratory will render a test report (pdf) to Eurovent Certita Certification with tested data compared to the original selection data. If at least one performance measurement is out of the acceptance criteria, the client manager shall conduct a “test check”, i.e. the selection software will be used to recalculate the performance at conditions used for the test: test data will be compared to recalculation data. Eurovent Certita Certification will transmit a copy of the report together with the results of the test check.

If the results are out of the allowable acceptance criteria, or the calculation model appears inconsistent, failure treatment shall be applied.

For each test, a performance item fails when the difference between the declared value and the measurement is not within the allowable acceptance criteria (see Appendix A). A test fails when one or more performance(s) fail. In case of failure, Eurovent Certita Certification shall promptly notify the applicant/participant. The applicant/participant shall examine the reason(s) of the failure.

III.1.5.4 Initial test failure

Is considered an initial test failure in any situation where:

- the unit to be tested cannot be operated, or
- any functional component of the unit to be tested is out of order, or
- the unit to be tested, or any of its components is damaged, e.g. due to transportation.

In case of an initial test failure, the unit may be repaired (under the responsibility of the manufacturer) or replaced by a new one of the same model within 4 weeks, which shall be tested then, according to the normal schedule of the laboratory.

If, while testing the unit, the whole testing programme cannot be implemented because the specified testing conditions cannot be reached, then the test will be considered as failed and the manufacturer will have to restart the test procedure. In this case, the applicant/participant shall examine the reasons for the failure.

III.1.5.5 Leakage classes reached during RU tests

In case of failure on RU tests not reaching any Filter By-pass Leakage (FBL) class or not following the highest filter class of the filters installed in the RU, it is considered as Initial test failure (immediate stop of the test), and complete retest is mandatory. In case the retest is failed, the manufacturer range is suspended from the programme for 1 *year*.

In case of failure on RU tests not reaching the declared Casing Air Leakage (CAL) class, it is considered an Initial test failure (immediate stop of the test), and a complete retest is mandatory. In case the retest is failed, the manufacturer range is suspended from the programme for 1 *year*.

III.1.5.6 Unit failure on a real unit

For each unit, upon completion of all the measurements, the laboratory will render a test report (pdf) to Eurovent Certita Certification with tested data compared to the original selection data. If at least one performance measurement is out of the acceptance criteria, the client manager shall conduct a “test check”, i.e. the selection software will be used to recalculate the performance at conditions used for the test: test data will be compared to recalculation data. Eurovent Certita Certification will transmit a copy of the report together with the results of the test check.

If the results are out of the allowable acceptance criteria, or the calculation model appears inconsistent, failure treatment shall be applied.

- *After a failure, the manufacturer can ask for a second test, based on the same selection, after analysis of the non-conformity and implementation of actions if applicable. This second test could be partial depending on the modified component and the impact on the performances. The selection software shall not be adapted between the first and the second test. To verify this point, the selection of the first test will be made on the software before the second test recalculation to be sure that the performances in the printout are the same. If a second test is asked by the participant, then, one penalty test will be required during the next test campaign if the failure was considered as a high failure. Without any request for a second test after 1 month after receiving the test results, the failure will be considered accepted.*
- If the failure is established after the recalculation and the results are accepted, the manufacturer shall rerate his data by adapting the software to the test results within 6 weeks.

For the following performances, the performances shall be corrected in the software to the measurement +/-50% of the acceptance criteria:

- Absorbed motor power (fan)
- Heat recovery temperature efficiency
- Heat recovery humidity efficiency

For the other performances, it shall be corrected in the acceptance criteria tolerances.

After the second verification (“test recheck”), if the software is still not following the test results, the manufacturer will have two additional weeks for the final adjustment of the software. In case of a new failure, no adjustment of software will be accepted, and the manufacturer must restart the test procedure.

The following performance failures will be recorded as high failures and will lead to penalty tests:

- Heat recovery *temperature* efficiency
- *Heat recovery humidity efficiency (not applicable for the first test per manufacturer including the heat recovery humidity efficiency measurement)*
- Heat recovery pressure drop (supply and/or exhaust)
- Absorbed motor power (fan)

Thresholds of deviation leading to a high failure can be found in Appendix A.

If a component is not available on the market anymore, the rerating of the software for this component is not mandatory.
The following conditions shall be fulfilled:

- *Official document mentioning that the manufacturer has stopped using the component because not available on the market anymore.*
- *Software Update Record Sheet shall be sent by the manufacturer with the new version without the component.*
- *The component shall not be selectable anymore in the software (checked by ECC).*
- *The component shall not be used anymore in the factory for new production (checked by the auditor), otherwise it will be considered as a critical non-conformity.*

III.1.5.7 Penalty Test on Real Unit

In case of high failure, a penalty test will be added and shall be done during the current campaign year, the selection shall be done within one month after the treatment of the test (it could be done remotely).

The penalty test will consist of a full test except for acoustics and coils performances.

A new normal test will be added to the next campaign year and shall be done in the following twelve months (only needed for ISO 9001-certified factories).

The participant shall inform ECC of the feedback regarding the investigations following high failure results with the sharing of a detailed report (with reasons for the high failures and actions taken).

In case of two high failures *in 2 successive campaigns*, the Participant range is immediately suspended for 2 years. A new Real Unit selection will follow straight after the unsuspension of the Participant range and the 3-year cycle of surveillance will restart from this Real Unit test.

III.1.5.8 Test Results on a Model Box

For each unit, upon completion of all the measurements, the laboratory will render a test report (pdf) to Eurovent Certita Certification with tested data compared to the original selection data.

The manufacturer has four weeks after reception of the result to select one of the following alternatives:

- Accept measured values. (Uprate is allowed.)
- Ask for a second test on the same unit. In this case, the manufacturer can choose to re-test only the performances which are not accepted.
- Ask for a second test on another unit of the same model selected by Eurovent Certita Certification. *Modified units or units collected from the laboratory are included in this part*. In this case, the delivery shall be completed within 8 weeks from the date of the test report and all measurements are to be re-tested.

III.1.5.9 Failure in case of multiple production places

When a range is tested for different production places, if one surveillance test fails, all production places will have to re-rate their data, and the software shall be re-rated according to the worst test results for each performance item.

III.1.6 Granted certification

Eurovent Certita Certification shall grant the certification until 6 months after the next planned period of annual audit, if the following conditions are fulfilled:

- All non-conformities are corrected.
- The software is per all measurements.

When certified, the range is published on the Eurovent Certified Performance website (see II.3.2). The participant is then entitled to use the certification mark for this range in literature and on products (see II.3 paragraph and Certification Manual conditions).

III.1.7 Procedure for Brand Name Companies

Brand Name Company (A) has to declare to Eurovent Certita Certification a place (“office”) where the orders to the customers can be accessed and the software can be annually verified by a Eurovent Certita Certification auditor, during the same quarter as the verification of software held by the certified manufacturer (B). A’s office is often B’s factory.

The application procedure shall consist of a pre-check of the selection software.

The software shall be a version not already used by the Brand Name manufacturer, but already including the Eurovent Certified Performance mark. The pre-check shall include at least two comparisons between selections made with the OEM’s software and the Brand Name company’s software.

If the technical requirements (Appendix E) are fulfilled and the comparisons show no differences between the calculation results, the applicant can be certified. The certificate will be valid for 6 months following its delivery date.

Once the certification is granted, an audit of the A company’s office shall be carried out no later than 3 months after the delivery of the certificate. Once the result of this audit is passed, the certificate shall be extended to its normal validity date.

If a range or a production place of B doesn’t fulfil the requirements and B’s certificate is suspended and/or withdrawn from the programme, A is also automatically suspended. If B quits certification, A is offered the possibility to cover test expenses for B’s products.

The Brand of the A company must be shown on the output.

A is fully responsible for his software and any non-compliance may have a consequence on A certification, even if B is the software provider.

The city(ies) and country(ies) of the production site(s) of Company B shall be displayed on the Eurovent Certified Performance website next to Company A units and on the Company A certificate.

III.2 Surveillance procedure

III.2.1 Surveillance audit

The first surveillance audit shall be conducted within 6 months after the certificate is granted.

Annual on-site checking shall be performed in each Participant’s factory(ies).

In addition to the provisions laid down in the Certification Manual, the following requirements apply.

Every year, upon receipt of the audit’s notification, the participant shall submit to Eurovent Certita Certification an updated version of its declaration list file with all the required characteristics and performance data, as required by this TCR.

Each certified range shall be allocated 15 audit points after the first delivery of the certificate. Each critical non-conformity related to a range (independently of the manufacturing place), shall remove 2 points to the account of the range. Should the same critical non-conformity be found in two different manufacturing places before the delay for correction has expired, it will not lead to an additional loss of points.

Any critical non-conformity linked to the Participant itself as per the Certification Manual (CM) Table 1 Art.193 (refer to CM §III.4 latest version in force) and not to a specific range (including non-conformity to the certify all) will be evaluated according to the table 1 Art.193 of the CM latest version in force.

If a range reaches 0 points, the Participant shall be notified for immediate suspension of the range for one year (even if another certified range still has points). The number of points in each range is reset to 15 once the participant is unsuspended.

Two consecutive audits without critical non-conformity reset the account to the initial level.

If the same range is produced in different sister factories, 3 additional points per sister factory will be allocated to the range.

During the annual on-site checking of software, the same procedure as the initial audit (cf. III.1.3) shall be applied. During audits without the selection of a unit for testing, any size may be selected.

The expected performance of at least one project shall be recalculated based on components reselected with the software provided to Eurovent Certita Certification. The composition, technical specifications and performance from recalculation shall be the same as the one specified and announced to the customer. If in the meantime the Participant has officially launched a new software version and recalculation is made with this version, deviations should be traceable in the software update record sheet. Deviations in performance above acceptance criteria can lead to additional tests. If it appears that different software had been used, this shall be considered as a non-application of procedures (see the relevant chapter in the Certification Manual).

In addition, the mechanical construction (all the parameters) of one production unit shall be verified by the auditor, to compare certified characteristics of production with the tested Model Box(es). If it appears that a different construction had been used, an additional Model Box test shall be required by the auditor.

Anytime, Eurovent Certita Certification has the right to ask an auditor to conduct a surprise audit of the participants' factory as well as to collect data directly from customers and perform extra checking of software.

At least one unit shall be verified with the two methodologies detailed in the following paragraphs (these checks shall only be performed when there is no Real Unit selection:

Consistency check of heat recovery systems

In case the selection is performed at a temperature lower than the lowest temperature allowed by a given Heat Recovery System (HRS) software, the comparison check has to be done at the lowest temperature available in the HRS software.

The auditor will check the consistency of the performance of heat recovery components by comparing the results of the printout with the output of the standalone software of the Heat Recovery System supplier (applicable only in case of certified supplier).

The software shall always deliver the latest certified performances of the HRS standalone software. Should a new version of the HRS supplier's software get approved by Eurovent Certita Certification, the AHU manufacturer shall update its selection software within 3 months. Any discrepancy (as described below) between the dll and the HRS standalone software found after these 3 months is considered a critical NC (for any discrepancy between the dll and the software on the certified performances). The dll version and date shall be documented, otherwise, it is considered a critical NC.

The efficiency and pressure drop data in the AHU quotation or software shall be compared with the results obtained from the current stand-alone certified software from the HRS supplier. AHU manufacturers can never claim higher efficiencies and/or lower pressure drops than the values received from the stand-alone software.

If possible one quotation with a rotor and one quotation with a plate heat exchanger must be checked.

Consistency check of small and large coils

During the factory audit, the auditor will check the consistency of the performances between small and large coils. The methodology is described in Appendix D.1.

Should the consistency check not meet the acceptance criteria described in the methodology below, the manufacturer shall be able to explain this deviation. The auditor shall be entitled to finally make the decision.

Heat recovery coils are excluded from this consistency check.

Specificity of the check software in the case of "sister factory":

In the case of sister factories, the Participant has the possibility on request to perform only one software check per range and per year remotely. If so, then only the re-selection of **at least one project** per range will be done during the audit on site.

The following checks will be performed during the remote software check once a year on one or several random selection(s):

- HRS consistency (of all HRS suppliers, for plate and rotary only)
- Energy efficiency class
- Coil consistency check (of all coil suppliers)
- Information to be found on the printout.

The onsite audit of each sister factory is then reduced to 5 hours of work (7 hours in case of RU selection).
The remote software check (valid for all the sister factories) consists of a minimum of 4 hours of work (for one HRS supplier and one coil supplier) + 1 additional hour per additional HRS and Coil supplier.

In case of additional range during the onsite audit, 2 additional hours will be performed (instead of 4 hours).

Additional requirements for the Hygienic option:

Every participant will have to re-validate 100% of the requirements listed in Appendix H for 3 years through annual on-site audits (0,5 day, audit duration can be adapted in case of combined audits). The audit consists of a visual checking of the unit/components available during the audit of the factory and, a review of the software and technical documents with the manufacturer.

If a visually checked hygienic requirement on a unit is fulfilled for one factory it is considered as fulfilled for all the sister factories.

During an annual audit (except the last year of a cycle) if some requirements haven't been validated this will be postponed for the following year, the validation of the remaining requirements will be the priority of the auditor.

If no order has been received by the manufacturer for a hygienic product and if the auditor cannot check all the requirements listed in Appendix H for 1 year, the auditor will review the capability of the manufacturer to produce units following the requirements specified in the Appendix H and the quality management system to check that:

- The suppliers are regularly evaluated, and the corresponding evaluations are recorded.
- The raw material or incoming goods conformity with the bill of material (BOM) specifications is regularly evaluated and the corresponding evaluations are recorded.
- The manufacturing process key steps are submitted to a validation check which results are recorded.
- The factory personnel is qualified to perform the specific tasks if any.
- Every product traceability is ensured, it includes the AHU system and its components.
- Calibration of measuring devices is performed regularly; production non-conformities are recorded and corrective actions initiated; customer complaints are registered and treated (OEM and BN).

After 3 years and if all the requirements have been validated a new cycle of 3 years will restart.

If after 3 years a manufacturer still hasn't received any order for a hygienic unit and cannot validate the requirements listed in Appendix H or if after 3 years it is not possible to validate 100% of the requirements listed in Appendix H, then the Hygienic option will be suspended from the certificate. To be granted again for the Hygienic option the admission process must be done again.

In case of modification of the design of a declared range and if this modification has an impact on the quality and more specifically on one of the requirements listed in Appendix H, the manufacturer shall inform Eurovent Certita Certification. The manufacturer will be asked to issue the relevant documents, and this will be followed by a documentation audit of the modification and checking of the requirements impacted by the new design.

An additional cost for the documentation audit will be applied based on the nature of the modification.

III.2.2 Selection of units to be tested

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

For manufacturers, Participant's quality control shall be appropriate to maintain the performance within the acceptance criteria. A quality system according to ISO 9001 (covering the production quality systems) is acknowledged by a reduction in the frequency of surveillance tests. The manufacturer shall then annually provide a valid ISO 9001 certificate to Eurovent Certita Certification.

For each certified range and factory (except for sister factories), surveillance tests in the independent laboratory selected by Eurovent Certita Certification shall be required every three years for performance of Real Unit for participant factories holding valid ISO 9001 (every year otherwise).

Eurovent Certita Certification shall select the units for surveillance using the same procedure as for the selection of units for the admission test.

A different configuration from that previously tested shall be selected, with a different Heat Recovery System from one year to another (HRS type and with or without humidity transfer). If possible, a RU size different from those previously tested shall be selected.

III.2.3 Surveillance tests

In addition to the provisions laid down in the Certification Manual, the following requirements apply.
The same procedure as the initial testing procedure for Real Units (cf.III.1.5) shall be applied.

III.2.4 Renewed certification

The certification is renewed for another campaign once all audits are passed, all tests are ordered, the previous campaign is finished, and the fees fully paid.

III.2.5 Procedure for Brand Name Companies

For a Brand name company, only on-site checking of software shall be conducted annually at the place ("office") where the customers' orders can be accessed.

III.3 Declaration of modifications

The provisions of the Certification Manual apply.

The applicant/participant shall inform Eurovent Certita Certification and the auditor of any modification to the range and/or software, using Form AHU-4C. A new software version without impact on performance does not have to be sent. If new components (fans, coils etc) are implemented in standard production, the manufacturer shall inform Eurovent Certita Certification and provide new software to the auditor. For the next test new components shall be selected.

The applicant/participant shall inform Eurovent Certita Certification of any modification of the product portfolio by updating the declaration list file and sending the updated selection software together with the software update record sheet AHU-4C.

Non-compliance is considered as a non-respect of procedures.

Anytime, Eurovent Certita Certification has the right to perform extra checking of software. Eurovent Certita Certification decides whether the modification is significant for the certified performance data or not. In the case of significant modifications, Eurovent Certita Certification is entitled to demand adequate tests to verify the influence on performance data. This test shall not be considered as a surveillance one.

Ranges to be taken out of production

Running a test on a unit from a range/model (Real Unit or Model Box) which is going to disappear from the market can represent a useless cost for the Participants. If a test is necessary on a unit from a range/model (Real Unit or Model Box) which is going to disappear from the market, the Participant may send an official letter to Eurovent Certita Certification stating that the range/model (Real Unit or Model Box) will disappear between the date of the scheduled test and the date + one year. The range/model (Real Unit or Model Box) remains then certified for a maximum of one year. If the Participant changes his mind or if it appears that the range is still available after that time, it is considered a major breach of the rules, and the Participant will have to pay a penalty fee of 15 000 €. In addition, the unit will have to be tested and the following test will have to follow a normal schedule.

If the concerned range or model has been already selected for the sake of a surveillance campaign this process cannot be applied following the Certification Manual (latest version in force).

III.4 Suspension/cessation conditions

Following the Certification Manual and these Technical Certification Rules, participant contract or range is suspended due to:

- Contract counter reaches 0 points.
- Range counter reaches 0 points.
- 2 successive campaigns with high failure.
- Non-compliance with certification rules.
- Non Payment of EUROVENT CERTITA CERTIFICATION fees
- Voluntary suspension.

By application of the certify all principle, in case of range suspension, all the ranges produced in the same declared factory are suspended and all the ranges selectable in the same software are suspended.

In addition to the provisions laid down in the Certification Manual and in these Technical Certification Rules, the following requirements apply for unsuspension:

- Conditions to unsuspend the certification are described in the suspension notification.
- Software check if a new version is implemented.
- Declaration list file check.
- Factory audit if the last one was performed before the N campaign.
- RU surveillance test if the last one was performed before the N-2 campaign (or N campaign for non-ISO 9001 factories).
- MB surveillance test if new construction variations are declared.

APPENDIX A. TECHNICAL APPENDIXES

A.1 Purpose

The purpose of this technical appendix is to establish definitions and specifications for testing and rating of Air Handling Units for the related Eurovent Certified Performance Programme, following these Technical Certification Rules.

A.2 Testing requirements

A.2.1 Air flow rate – pressure – absorbed motor power (fan) – OACF/EATR

Aerodynamic tests (airflow - pressure - absorbed motor power) shall be performed following the test standard ISO 5801:2017, in an operating range of +/-5% around the selected rating point.

Air flow rate, pressure and absorbed motor power shall be established for three points *and one "secret" point chosen by the laboratory* in the range of normal operation of the unit. Both the supply air side and the exhaust air side shall be measured (*both air sides in operation*) and certified. *Tests shall be done under isothermal conditions.*

The HRS needs to operate in dry conditions as in the duty points (rotors run, for plate heat exchangers the bypass is closed, RACs without any special demand). The HRS shall be delivered ready to use by the manufacturer (including the purge sector).

All pressure drops measured during the airflow test shall be converted to standard conditions (1.2kg/m^3) in the test report.

50 Pa of the external static pressure in the nominal duty point should be on the outdoor (21) and exhaust (12) airside. The rest of the ESP shall be adjusted on the supply and extract sides.

In the case of fans with adjustable speed, the airflow and the ESP shall be set by adjusting the fan speed.

In the case of fans without adjustable speed, the airflow shall be set and, the ESP, shall be measured. *If the ESP_{test} is lower than the declared one, the test is considered as an initial test failure and the test has to be stopped.*

The following procedure must be followed in the case of a fan with adjustable speed for the testing conditions:

1. Set airflow at nominal airflow by adjusting fan speed and then measure clean filter pressure drop (PD). The Clean measured pressure drop should then be converted to standard conditions (1.2kg/m^3).
2. Determine the corrected design pressure drop (PD) using the following formula:

$$\text{Corrected Design PD} = \frac{\text{Declared Final PD} + \text{Measured Clean PD}^{1}}{2}$$

3. Determine the ESP_{test} by applying the following formula:

$$\text{ESPtest} = \text{Declared ESP} + (\text{Corrected Design PD} - \text{Measured Clean PD})$$

   The extra pressure drop $(\text{Corrected Design PD} - \text{Measured Clean PD})$ is added at the airside where the filter is placed.

4. Set airflow to nominal airflow and ESP to ESP_{test} by adjusting fan speed and damper.
   a. Once airflow and ESP_{test} are successfully set to desired values, the test is passed if the measured absorbed motor power is within the acceptance criteria.
   b. If the fan reaches its maximum speed the following conclusion must be made based on the situation of the nominal airflow and the ESP_{test}:

[1] Converted to standard conditions

i. The nominal airflow is reached but the ESP_{test} cannot be reached, then a correction of the airflow from the Technical Data Sheet and the maximum ESP that the unit can sustain will be requested to the Participant/Applicant. In that case, the test is **not** considered as an initial test failure (cf section III.1.5.4 apply)
ii. The nominal airflow cannot be reached, and the ESP is so low that the airflow cannot be increased, then the test is considered an initial test failure and the procedure described under section III.1.5.4 apply.

Measured values:

- *Absorbed motor power of each fan ("wire to air" including the speed control)*
- *pressure drop of the HRS (both air sides)*
- *static pressure increase of the fans*
- *clean pressure drop of the filter*
- *extract, supply, and outdoor airflows*
- *EATR at nominal operating point, according to EN 308:2022. This test is required for:*
    - *Units equipped with AARE.*
    - *Units equipped with AAHE or RAC with a common wall between the exhaust and supply side, only if the internal static leakage test according to EN308:2022 5.6.2 fails (higher than 3%).*

Following parameters shall be calculated from measured values:

- *OACF*

Airflow using the AHU integrated airflow measuring device is reported (only for information).

A.2.2 Cooling capacity

Thermal tests shall be performed under two conditions in cooling with only the supply side open:

- design conditions corresponding to values used to select the unit for the test,
- slightly different conditions selected by Eurovent Certita Certification.

These conditions shall be chosen in the normal operating range of the unit selected for the test. The corresponding performance characteristics shall be calculated using the same manufacturer's software.

Typical design thermal conditions shall be:

- for cooling:
    - air inlet temperature 27°C
    - air inlet humidity 47 % r.h.
    - water inlet temperature 7°C

The test shall be performed at the specified water flow rate and the specified air mass flow rate.

Measured values:

- *Air volume flow rate.*
- *Air temperature inlet and outlet of the AHU.*
- *Water mass flow rate.*
- *Water temperature at coil inlet and outlet.*
- *Water pressure drop of the coil.*

A.2.3 Heat recovery

All tests are performed according to EN 308:2022 (test type B) and the airflows and ESP_{test} are adjusted to the nominal duty point 100%.

The following conditions from EN 308:2022 should be adjusted.

- *W1 for dry temperature efficiency (all HRS)*
- *S1 for summer conditions (for units with humidity recovery in summer like sorption wheels and enthalpy plates)*

Measured values:

- *Temperature conditions (temperature efficiency)*
- *Humidity conditions (humidity efficiency if the humidity is declared greater than zero)*

- *Air volume flow rates*
- *Pressure drop of the HRS*

Measured values for units equipped with RAC:

- *Brine test (%-volume of the concentration of anti-freeze agent) (not defined in EN 308)*
  - *Measure density: The density of the brine (at 25°C) should be tested with a hydrometer or a refractometer. This density will be used to determine the %-volume of the concentration of the anti-freeze agent with the following table Glysofor-N-Specification-EN.pdf. Tolerance on glycol content is +/-3%-points (in volume).*
- *Fluid flow: Should be measured to validate the results on the airflow (by the integrated measurement device from the manufacturer). If the test is not passed, it should at least confirm the negative results on the air side (only if needed by the manufacturer).*
- *Fluid pressure losses*
- *Circulation pump absorbed power.*

The following systems could be tested:

(1) Run-around coil system

Testing can be done on the complete system or the coils only.

Test on the complete system

Delivery scope: Variant 3 according to EN308:2022 (5.7).

- *Heat exchangers on both airsides.*
- *Hydraulic assembly: pump, valve, pipes, pressure measurement taps, measurement devices (measurement devices for internal use not for testing) if needed.*
  - *The pressure measurement taps must be defined and executed according to EN 1216.*
  - *The pressure measurement tap must be positioned in the middle of a straight pipe with a constant diameter.*
  - *This pipe must have a length of a minimum of ten times the pipe diameter.*
- *Fluid (the system is filled and ready for use) with a minimum 25%-volume of ethylene glycol or higher as declared by the manufacturer's software.*
- *Mounting instructions.*
- *Control equipment and control instructions to reach the operative point.*

Coils and fluid circulating system should preferably be delivered ready for use with the air handling unit. Otherwise, it will be completed in the laboratory by the manufacturer. The frequency of the pump shall be pre-set by the manufacturer but can be adjusted by the laboratory when provided by the manufacturer.

Test of the coils only

If the software doesn't allow selecting a system with 25% glycol, selection and test shall be done with water only. Otherwise, the unit shall be selected and tested with 25% (volume) ethylene glycol.

- Identical coils

If the coils on both air sides have the same geometry only one coil is tested at the declared inlet fluid temperature and the declared fluid mass flow rate. The measured capacity will be transposed to the other air side to calculate the outlet temperature.

If the configuration of fans and coils are different on the supply and the exhaust side, then the coil being installed downstream to the fan has to be tested (worst configuration for a uniform airflow across the coil).

- Different coils

In case the coils have different geometry (e.g. different fin spaces) both coils have to be tested.

(2) Rotary heat exchanger system

(3) Plate heat exchanger system.

A.2.4 Sound power level

This test is performed on supply side with the other air path closed.

(1) In duct sound power level

The test for determination of the in-duct sound power level will be performed with a free inlet and a duct with (at least) the length of one equivalent diameter at the inlet and the outlet. The outlet shall terminate flush with the wall surface.

The method of measurement will be selected according to the possibilities of the test laboratory:

- by free field method in the inlet and outlet plane of the duct,
- by sound intensity method in the inlet and outlet plane of the duct,
- by the reverberation room method installing the inlet and outlet duct through the wall of a reverberation room.

The acoustic test will be performed with the specified air flow rate and fan speed at ambient conditions.

Corrections for end reflection will be made following the relevant Standards (see below A.3.6).

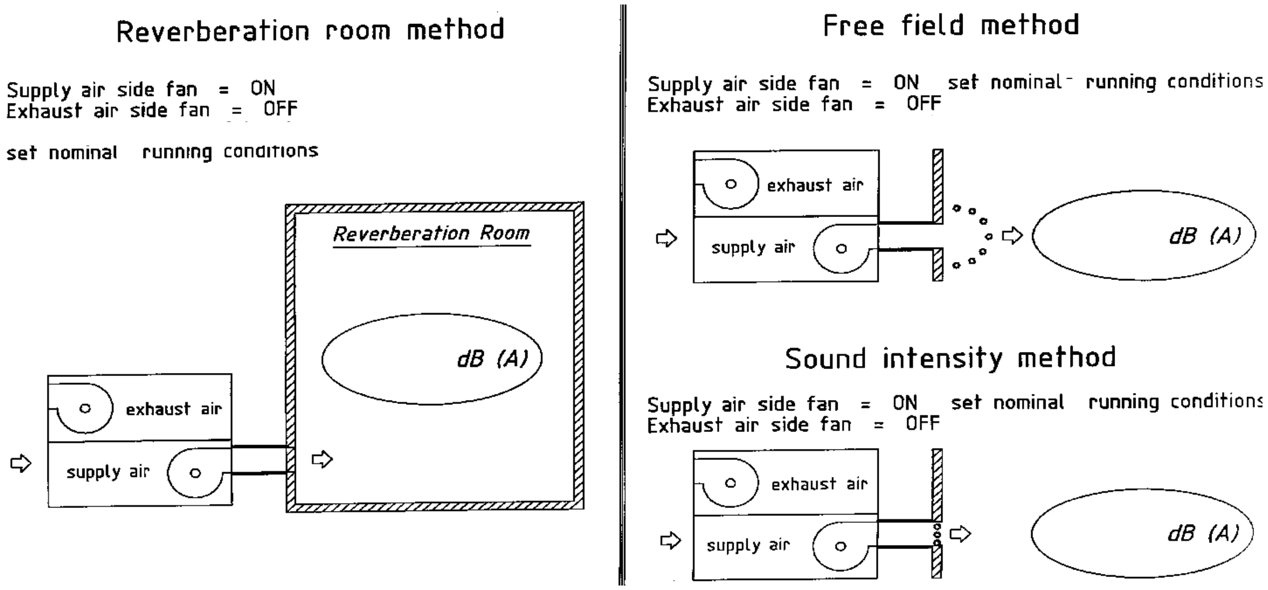


Figure 4: In duct sound power level measurement

(2) Airborne sound power level

The airborne sound power level will be measured with a ducted inlet and ducted outlet.

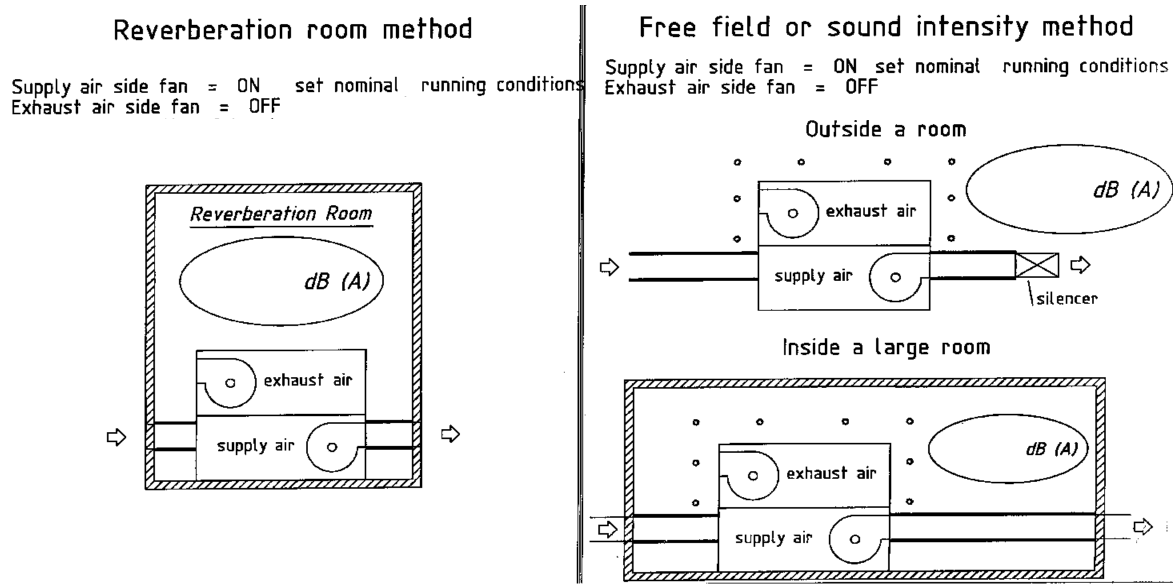


Figure 5: Airborne sound power level measurement

A.2.5 Check of insulation material (MB test)

After a test on a standard MB according to EN 1886:2007, the laboratory shall drill a hole from the outside, take a picture and identify the insulation material.

A.2.6 Mechanical performances (RU test)

In case the biggest size of a range has lower dimensions than the minimum dimensions required in EN 1886:2007 then the biggest size shall be tested with the conditions given in EN 1886:2007. All other requirements given in EN 1886:2007 shall be fulfilled.

The casing air leakage (CAL) shall be measured according to EN 1886:2007 at -400Pa, +400 and +700Pa. The CAL shall then be calculated at +700 Pa using the formula (2) of EN 1886:2007 using the measured value at +400Pa as an input parameter.

CAL at -400Pa +400Pa must be reported in the report as well as the CAL at +700Pa calculated with the formula (2) but for information only.

The deflection shall be measured according to EN 1886 (test pressure according to EN 1886:2007 from 100% duty point).

The filter bypass leakage shall be measured according to EN 1886:2007.

The internal static leakage test is performed according to EN308 5.6.2 with the conditions described in the EN308 Table 24 to determine the leakage rate.

A.2.7 Filter efficiency (applicable from the 2025 campaign)

If applicable (III.1.4), ISO efficiency test for the selected filter is performed following EN ISO 16890:2016 in a laboratory from the ECP FIL certification programme.

A.3 Rating requirements

A.3.1 Air velocity in the AHU

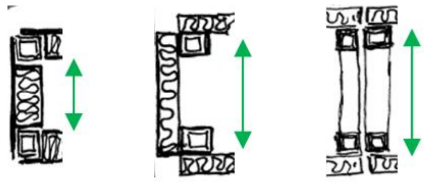


Figure 6: Several construction possibilities

Whatever the configuration of the mechanical construction, the cross-section to be used for the calculation of the air velocity is the distance between the panels of the section (filter section, or fan section if no filter section).

A.3.2 Fan pressure and absorbed motor power

Recalculation after the update of software for fan external static pressure and absorbed motor power shall be based:

- *for fixed speed fans: on nominal airflow and measured fan speed*
- *for variable speed fans: on nominal airflow and external static pressure.*

All three dry duty points shall be recalculated and evaluated. The three dry duty points must be within the acceptance criteria. This is also applicable for the secret airflow point if used during the second recalculation.

The recalculation and evaluation procedure will be as follows for fixed-speed fans:

- Reselect the real unit on measured fan speed and measured volume flow rate. The measured fan speed can be attained by changing the external static pressure until the displayed selection value is equal to the measured value.

- Compare the external static pressure in the selection with the measured external static pressure, (corrected for clean filter pressure drop). The available static pressure obtained from the reselection shall be *higher than the measured one.*
- Compare the measured absorbed motor power with the absorbed motor power obtained from the reselection. The measured value shall be within the allowable deviation (not higher than *6*% of the selection value).

The recalculation and evaluation procedure will be as follows for variable speed fans:

- Reselect the real unit using the measured airflow and record the filter pressure drops (clean and design)
- Calculate the correction to apply to the external static pressure (to consider the clean filter installed in the real unit Vs design declaration from the software) as follows:

ΔpCorrection= Δpdesign filter – Clean measured filter pressure drop

Δpdesign filter = Applied Design Filter(s) pressure drop + (Clean measured pressure drop – Clean applied pressure drop)/2

"Applied" means the value the software declares during the recalculation with measured airflow.

- The corrected external static pressure shall then be used as the second input together with measured airflow.
- Compare the measured absorbed motor power with the absorbed motor power obtained from the reselection. The measured value shall be within the allowable deviation.
- The test fan revolution is not compared with the declared one.

In case of a second recalculation, the "secret" airflow point shall be recalculated and evaluated as defined above.

Secret air flow operating point: this point shall be in the range of the fan and will not be selected during the audit. It will be tested following the same process as the other points but will be used only in the case of a second recalculation of the unit.

This secret operating point aims to ensure that the applicant/participant does not only modify its software for the selected and tested points but for the complete working range of the fan.

The secret airflow point will be selected by the laboratory and can be selected anywhere along the fan curve *within +/- 5% of the nominal air volume flow*.

A.3.3 Recalculation on sound power levels

Recalculation after software update for sound power level shall be based on airflow and measured rpm.

A.3.4 Cooling coils

Recalculation of coils shall be based on measured performance using test inlet conditions (mass flows air and water; inlet temperatures air and water).

A.3.5 Heat recovery

There shall be one digit after the decimal when displaying the heat recovery efficiency in the AHU selection software.

A.3.6 Sound power levels in unit openings - impact of end reflection

Low frequencies shall be corrected according to EN 13053:2019 duct end corrections.

A.3.7 Management of filter holding system for pre-filtration

Should a certain type of filter holding system be used only for pre-filtration (ISO Coarse filters only), and always together with a second stage with a better FBL class, then the filter bypass leakage on the supply side of this option should not be displayed on the website. The auditor shall check that the software does not allow any fine filtration with this option, nor the unit to be calculated without a second filtration stage.

A.4 Acceptance criteria

When tested in the laboratory the obtained performance data shall not be different than the acceptance criteria defined in the table below:

Performance	Acceptance criteria	High Deviation
Absorbed motor power	+6%	+*15%*
Heat recovery efficiency	-*4*%-points	-6%
Heat recovery humidity efficiency	*-6%-points*	*-8%-points**
Heat recovery pressure drop (air side)	Max. of +10% or +15Pa	+26%
Water coil performances *(cooling)*	-2%	
Water coil pressure drop (water side)	Max. of +*15*% or +*4*kPa	
EATR	*-2%*	
OACF (>1) ***OACF (<1)***	*+0,05* *-0,05*	
Radiated sound power level casing	+3 db(A)	
Sound power level unit openings	+5 dB @125Hz +3 dB @ 250-8000Hz	
Run-around coils, fluid side pressure drop for each coil	Max. of +*15*% or +*4*kPa	
Absorbed motor power of circulation pump	+15%	
Casing Air Leakage	Same class or higher	
Filter ISO efficiency	*-7%-point and ≥50% for declared* *ePMx group*	

**The first test per manufacturer including the heat recovery humidity efficiency measurement will not lead to a penalty test for high deviation on this performance.*

If lower performance is found than claimed on the unit (Real Unit or Model Box) tested, all other sizes or constructions not yet tested shall be re-rated following test measurements (to claim better class on one performance data on MB configuration, another MB with the construction parameter variation shall be tested).

APPENDIX B. FORM

B.1.1 Form AHU-4C: Software Update Record Sheet

Company Logo

XXXXX Software Name
Software Update Record Sheet

Prepared By: ______________________________

Software Revision	Date	Brief Description of the update

APPENDIX C. CAMPAIGN SCHEDULE

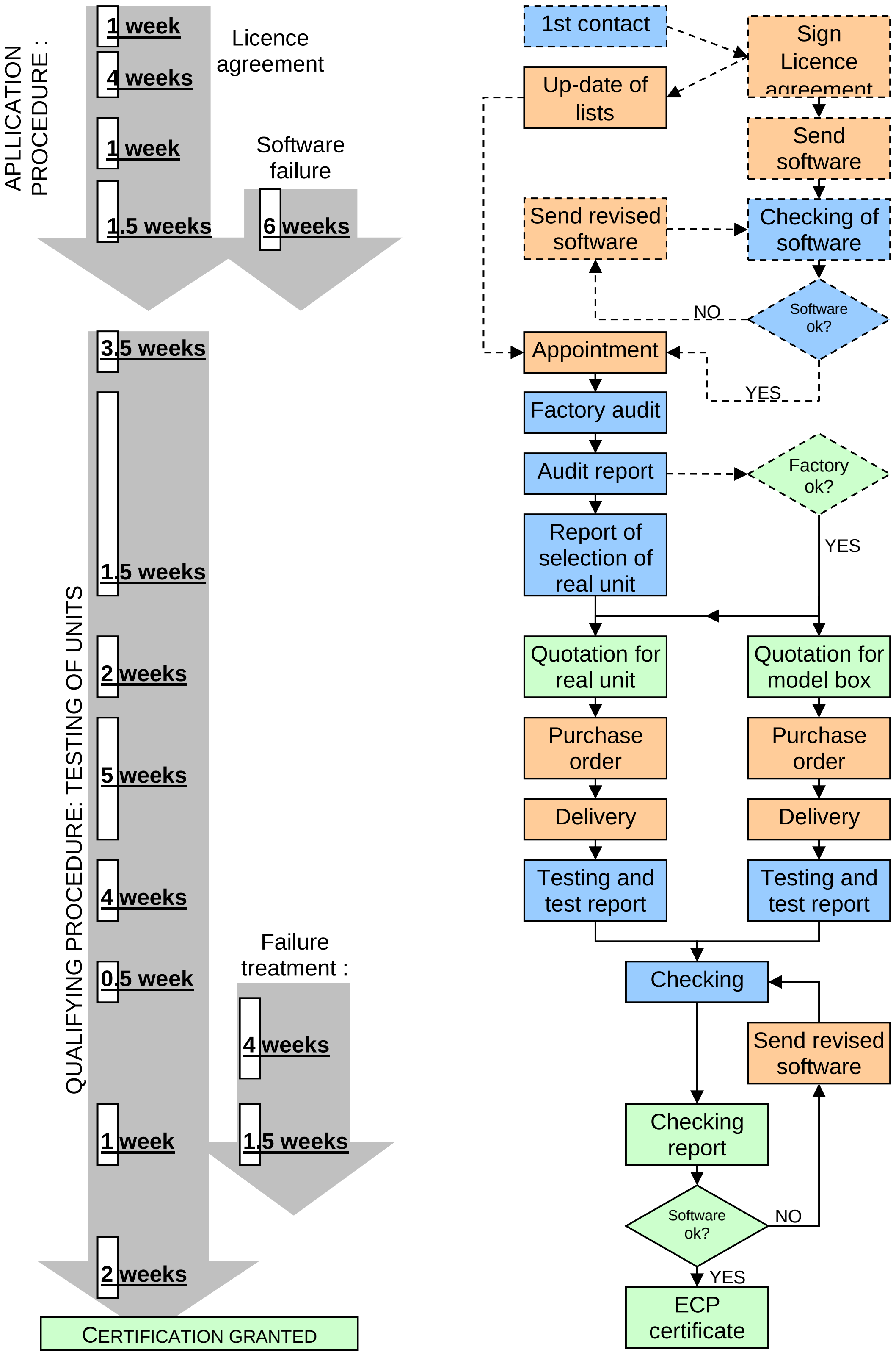
C.1 Application and test schedule

The process lasts an average of about 8½ months, including the preliminary steps, provided that the participant responds in time to EUROVENT CERTITA CERTIFICATION requests. About 7 months are necessary for surveillance tests (pre-checking is not included).

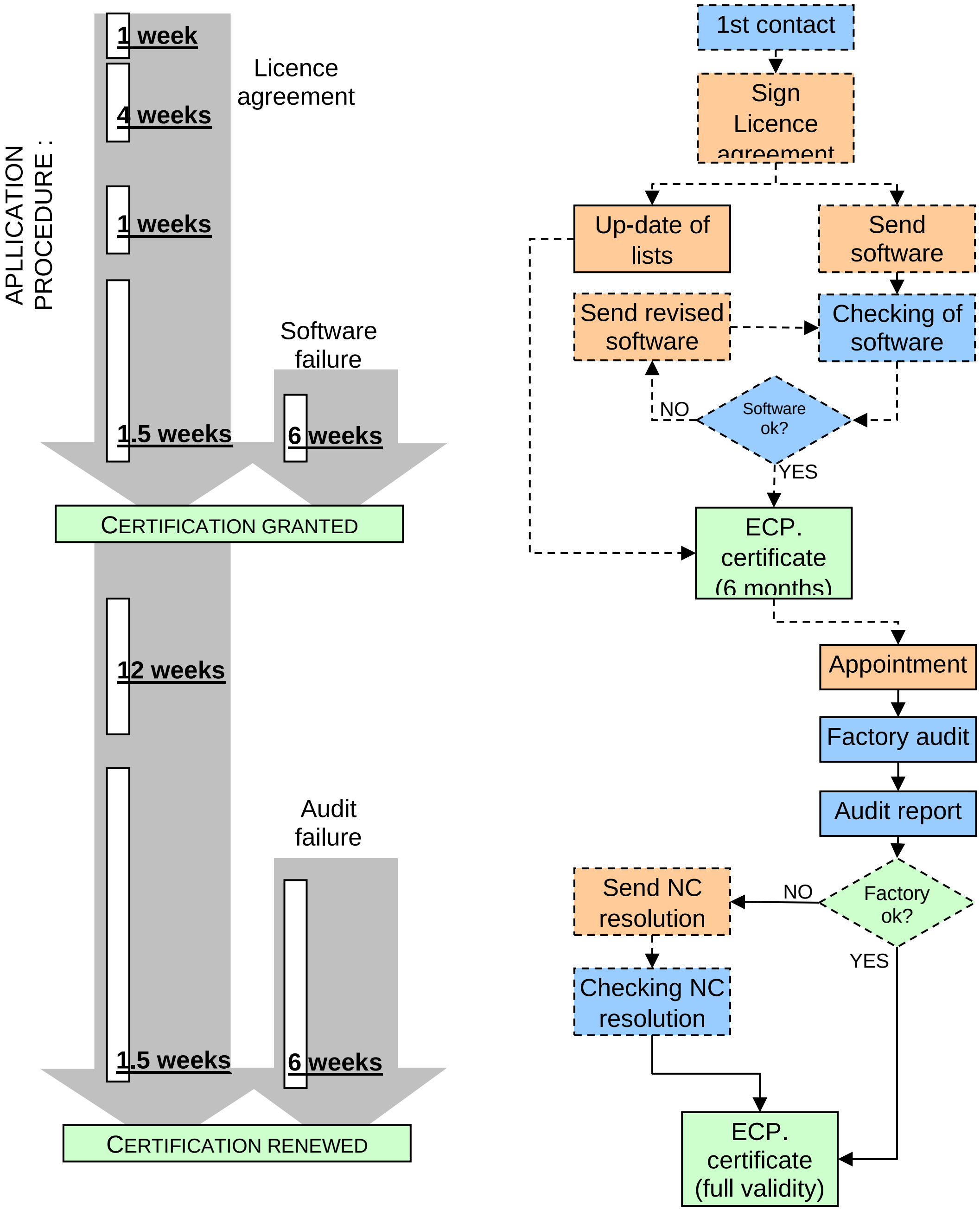
Certification Step			
How many weeks does it take (for information)?	min	max	
			Average week number
The auditor appointed by Eurovent Certita Certification contacts the manufacturer.	1	1	1
The manufacturer sends software to the auditor.	1	4	3.5
The auditor pre-checks the software. When software does not meet the certification requirements, the manufacturer has to correct it and send a new version. When the software meets the certification requirements, the manufacturer makes an appointment with the auditor to audit the factory.	1	2	5
Waiting for the audit date.	1	4	7.5
The auditor audits the manufacturer’s factory, checks sale data and selects one unit for testing. The auditor gives the report to the manufacturer at the end of the audit and forwards a signed copy to Eurovent Certita Certification, along with the technical data sheet of the RU selection. The manufacturer must update his list of products and then send it to Eurovent Certita Certification.	0	1	9
Eurovent Certita Certification has to send the manufacturer the audit report and the quotation according to the technical form of the selected real unit(s). When necessary, Eurovent Certita Certification has also to send the quotation for the model box(es).	1	3	11
The manufacturer has to send the order/payment(s) to Eurovent Certita Certification. The unit(s) has(have) then to be delivered to the independent laboratory(ies) (2 to 6 weeks for Europe, 4 to 8 weeks for outside of Europe).	2	8	16
Waiting for the availability of the test rig.	0	5	18.5
The unit(s) is/are tested at the laboratory(ies).	1	2	20
The client manager checks that the software is following the test results. The laboratory has to send the test report to Eurovent Certita Certification.	1	2	21.5
Eurovent Certita Certification has to send the report (comments included) to the manufacturer. If the software is following the test results, the certification is granted for the next period.	0	2	22.5
In case the software is not following the test results, the manufacturer has to send the software revised according to the test results to the client manager.	2	6	26.5
The client manager has to check the revised software and send Eurovent Certita Certification a new, revised report.	1	2	28
Eurovent Certita Certification has to check this report and send it to the manufacturer. If the software is following the test results, the certification is granted for the next period.	0	2	29
In case the software is still not following the test results, the manufacturer may correct it again and send it back to the auditor for rechecking.	2	4	32
The client manager has to check the software and send a new report to Eurovent Certita Certification.	1	2	33.5
If the software is following the test results, the certification is granted for the next period. In case the software is still not following the test results the selection process has to start again from the beginning and the manufacturer’s data are withdrawn from the Eurovent Certified Performance Website until the certification is granted (min. one year after the first certification step).	0	1	34
TOTAL number of weeks necessary	15	51	**34**

Table 3: Minimum, maximum and average time needed for certification of a range

C.1.1 Planning for OEM application procedure



C.1.2 Planning for BN application procedure

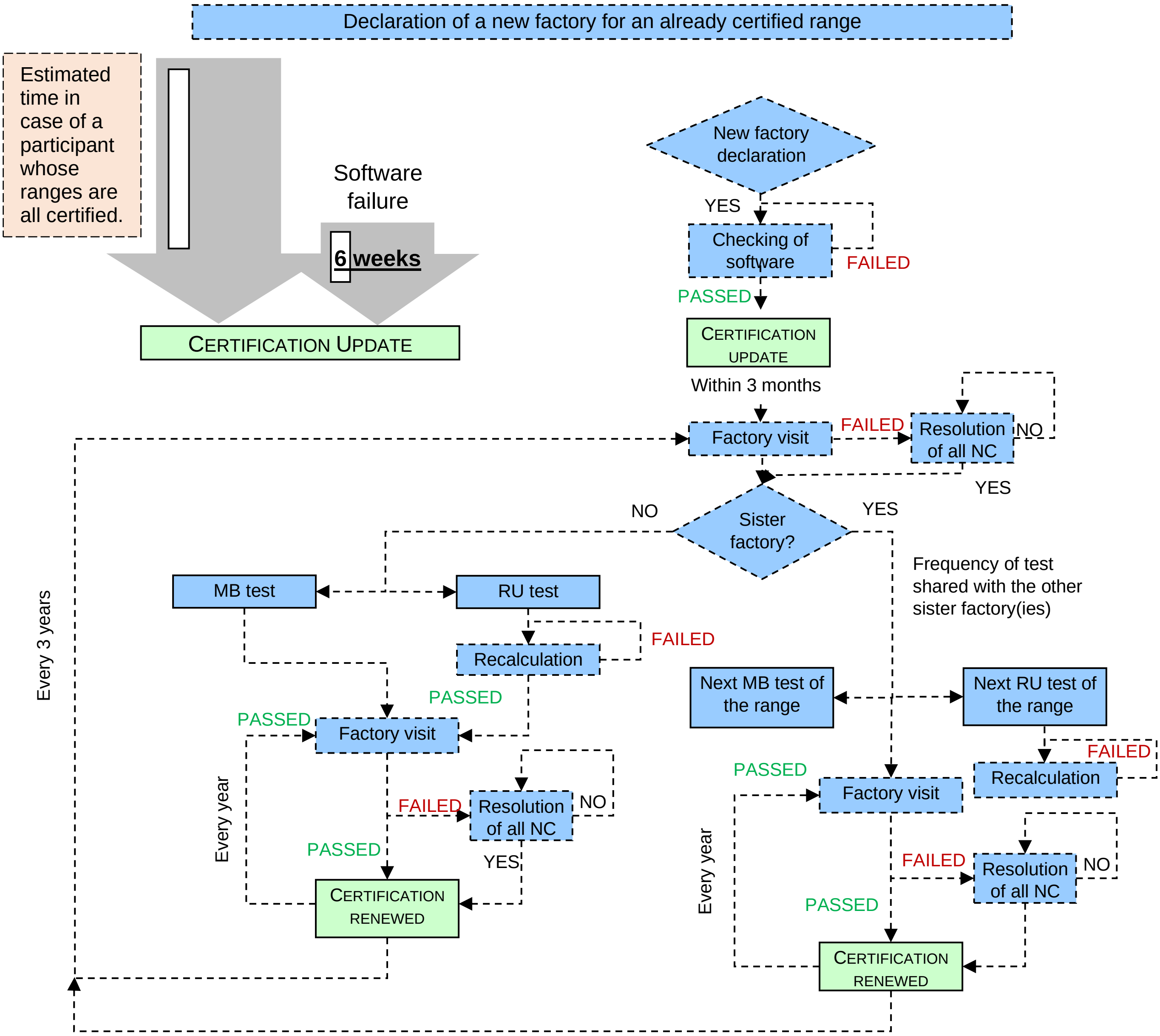


C.2 Annual surveillance procedure schedule

	Q1	Q2	Q3	Q4
Eurovent Certita Certification sends a notification for the beginning of the Annual Surveillance Procedure	30/09/n-1	31/12/n-1	31/03/n	30/06/n
Payment of Annual Onsite Checking (AOC) from Participant is completed	31/10/n-1	31/01/n	30/04/n	31/07/n
AOC date with the assigned auditor is planned	30/11/n-1	28/02/n	31/05/n	31/08/n
AOC is conducted by the auditor	01/01 – 31/03/n	01/04 – 30/06/n	01/07 – 30/09/n	01/10 – 31/12/n
AOC report is given to the Participant during the audit closing meeting	-			
Critical NC are corrected	4 weeks after audit (unless otherwise stipulated)			
Non-critical NCs are corrected	Next AOC			
Diplomas are valid until	30/09/n+1	31/12/n+1	31/03/n+2	30/06/n+2

<u>Note:</u> The audit period (or quarter: Q1, Q2, Q3 or Q4) is defined by ECC for each participant and shall remain the same for the following campaigns even if delays are experienced regarding the audit date.

C.3 Planning for manufacturers introducing a new factory (or already known factory) for an already certified range



APPENDIX D. METHODOLOGIES

D.1 Methodology for the consistency check on small and large coils

The following methodology is to be used to check that the performances given for small and large coils are consistent with each other:

1) Select a small air handling unit (AHU) with an air volume performance below the upper limit (3 m^3/s) of the test laboratory.

2) Select a cooling coil or heating coil in the AHU on inlet conditions within the normal operating range for water coils.

Register the coil code of the coil manufacturer or at least the distinctive characteristics of the selected coil, like coil geometry, pipe configuration, tube dimensions, fin thickness and fin spacing, number of rows, and header diameters.

Change the air outlet temperature until the coil performs at maximum duty (0% safety on performance). If the safety margin is not displayed during the selection, increase the coil performance in small steps until the software automatically switches to another coil (different coil code or configuration).

3) Record at least the following selection data at the maximum duty point of the selected coil.

- air volume flow [m^3/s or m^3/h]
- coil capacity [kW]
- air inlet temperature [°C]
- air inlet humidity [% or g/kg]
- water inlet temperature [°C]
- air outlet temperature [°C]
- air outlet humidity [% or g/kg]
- water outlet temperature [°C]
- water (fluid) flow [kg/h, kg/s, m^3/h, dm^3/s]
- air (face) velocity on finned area [m/s]
- water (fluid) velocity in tubes [m/s]
- air side pressure drop [Pa]

If available, the following data can also be collected.

- fluid side pressure drop [kPa]
- condensate flow (cooling coils) [l/h, kg/h]
- finned dimensions [mm]
- number of circuits [-]
- external heat exchange surface [m2]

4) Select a larger AHU with an internal cross-section of at least three times the cross-section of the small (reference) size AHU. Alternatively, the number of full-size filters in the large AHU shall be at least three times more than in the small AHU.

5) Choose an initial air volume performance proportional to the size increase of the unit.

6) Select a cooling coil or heating coil in the AHU on the same air inlet conditions, water temperatures and design outlet temperature as applied for the coil in the small AHU.

If different brands and/or coil types (geometry) can be selected, choose the same type as in the small AHU. In case the same coil geometry cannot be obtained, ask the AHU manufacturer's representative for the reason for this alteration. Deliberate what changes are needed to get the same coil geometry.

Check if the coil geometry is the same (same rows, fin spacing, tube thickness, foil fin thickness, tube diameter, fin and tube material). The circuit's number, tube number and connector diameter shall be different.

Compare face velocity and media velocity in tubes, respectively +/-2% and +/-10% tolerances can be used.

Fine-tune the air volume flow until the face velocity on the large coil is the same as on the small coil.

Change the outlet temperature and maximum fluid side pressure drop alternately until the coil performs at maximum duty with more or less the same water velocity in the tubes as for the small coil.

A (small) deviation in fluid velocity is still acceptable for a reliable consistency check.

Register the same selection data as mentioned under point 3.

7) Conduct the consistency check as follows:
   a) Calculate the ratio Rv between the fine-tuned air volume flow across the large unit and the small unit.
   b) Calculate the ratio Rp between the capacity of the large coil and the small coil
   c) Calculate the ratio Rw between the water flow through the large coil and the small coil
   d) Compare Rv and Rp.
   e) Both figures should be more or less the same. Consistency is granted if figures do not deviate by more than 5%.
   f) Compare Rp and Rw.

Both figures shall be the same. A deviation of 1% however is acceptable.

Bigger deviations indicate that a mistake during the selections has been made!

8) If the associated data are available, the following additional checks can be performed.
   a) Calculate the ratio Ra between the finned surface of the large coil and the small coil
   b) Calculate the ratio Re between the external heat exchange surface of the large coil and the small coil
   c) Calculate the ratio Rc between the condensate flow of the large cooling coil and the small coil
   d) Compare Ra and Re. Values shall be the same.

      Compare Rp with Rc. Values should be nearly the same.

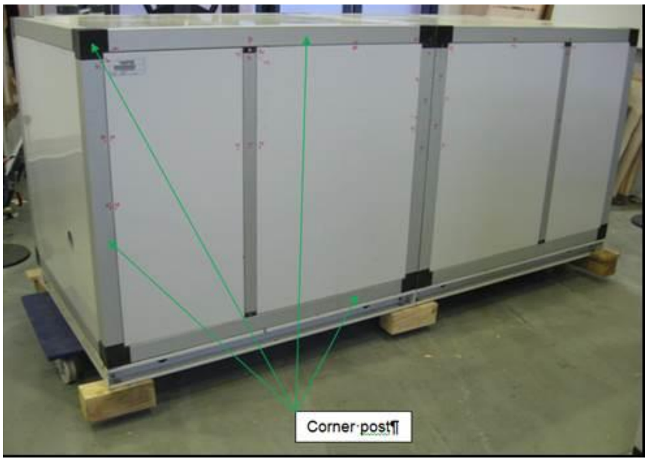
These additional checks are not mandatory and serve only as verification enhancement!

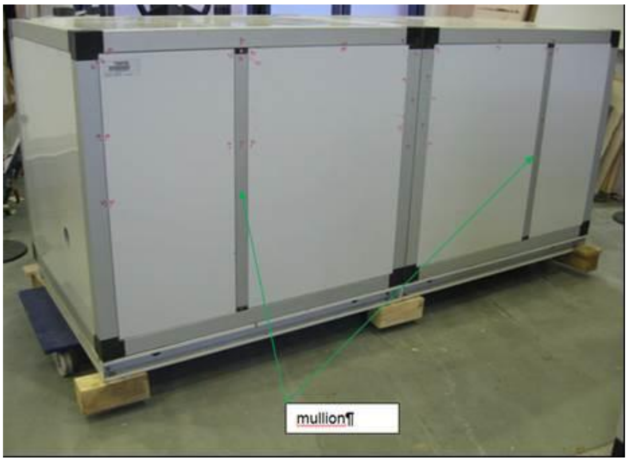
9) Some practical facilitation tips:
   - Select the small unit size in such a way that velocity in the cross-section is between 2 and 2.5 m/s
   - Set, where possible, the maximum fluid side pressure drop for the small coil on a relatively low value (15 kPa)
   - Use rounded figures for air inlet temperature and humidity
   - Use rounded figures for water inlet and outlet temperature
   - Change the outlet air temperature in small steps to find the maximum duty point of the coil
   - Ask for a stand-alone selection software program from the coil supplier
   - Use the AHU selection software and coil selection software together to simplify the selections
   - To compare coils with many rows and/or narrow fin spacing select air outlet temperature between water temperatures (small temperature differential)

D.2 Construction variations of AHU model boxes

D.2.1 Corner post (corner and frame)

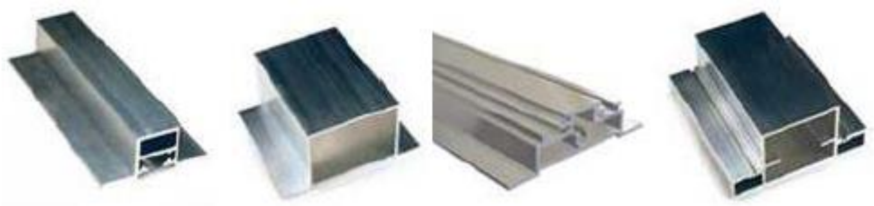
- material: steel/aluminium/plastic
- shape (see pictures):
- thickness of the material
- with/without thermal break





D.2.2 Mullion

- material: steel/aluminium/plastic
- shape (see pictures):
- thickness of the material
- with/without thermal break



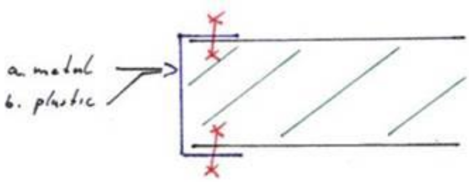
D.2.3 Filter holding system.

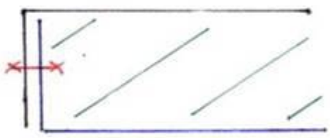
Definition: Modular holding frame to hold a filter within an air handling unit

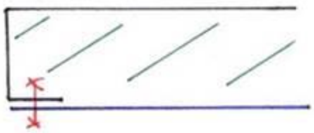
- fixed or laterally extractable
- position in the unit (fixed on mullion or panel)
- kind of filter gasket (flat/profiled)
- material/thickness of gasket
- fixing of gasket (glued/clamped/foamed)
- fixing of filter cell (with springs/screws/...)
- used sealing material (gasket/silicone/...)

D.2.4 Panel structure/geometry

- with/without thermal break
- design (see sketch)







APPENDIX E. SELECTION SOFTWARE MANDATORY REQUIREMENTS

The auditor assigned by Eurovent Certita Certification shall receive a software program, on a CD-ROM or a website with remote access. Other access facilities are only possible in consultation with Eurovent Certita Certification and the auditor. The primary language of the software including outputs must be in English.

The software must be able to calculate operating points between the upper and lower operating conditions without changing any components (for example):

- The operating point of the fan (nominal air flow = 100 %) must be calculated by +5% and -5% of nominal airflow. The fan speed must be constant. The external pressure will be variable. The software must calculate the power input (in kW) at the electric terminal of the motor / FU controller.
- The software must have the possibility to calculate the heating capacity with the selected heating coil between the upper and lower operating conditions. It must be possible to change the airflow rate, the water flow rate, and the air inlet temperature. The software must show and print out the results. The software must give a warning, in case the result data runs out of limits.
- The software must have the possibility to calculate the cooling capacity with the selected cooling coil between the upper and lower operating conditions. It must be possible to change the airflow rate, the water flow rate, the air inlet temperature and the air inlet humidity. The software must show and print out the results. The software must give a warning, in case the result data runs out of limits.
- The software must have the possibility to calculate the heat recovery capacity with the selected heat recovery system between the upper and lower operating conditions. It must be possible to change the airflow rate, the supply air inlet temperature and humidity, and the exhaust air inlet temperature and humidity. The software must show and print out the results. The software must give a warning, in case the result data runs out of limits.

The selection software must have the following Mandatory requirements including Input data and output data.

E.1 General Requirements

- Printouts should be provided as a minimum pdf file.
- There must be only one Eurovent-certified software version.
- All components must be described by a product key or relevant information (manufacturer name and reference).
- Calculations must all be at a minimum in SI units. The manufacturer is authorized to display data from the selection software in non-SI units as an option.
- The software must show a sketch of the AHU
- Software shall be able to store and restore the selection details from the same software version without any alterations to the calculation.
- Should the certified performances change due to the software revision, it shall not be possible to get the printout of the project without a new calculation considering the performance revision.
- *The manufacturer shall declare in the software if the filter is not Eurovent certified.*
- *It shall not be possible to select a filter with a higher class than the FBL class (according to the EN 779:2012 filter classification). This does not apply to HEPA filters.*
- $F_{s\text{-}Pref}$ value of the energy efficiency class calculation shall be available on the software for the sake of the energy efficiency class check during the audit.

Item	Acceptance criteria	Non-critical NC	Critical NC
$F_{s\text{-}Pref}$	Max of +/- 0,01 or equal	Between +/- 0,01 and +/-0,04 or equal	Out of +/- 0,04

E.2 Mandatory Input Data

- Reference nomenclature of unit i.e. ABC 40.
- Upper & lower Summer & Winter operating conditions (outdoor air temp & humidity).
- Air flow rate & external pressure.
- Heating coil water inlet temp, water flow rate or water outlet temp & supply air temp behind the heater coil.
- Cooling coil water inlet temp, water flow rate or water outlet temp & outlet air temp & relative humidity and supply air temp and humidity behind the cooler.
- Selected filter section (filter class).
- Selected fan section (fan type, motor type).
- Selected inlet & outlet sections.
- Selected heat recovery system with all necessary inputs (Rotary, Plate HX & Run around coils.)

E.3 Mandatory information to be found on printouts

E.3.1 General information

- On the first page:
  - Unique identification No or reference of the selection
  - Unit range
  - Unit designation
  - Eurovent Energy efficiency class(es) as described in Appendixes F and G. Preferably the graphical energy efficiency label shall be displayed, and shall not be confused with other labels. Otherwise, the statement: “Eurovent energy efficiency class X”, must be announced (where X is the label letter and sign). Air handling units with heat exchangers in combination with an integrated extract/exhaust-to-supply air heat pump are exempt from calculating and displaying an energy efficiency class, as the ECC calculation methodology does not cover and reflect the heat recovery effect and energy saving potential of air-to-air heat pumps.
  - If the graphical energy efficiency label is not used, the Eurovent Certified Performance mark shall be displayed (II.3.1.1)
  - If it is not allowed to display the Eurovent Certified Performance mark or energy class/label (see II.3.3.2), a statement shall be written instead, e.g. “Heat recovery component and/or fan selection beyond certified software do not comply with Eurovent Certified performance rules for label designation”.
- On each page (including the first page):
  - Software name, version code and version date
  - Printout date
  - Page numbering with the total number of pages of the printout (e.g. page x of y)
- Statement “This component is not included in the Eurovent certified software”, if a component, serving a certified performance (e.g. fan, coil, HRS, etc.), cannot be selected

within the certified software. This statement is not required for non-certified components that are not included in the software (e.g. filters, attenuators, humidifiers, etc.).

- Unit sketches with overall dimensions.

E.3.2 Technical data

The technical specification of a quoted AHU shall include all technical data required to verify the claimed energy efficiency class.

General

- RU certified performances (I.2.2).
- Nominal air flow rate in m^3/s or m^3/h
- Velocity in the cross-section of the filter section (or of the fan cross-section if no filter)
- Inlet, outlet and airborne sound power: octave bands in dB and total sound power in dB(A).
- *All airflow and pressure loss calculations in the printout are based on a standard air density of 1.2 kg/m³. Density, if different than standard conditions, is calculated for a given altitude and temperature (given in the printout), all air mass flow and pressure loss calculations are based on this density.*
- Design winter outdoor temperature (temperature at the inlet of the unit) for the selected unit
- Mixing ratio (RCA/SUP) at design winter outdoor temperature (maximum value 85%)
- External static pressure for the supply and extract unit (where applicable)
- Basic unit construction (same as model box name), as declared to ECC.
- Leakage class of the Real Unit by displaying the corresponding CAL class (R) as per EN 1886:2007.
  - CAL @ -400Pa is mandatory on printouts.
  - CAL @ +400Pa is mandatory on printouts.
- *OACF according to EN308 (not for units equipped with RAC, UVUs)*
- *EATR according to EN308 (not for units equipped with RAC, UVUs)*
- *Auxiliary powers (RAC pump, AARE HRS electrical motor)*
- ErP identification code (NRVU / RVU – BVU / UVU)
- Internal static pressure drop across the components in the AHU. The two requirements below shall be fulfilled:
  - the air side pressure drop across each component is specified in the technical specification
  - The external static pressure and static fan pressure for the design duty point are specified.
  - Fan system effect shall be considered:
    - Either by displaying an additional pressure drop or
    - Within the fan performances. In this case, a statement shall be provided (e.g.: “The fan system effect is taken into account in the fan performances.”)
- Reference city and optionally design dry-bulb, wet-bulb and dew point temperature (from ASHRAE 2017 Climatic Design Condition) used for the assessment or the Energy Efficiency Class for summer application (preferably the reference city). The reference city is mandatory to be displayed on all printouts and if applicable the reference city must be displayed right below the energy efficiency label for summer application.
- As a minimum, the following decimal places and significant values for the performances used for the fs-pref value calculation (if one parameter has more than these required decimal places/significant figures, it is mathematically rounded for the calculation).

Pressure drop [Pa]: 0 decimal places Illustration 325 Pa	**Area** [m²]: 3 significant figures Illustration 2,32m² or 3,00m²
Fan capacity [kW]: 3 significant figures Illustration 4,82kW or 5,02	**Velocity** [m/s]: 3 significant figures Illustration 1,84 m/s
Temperature [°C]: 1 decimal place Illustration 32,8°C or 39,0°C	**Airflow** [m^3/h]: 3 significant figures Illustration 4520 m^3/h or 8450 m^3/h
HRS efficiency [%]: 2 significant figures Illustration 78%	**Airflow** [m^3/s]: 3 significant figures Illustration 3,21 m^3/s or 1,00 m^3/s
Relative humidity [%]: 0 decimal place Illustration 45%	**Humidity efficiency** [%]: 2 significant figures Illustration 78%

- The useful fan static pressure increases to calculate the fan reference power that can be derived from all data sets.

Fans

- Fan speed in rpm
- Absorbed motor power from the mains for each fan in the AHU, including the power losses in any motor speed controller. If no fan speed controller is quoted, but the fan needs such a device to operate on the design fan speed, the power loss of such device shall be included in the specified absorbed motor power.
- Fan efficiency for Uni-Directional Units (UVUs) (η_{vu})
- Internal Specific Fan Power of ventilation components (SFP_{int}) in W/(m^3/s)

Filters

- Filter type and class (acc. to ISO 16890:2016)
- *Specify if the filter is not Eurovent certified.*
- Pressure drops: clean, design and final conditions (the final pressure drop shall not be less than the minimum defined in Table 1 below)
- Filter Energy Performance calculated according to the ECP-11-FIL (latest version in force) for filter (section A.I) and the Eurovent 4/21:2018; preferably energy classification
- The AHU energy efficiency shall be calculated on the design filter pressure drop (however, it is allowed to display the fan performance based on the clean filter pressure drop). This does not apply to ISO coarse filters.

Filter class	Final pressure drops
ISO coarse	The smallest value of the following: • DP_{init} +50 Pa • DP_{init} x 3
ISO ePM_1; ISO $ePM_{2.5}$ ISO ePM_{10}	The smallest value of the following: • DP_{init} + 100 Pa • DP_{init} x 3

Table 1: Minimum final pressure drops for filters

Heat recovery system (HRS)

- *Temperature conditions (inlet/outlet)*

- Dry temperature efficiency (no condensation on the extract side) of the HRS for design winter operation at equal mass flows (extract flow equal to design supply flow)
- *Humidity recovery efficiency, if it is not on the printout, it is assumed to be 0.*
- Air side pressure drops across the heat recovery system on the extract side and supply side for the design air flows at winter conditions and a standard density of 1.2 kg/m^3.
- *Pressure drop reduction (supply and extract) due to the airflow bypass at the design air volume flows across the heat recovery section for summertime for standard air density at 1,2 kg/m^3.*
- *Medium mass flow (where applicable)*
- *Medium pressure drop (where applicable)*
- Brine concentration in the fluid of the run-around coil system (where applicable).

Coils

- Statement if air side pressure drop cooling coil is for dry (“dry pressure drop”) or wet (“wet pressure drop”) conditions or statement if the fan has been designed for dry or wet conditions.
- Heating coil: airside Inlet/Outlet temperatures, airside pressure drop, water flow, & waterside Inlet/Outlet temperatures & pressure drop.
- Cooling coil: airside Inlet/Outlet temperatures, inlet/Outlet relative humidity, air side pressure drops (designed: wet or dry, both can be provided, however dry shall be always visible in the software), waterside flow rate and Inlet/Outlet temperatures and pressure drop.
- Air velocity in the finned part of the coil (if not in the printout, at least in the software).

Additional requirements for the Hygienic option:

If the Hygienic option is selected the print-out of the selection software must include the following data, in addition to the one already listed above:

- General arrangement: The general disposition of the components and design of the AHU shall be included.
- Unit housing: The selection software shall include the dimensions of the housing as well as the accessibility to the components (localisation and dimensions of doors and hatches). Mechanical characteristics shall be included:
  - Casing Strength
  - Thermal bridging
- Components: The selection software shall include the components used for the AHU as well as their properties:
  - Filters: dimensions and weight
  - Droplet Separator: Dimensions and weight
  - Cooling/Heating Coils: Fin thickness, distance between fins
  - Fans: Type and property

The mark of the hygienic option as well as the level achieved for the unit must be displayed on the first page of the print-out, this mark can replace the ECP mark.

APPENDIX F. ENERGY EFFICIENCY CLASS FOR WINTER APPLICATION

F.1 Foreword

In this method, the impacts of the various factors are weighted together to establish the final energy class.

Energy to Air Handling Units (AHUs) can be divided into two main groups; thermal energy (for heating and cooling) and electrical energy for fans. Different levels of thermal energy consumption for heating are covered by the consideration of the Heat Recovery System (HRS) efficiency. The climate dependency for the thermal energy consumption is considered, and the difference in primary energy between thermal energy and electrical energy is taken into account to evaluate the impact of the pressure drops across the HRS (factors 1 to 2). The thermal energy for cooling is not considered because it will have less impact (negligible for most of Europe). Regarding electrical energy for fans, the method only accounts for the impact of the unit size and efficiency of fan assembly. Other components (e.g. coils) are not individually covered (hence the total pressure increases for fans are not considered) because there is a huge variation in the use of components in different AHU applications. The major influencing factors; velocity, HRS pressure drop, overall static efficiency of the supply and/or the extract air fan and efficiency of the electric motor(s), will give a good estimation of the used energy for fans. The classification, however, cannot be considered as a system energy label. Use LCC calculations to evaluate differences between systems.

The required values for the classes adopted in the calculations are taken from the European Standard EN13053:2019: “Ventilation for buildings – Air handling units – Rating and performance for units, components and sections.”

F.2 Prerequisites

- The temperatures are considered in °C.
- The calculations shall be made with standard air density = 1.2 kg/m³
- In the calculations for classification evaluation, the design conditions for winter time shall be used for air flows, outdoor temperature, mixing ratio, heat recovery efficiency, etc.
- *The ASHRAE 2017 Coldest Month 99% data shall be used to determine the winter design outdoor temperature (applicable from the 1st of May 2024 and for the 2024 campaign, this requirement will be considered as non-critical). See section G.3.1. City approach for further details.*
- The velocities in the calculations are the air velocities in the AHU cross-section based on the inside unit area for outdoor, respective of the extract air flow of the air handling unit. The velocity is based on the area of the filter section of the respective unit, or if no filter is installed, it is based on the area of the fan section.
- The relationship between velocity in the cross-section of the unit and internal static pressure drop is considered to be exponential to the power of 1.4:

$$\Delta p_{st-1} = \left(\frac{v_1}{v_0}\right)^{1.4} \times \Delta p_{st-0}$$

- V1 is the air speed in the AHU and the V0 comes from the reference table corresponding to a class.
- The heat recovery dry efficiency at balanced air volume flows shall be used. If the extract (also called “exhaust air in”) air volume flow across the heat recovery section diverges from the supply air volume flow through the heat recovery section, the efficiency shall be calculated for both air volume flows equal to the supply air volume flow. For efficiency evaluation, the supply air volume for the heat recovery section, winter time shall be taken (the supply air volume flow of the unit can be higher in case of a mixing section).

- For pressure drop evaluation of the heat recovery section the design air volume flows across the heat recovery for winter time shall be taken. Pressure drop increase due to condensation is not considered! Air pressure drop shall be considered for standard air density at 1.2 kg/m^3.
- Heat recovery efficiency figures for run-around coil systems shall be based on fluid with the actual ethylene glycol design percentage, design fluid flows and design inlet temperatures.
- The weighting ratio between electric energy and thermal energy is 2 (1 kWh of electric energy ≈ 2 kWh (primary) thermal energy).
- An empirical formula for the equivalence between the efficiency and the pressure drop of a heat recovery system, as a function of the outdoor climate, has been derived from numerous energy consumption calculations all over Europe, (see Figure *7* below): $f_{pe} = (-0.0035 \times t_{ODA} - 0.79) \times t_{ODA} + 8.1$ [Pa/%]

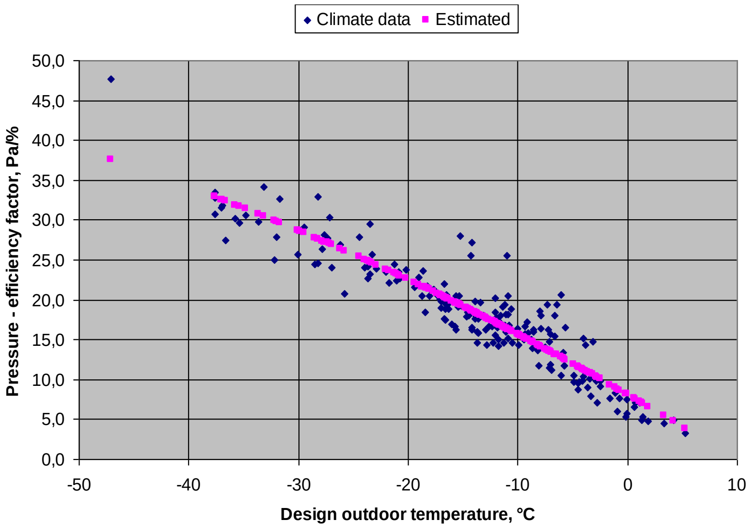


Figure 7: Equivalence Efficiency / Pressure Drop

F.3 Air Handling Unit subgroups

Three subgroups, with different label signs, are defined (the display of the energy efficiency class for winter application is mandatory for any project falling under any subgroup):

F.3.1 Subgroup 1

Units for full or partial outdoor air at design winter temperature ≤ 9°C.

This subgroup will consider the velocity in the filter cross-section, the HRS efficiency and pressure drop and the mains power consumption to the fan(s). The class signs are **A+** to **E**.

This subgroup comprises units connected to outdoor air with the design outdoor temperature, winter time *(from ASHRAE 2017 Climatic Design Conditions)* ≤ 9°C. The unit can be supply only or supply and extract unit, and can be with or without HRS. If it is a supply-only unit, there shall be no consumption and no pressure drop on the extract side. If the unit doesn't have an HRS, the heat recovery efficiency shall be considered as 0. If the unit contains a mixing section; it will be treated within this group as long as the amount of recirculation air is less than 85 %. If more recirculation is claimed, the calculation value for 85% shall be used in the applicable equation for pressure correction Δ_{pz}.

F.3.2 Subgroup 2

Recirculation units or units with design inlet temperatures always > 9°C *(from ASHRAE 2017 Climatic Design Conditions).*

This subgroup will only consider the cross-section velocity of the filter section and mains power consumption to the fan(s). The class signs are from **A+↳** to **E↳**.

This subgroup includes units with 100% recirculation air, units connected to outdoor air for which the design outdoor temperature during winter time *(from ASHRAE 2017 Climatic Design Conditions)* > 9°C or units with (pre-conditioned) inlet temperature > 9°C emanating from a make-up air unit up-stream.

The unit can be a supply-only or supply and extract unit. If it is a supply-only unit, there shall be no consumption and no pressure drop on the extract side. Even if the heat recovery efficiency is not taken into account in the calculation, the unit can be with or without HRS.

F.3.3 Subgroup 3

Stand-alone extract air units.

This subgroup will only consider the cross-section velocity of the filter section and mains power consumption to the fan(s). The class signs are from **A+↑** to **E↑**.

This subgroup is for pure extract air units (The first reason to allocate an energy label to this kind of unit application is that they could not include heat recovery. Another reason is that the design outdoor temperature has no relevance for such units).

F.4 Reference table

The following reference is applicable for the calculation of the correction factors for winter application:

CLASS	All Units	Units for full or partial outdoor air at design winter temperature ≤ 9°C		
	Velocity	Heat recovery system		Fan Efficiency Grade
	v_{class} [m/s]	η_{class} [%]	Δp_{class} [Pa]	$NG_{ref\text{-}class}$ [-]
A+ / A+↳ / A+↑	1.4	83	250	64
A / A↳ / A↑	1.6	78	230	62
B / B↳ / B↑	1.8	73	210	60
C / C↳ / C↑	2.0	68	190	57
D / D↳ / D↑	2.2	63	170	52
E / E↳ / E↑	No calculation required			No requirement

Table 4: Table for energy efficiency calculations

The lowest classes E, E↳ and E↑ have no requirements.

F.5 Methodology

The principle is to establish whether the selected unit with different energy parameters will consume no more energy than a unit that would exactly meet the requirements for the aimed class in Table *4*: Table for energy efficiency calculations.

Perform the four following steps for respective air sides, supply and/or extract:

1) Assume an AHU is designed to meet the requirements for a particular class, so apply the corresponding class values (subscript "class") from Table 4: Table for energy efficiency calculations:
   - for velocity v_{class}
   - for Fan Efficiency Grade $NG_{ref\text{-}class}$

If subgroup 1 (units for full or partial outdoor air at design winter temperature ≤ 9°C), apply also:

   - heat recovery efficiency η_{class}
   - pressure drop Δp_{class}

2) Use, for the actual air handling unit to be classified at design airflow, winter time, the actual selection values (subscript "s") values:
   - fan static pressure increase $\Delta p_{s\text{-}static}$
   - external pressure drop $\Delta p_{s\text{-}external}$
   - velocity v_s
   - power supplied from mains to selected fan $P_{s\text{-}sup}$ if supply air side else $P_{s\text{-}ext}$

If subgroup 1 use also:

   - HRS dry efficiency η_s
   - HRS pressure drop $\Delta p_{s\text{-}HRS}$

3) Calculate the pressure correction due to velocity Δp_x

If subgroup 1, then calculate:

- pressure correction due to HRS pressure drop Δp_y (see F.7)
- pressure correction due to HRS efficiency Δp_z (see F.8)

4) Calculate fan reference power $P_{air\ side\text{-}ref}$ for the actual air handling unit side, i.e. $P_{sup\text{-}ref}$ if supply air side or $P_{ext\text{-}ref}$ if extract air side (see F.9).

The final check consists of verifying whether the selected unit meets the absorbed power consumption criterion for the aimed class. So, calculate the absorbed power factor; $f_{s\text{–}Pref}$ (see F.10). If the value $f_{s\text{-}Pref}$ is equal to or lower than 1, the unit meets the requirements for the class. If not, the same calculation procedure shall be repeated for a lower class.

F.6 Pressure correction due to velocity; Δpx

$$\Delta p_x = \left(\Delta p_{\text{s-internal}} - \Delta p_{\text{s-HRS}}\right) \times \left\{1 - \left(\frac{v_{\text{class}}}{v_s}\right)^{1,4}\right\}$$

where: Δp_x = pressure correction due to velocity [Pa]
$\Delta p_{s\text{-internal}}$ = $\Delta p_{s\text{–static}}$ - $\Delta p_{s\text{–external}}$ internal pressure drop across components; exclusive system effect pressure drops [Pa]
$\Delta p_{s\text{-static}}$ = useful fan static pressure increase measured between fan inlet and fan outlet [Pa]
$\Delta p_{s\text{-external}}$ = external (ductwork system) pressure drop [Pa]
$\Delta p_{s\text{-HRS}}$ = HRS pressure drop [Pa] (0 if no HRS or subgroup 2 or 3)
v_{class} = value from Table *4* [m/s]
v_s = velocity in AHU filter (fan if no filter) cross-section [m/s]

With pressure drop correction for velocity, the equivalence figures for primary energy and the corrections for heat recovery, it is possible to make a conversion to static pressure surplus or deficit compared to a unit fully compliant with the energy class. A surplus of static pressure means that the actual unit demands a higher static pressure; a deficit of static pressure means that the actual unit needs a lower static pressure than the class-compliant unit. Hence, a surplus of static pressure means higher energy consumption while a deficit of static pressure will mean lower energy consumption.

F.7 Pressure correction due to HRS pressure drop; Δpy

$$\Delta p_y = \Delta p_{\text{s-HRS}} - \Delta p_{\text{class}}$$

where: Δp_y = pressure correction due to HRS pressure drop [Pa]
$\Delta p_{s\text{-HRS}}$ = HRS pressure drop (0 if no HRS or subgroup 2 or 3) [Pa]
Δp_{class} = value from Table *4* [Pa] (0 if subgroup 2 or 3)

F.8 Pressure correction due to HRS efficiency; Δpz

$$\Delta p_z = \left(\eta_{\text{class}} - \eta_s + 5 \times cf_{\text{heater}}\right) \times \left(1 - \frac{mr}{100}\right) \times f_{pe}$$

where: Δp_z = pressure correction due to HRS efficiency [Pa]
η_s = HRS dry efficiency winter [%] (0 if no HRS or subgroup 2 or 3)
η_{class} = value from Table *4* [%] (0 if subgroup 2 or 3)
mr = mixing ratio, winter (recirculation air / supply air; maximum), allowed range 0 to 85 [%]
f_{pe} = pressure – efficiency factor
= $(-0.0035 \times t_{ODA} - 0.79) \times t_{ODA} + 8.1$ [Pa/%]
t_{ODA} = design outdoor temperature, winter [°C]
cf_{heater} = correction for the electrical heater (reheater, i.e. heater downstream

the HRS).
= 0 when there is no electrical heater
= 1 when there is an electrical heater

F.9 Fan reference power; Psup–ref if supply air side or Pext-ref if extract air side

The total static pressure correction $\Delta p_x + \Delta p_y + \Delta p_z$ has a negative or positive value. A negative value means that the required static pressure for the selected unit is lower than the static pressure for the class-compliant unit. For a positive pressure value, it is just the other way around. Now the fan reference power for a class-compliant unit has to be derived from the available static pressure of the selected unit by taking into account the calculated pressure corrections.

$$P_{airside-ref} = \frac{\lfloor \Delta P_{s-static} - \left(\Delta p_x + \Delta p_y + \Delta p_z\right) \rfloor \cdot q_{v-s}}{\left(a \cdot \ln\left(\frac{P_{airside-ref}}{1000}\right) - b + NG_{ref}\right)/100}$$

where: $P_{air\ side-ref}$ = fan reference power [W] (use $P_{sup-ref}$ for supply air side or $P_{ext-ref}$ for extract air side)
q_{v-s} = air volume flow rate [m^3/s]
NG_{ref} = Fan Efficiency Grade corresponding to the class value in %
a, b = coefficients as per Table 5 below.

$P_{air\ side-ref}$	a	b	NG_{ref}
≤ 10 kW	4,56	10,5	$NG_{ref-class}$
> 10 kW	1,1	2,6	$NG_{ref-class}$

Table 5: Coefficients for the calculation of Pair side-ref

The first iteration of $P_{air\ side-ref}$ is:

$$P_{airside-ref(1st\ iteration)} = \frac{\lfloor \Delta P_{s-static} - \left(\Delta p_x + \Delta p_y + \Delta p_z\right) \rfloor \cdot q_{v-s}}{NG_{ref}/100}$$

If the value of the $\lfloor \Delta P_{s-static} - \left(\Delta p_x + \Delta p_y + \Delta p_z\right) \rfloor$ *parameter is lower than zero, then the class of the unit is lower than the current one used for the calculation.*

F.10 Absorbed power factor; fs–Pref

$$f_{s\text{-}Pref} = \frac{P_{s\text{-}sup} + P_{s\text{-}ext}}{P_{sup\text{-}ref} + P_{ext\text{-}ref}} \leq 1$$

where: f_{s-Pref} = absorbed power factor
P_{s-sup} = active power supplied from the mains, including any motor control equipment, to selected supply air fan [kW]
P_{s-ext} = active power supplied from the mains, including any motor control equipment, to select extract air fan [kW]
$P_{sup-ref}$ = supply air fan reference power [kW]
$P_{ext-ref}$ = extract air fan reference power [kW]

F.11 Heat recovery for run-around coil systems

The following applies to run-around coil systems.

Regarding the glycol or temperature, no corrections of efficiency shall be considered: efficiency shall be evaluated on the actual glycol percentage and actual temperatures.

A correction shall be applied for the efficiency at balanced airflows. If the real correction can be obtained from the selection software, it is always possible to use it. Otherwise, the following equation shall be used:

$$\varphi_{1:1} = \varphi_s x \sqrt{\frac{\dot{m}_{ODA}}{\dot{m}_{ETA}}}$$

where:

$\varphi_{1:1}$	=	efficiency for balanced airflows [%]
φ_s	=	actual efficiency for unbalanced airflows [%]
$\dot{m}_{ODA}$	=	outdoor (supply) airflow [kg/s]
$\dot{m}_{ETA}$	=	extract air flow [kg/s]

The equation is valid for a minimum extract airflow of 0.6 x supply air side or a maximum extract airflow of 1.2 x supply air side. If the ratio is out of the limits, the 0.6 and 1.2 corrections shall be used.

F.12 Assessment of the Energy Efficiency Class in the case of swimming pool units

AHUs with dynamic outdoor airflow rates in the heating period (i.e. swimming pool units) must be treated differently.

1) The heating period must be clearly defined in the printout or the software.
2) Thermal efficiency and pressure drop of the heat recovery, as well as the power input and mixing ratio, shall be determined at the point of the highest expected air flow rate across the heat recovery section during the heating period.
3) Design outdoor temperature shall remain for winter conditions.

APPENDIX G. ENERGY EFFICIENCY CLASS FOR SUMMER APPLICATION

The main idea is from numerous hourly energy consumptions, calculated from all over Europe, the Middle East, North Africa and some extreme weather locations totalizing 58 places, to create a model that balances the benefit of 3 different solutions that could result in AHU energy saving.

1) Humidity Recovery
2) Reduction of the pressure drop in the Heat Recovery System (HRS) bypass
3) Indirect adiabatic cooling (IAC)

The base used to assess the energy efficiency class for the summer application is the same as the winter application described in Appendix F. The difference with the calculation for summer application is based on the correction factors (Δp_y, Δp_z), each of the 3 features listed above will have an impact on the correction factors (Δp_y, Δp_z).

Note: there are no impacts on Δp_x which is purely linked to the fan performance.

Important note: Until further notice and/or update of this TCR, only the humidity recovery feature and the reduction of the pressure drop in the HRS bypass must be considered for the calculation of the Energy Efficiency Class.

The Indirect Adiabatic Cooling will be considered only later; they then must be ignored at the moment for the calculation of the EEC.

Until the 1st of May 2024, a period of transition for the reduction of the pressure drop in the HRS bypass is in place, meaning that the display of the label for summer application with this reduction of the pressure drop in the HRS bypass consideration is optional.

The display of the energy efficiency class for summer application is mandatory for any project falling under subgroup 1 (cf section G.2.). In other words, the display of the energy efficiency class for summer application is optional for projects falling under subgroup 2 or 3 (cf section.G.2.).

Any Participant displaying the EEC for summer application is entitled to base its assessment on a region approach (cf section 0 for further details), the city approach is highly recommended.

G.1. Prerequisites

- The temperatures are considered in °C.
- The calculations shall be made with standard air density = 1.2 kg/m³.
- In the calculations for classification evaluation, the design conditions for summertime shall be used for air flows, outdoor temperature, mixing ratio, heat recovery efficiency, etc.
- The ASHRAE 2017 Monthly design Dry Bulb 2% data shall be used to determine the design dry bulb temperature and the design dew point temperature. The location where the unit will be installed must be used as a reference. See section 0 for further details.
- The ASHRAE 2017 Coldest Month 99% data shall be used to determine the winter design outdoor temperature. See section G.3.1. City approach for further details.
- The velocities in the calculations are the air velocities in the AHU cross-section based on the inside unit area for outdoor, respective of the extract air flow of the air handling unit. The velocity is based on the area of the filter section of the respective unit, or if no filter is installed, it is based on the area of the fan section.
- The relationship between velocity in the cross-section of the unit and internal static pressure drop is considered to be exponential to the power of 1.4:

$$\Delta p_{st-1} = \left(\frac{v_1}{v_0}\right)^{1.4} \times \Delta p_{st-0}$$

- V1 is the air speed in the AHU and the V0 comes from the reference table corresponding to a class.

- The heat recovery dry efficiency and wet efficiency at balanced air volume flows shall be used. If the extract (also called "exhaust air in") air volume flow across the heat recovery section diverges from the supply air volume flow through the heat recovery section, the efficiency shall be calculated for both air volume flows equal to the supply air volume flow. For efficiency evaluation, the supply air volume for the heat recovery section, in summertime shall be taken (the supply air volume flow of the unit can be higher in case of a mixing section).
- For pressure drop evaluation of the heat recovery section, the design air volume flows across the heat recovery for summer time shall be taken. Air pressure drop shall be considered for standard air density at 1.2 kg/m^3
- Heat recovery efficiency figures for run-around coil systems shall be based on fluid with the actual ethylene glycol design percentage, design fluid flows and design inlet temperatures.
- The weighting ratio between electric energy and thermal energy is 2 (1 kWh of electric energy ≈ 2 kWh (primary) thermal energy).
- This summer label considers that a cooling system is installed and therefore condensation can occur. If an AHU is installed in a system without a cooling device (within or outside the AHU) and no enthalpy control then the humidity efficiency η_{s-H} must be set at 0.

G.2. Subgroups

The energy efficiency labelling for summer application is divided into three subgroups (1, 2 and 3).

G.2.1. Subgroup 1

The unit falls under subgroup 1 if the outdoor conditions of the place where the unit will be installed are the following (The class signs are **A+** to **E**):

- Winter Design condition (from ASHRAE 2017 Climatic Design Conditions) ≥ -3°C **AND** Design dry-bulb temperature (from ASHRAE 2017 Climatic Design Conditions) ≥ 30°C

  OR
- Winter Design condition (from ASHRAE 2017 Climatic Design Conditions) ≥ -3°C **AND** Design dew-point temperature (calculated with wet bulb temperature from ASHRAE 2017 Climatic Design Conditions) ≥ 17°C

  OR
- Design dry-bulb temperature (from ASHRAE 2017 Climatic Design Conditions) ≥ 30°C **AND** Design dew-point temperature (calculated with wet bulb temperature from ASHRAE 2017 Climatic Design Conditions) ≥ 17°C

If the unit contains a mixing section; it will be treated within this group as long as the amount of recirculation air is less than 85 %. If more recirculation is claimed, the calculation value for 85% shall be used in the applicable equation for pressure correction Δ_{pz}.

G.2.2. Subgroup 2

If the outdoor conditions where the unit will be installed are different than the ones defined above, then the unit falls under subgroup 2 and the class will be displayed with an arrow. The class will then be the same as the winter application one *calculated according to the Appendix F methodology for sub-group 2 (Winter design temperature Toda>9°C).*

Recirculation units also fall under subgroup 2. The class signs are from **A+↳** to **E↳**.

G.2.3. Subgroup 3

This subgroup will only consider the cross-section velocity of the filter section and mains power consumption to the fan(s).

This subgroup is for pure extract air units (The first reason to allocate an energy label to this kind of unit application is that they could not include heat recovery. Another reason is that the design outdoor temperature has no relevance for such units). The class will then be the same as the winter application one (subgroup 3).

Refer to the Methodology for winter application for further details. The class signs are from **A+↑** to **E↑**.

G.3. Reference cities and region approach

G.3.1. City approach

It is highly recommended to use the city approach.

The design dry bulb temperature and the design wet bulb temperature are obtained from the "ASHRAE 2017 Climatic Design Conditions" – Table "Monthly design dry bulb and mean coincident wet bulb temperature" – Line data: 2%. The highest temperature recorded in this line must be used for the calculation.

<u>Example</u>:

Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures	0.4%	DB	13.7	15.2	20.4	25.0	27.8	31.1	33.3	35.3	28.9	23.7	17.3	13.6
		MCWB	12.0	10.6	12.7	16.6	19.4	21.1	21.1	21.5	19.0	18.0	14.0	12.1
	2%	DB	12.3	12.6	17.6	22.2	25.2	28.2	30.6	30.9	25.9	20.9	15.3	12.5
		MCWB	10.9	9.9	12.0	14.5	17.6	20.0	20.4	20.1	18.4	16.6	13.3	11.3
	5%	DB	11.2	11.2	15.2	19.5	23.1	26.0	28.4	28.3	23.2	18.8	13.7	11.3
		MCWB	9.8	9.4	11.0	13.3	16.5	19.1	19.5	19.3	17.1	15.5	12.1	10.3
	10%	DB	9.9	10.0	13.4	17.2	20.9	23.9	26.3	25.8	21.3	17.2	12.4	10.1
		MCWB	8.7	8.5	10.2	12.1	15.4	17.9	18.7	18.4	16.2	14.6	11.2	9.1

The winter design outdoor temperature is obtained from the "ASHRAE 2017 Climatic Design Conditions" – Table "Annual Heating and Humidification Design Conditions" – Line data "Coldest month": 99%.

<u>Example</u>:

Annual Heating and Humidification Design Conditions														
Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB	
			99.6%			99%			0.4%		1%			
	99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD
1	-5.6	-3.5	-8.9	1.8	-3.7	-6.6	2.2	-2.6	14.0	10.8	12.7	10.4	2.5	10

The location used as a reference must be the location where the unit will be installed. The user must select the closest location from the site where the AHU will be installed.

Source: http://ashrae-meteo.info/index.php.

G.3.2. Region approach

Alternatively to the city approach, the Participant is entitled to use the region approach when the exact location of the project is unknown. Each region is linked to a reference city from the "ASHRAE 2017 Climatic Design Conditions". The Participant must refer to a region from the Eurovent Energy Efficiency Class database available on the restricted access of the Eurovent Certita Certification website (https://extfile.eurovent-certification.com/AHU/).

G.4. Methodology for summer application

The principle is to establish whether the selected unit with different energy parameters, will consume no more energy than a unit that would exactly meet the requirements for the aimed class in 0 for summer application.

Perform the four following steps for respective air sides, supply and/or extract if in subgroup 1:

4) Assume an AHU is designed to meet the requirements for a particular class, so apply the corresponding class values (subscript "class") from 0 for summer application:
   - for velocity v_{class}
   - for Fan Efficiency Grade $NG_{ref\text{-}class}$
   - heat recovery dry efficiency $\eta_{T\text{-}class}$
   - heat recovery wet efficiency $\eta_{H\text{-}class}$
   - pressure drop $\Delta p_{T\text{-}class}$ and $\Delta p_{H\text{-}class}$
5) Use, for the actual air handling unit to be classified at design airflow, summer time, the actual selection values (subscript "s") values:

- fan static pressure increase $\Delta p_{s\text{-}static}$
- external pressure drop $\Delta p_{s\text{-}external}$
- velocity v_s
- power supplied from mains to selected fan $P_{s\text{-}sup}$ if supply air side else $P_{s\text{-}ext}$
- HRS temperature efficiency $\eta_{s\text{-}T}$
- HRS humidity efficiency $\eta_{s\text{-}H}$
- HRS pressure drop $\Delta p_{s\text{-}HRS}$

6) Calculate the pressure correction due to velocity Δp_x
   - pressure correction due to HRS pressure drop Δp_y (see 0)
   - pressure correction due to HRS efficiency Δp_z (see 0)

7) Calculate fan reference power Pair side-ref for the actual air handling unit side, i.e. $_{Psup\text{-}ref}$ if supply air side or $P_{ext\text{-}ref}$ if extract air side (see G.10).

The final check consists of verifying whether the selected unit meets the absorbed power consumption criterion for the aimed class by calculating the absorbed power factor; $f_{s\text{–}Pref}$ (see G.10). If the value $f_{s\text{-}Pref}$ is equal to or lower than 1, the unit meets the requirements for the class. If not, the same calculation procedure shall be repeated for a lower class.

G.5. Humidity recovery on Energy Efficiency Class methodology (1st step)

G.5.1. Determination of the three functions $f_{T\text{-}H}$, $f_{pe\text{-}DB}$, $f_{pe\text{-}DewP}$

The inputs are the summer outdoor location design conditions: Dry bulb temperature and Dew-point temperature.

The aim is to quantify the impact of the humidity recovery. Different empirical formulas for the equivalence between the efficiency and the pressure of a heat recovery system, as a function of the outdoor climate, have been derived from numerous energy consumption calculations.

For more information about the calculations and how the coefficients have been obtained, refer to the end of this appendix – section G.11.

G.5.1.1. Methodology used to determine the function $f_{T\text{-}H}$

$f_{T\text{-}H}$ is a factor that weighs the importance between recovery temperature and recovery humidity. The higher the value, the less important the humidity recovery.

$$f_{T-H} = a * X_{axis}^{b}$$

- Y-axis is the coefficient f_{T-H} (between >0.15 and 1)
- X-axis is an equation having for inputs dry and dew-point temperatures

$$X_{axis} = \frac{C1 * T_{dryB} - C2 * T_{dew-p}}{C3}$$

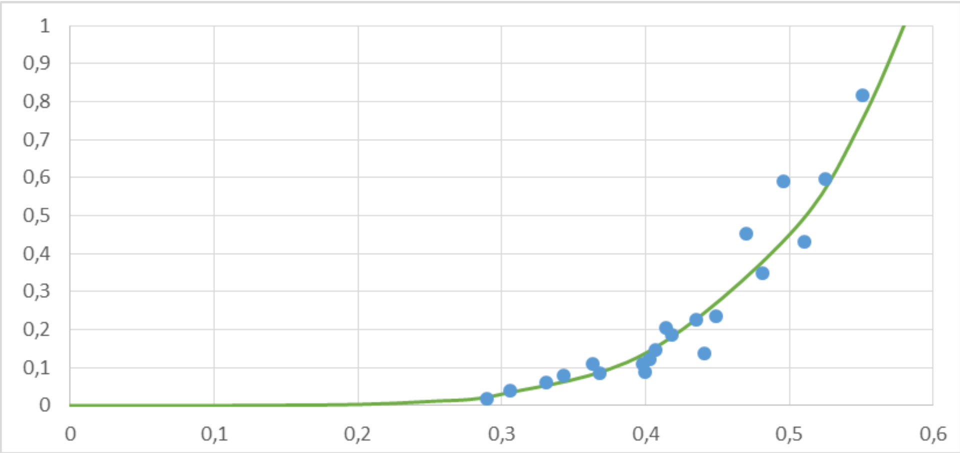
Where:

	c1	c2	c3	a	b
Coefficients	**1,805**	**1**	**100**	**18,6**	**5,3**

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

The design dry bulb temperature and the design wet bulb temperature are obtained from the “ASHRAE 2017 Climatic Design Conditions” – Table “Monthly design dry bulb and mean coincident wet bulb temperature” – Line data: 2%. The location used as a reference must be the location where the unit will be installed. The user must select the closest location from the site where the AHU will be installed.

Source: http://ashrae-meteo.info/index.php



The limits of the coefficient $f_{T\text{-}H}$ are the following:

Limits	Min.	Max.
	0.15	1

If the value of the coefficient is lower or higher than the above limits, then the limit value must be considered.

e.g.: if $f_{T\text{-}H}$ is equal to 1.2 then the value to be considered is 1. If $f_{T\text{-}H}$ is equal to 0.12 then the value to be considered is 0.15.

G.5.1.2. Methodology used to determine the function $f_{pe\text{-}DB}$

f_{pe-DB} is a factor that weighs HRS pressure drop and dry efficiency for a design dry bulb temperature.

$$f_{pe-DB} = a * X_{axis}^3 + b * X_{axis}^2 + c * X_{axis}$$

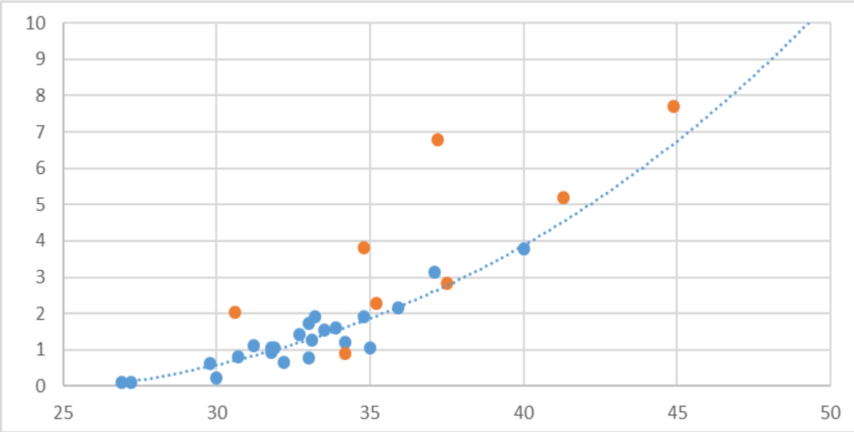
- Y-axis [Pa], in opposite to the winter application the relation between HRS pressure drop and efficiency almost doesn't exist. In other words, to dry bulb temperature of 35 °C if the HRS efficiency increases 1% the pressure drop admissible for that reason is to 2 Pa.
- X-axis is the dry-bulb temperature

$$X_{axis} = T_{dryB}$$

Where:

	A	B	C
Coefficients	**0,0002**	**-0,0057**	**0,017**

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user



The limits of the coefficient $f_{pe\text{-}DB}$ are the following:

Limits	Min.	Max.
	1	No limit

If the value of the coefficient is lower or higher than the above limits, then the limit value must be considered.

G.5.1.3. Methodology used to determine the function $f_{pe\text{-}DewP}$

$f_{pe-DewP}$ is a factor that weighs HRS pressure drop and humidity efficiency for a design dew point temperature.

$$f_{pe-DewP} = a * X_{axis}^2 + b * X_{axis} + c$$

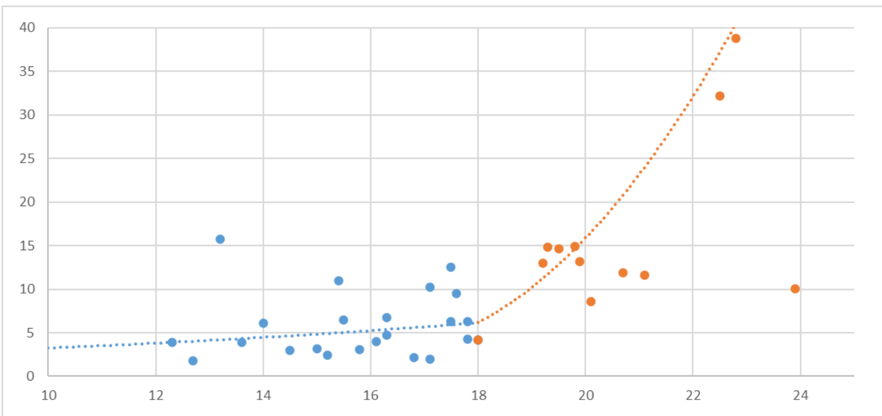
- Y-axis [Pa], similar to the f_{pe-DB}. The relation is different and for a dew point temperature of 20 °C the admissible pressure drop is 15 Pa.
- X-axis is the dew-point temperature

$$X_{axis} = T_{dewpoint}$$

Where:

	Dew-point Temperature	a	b	c
Coefficients	≤ 18	**0,0141**	**-0,0346**	**2,2**
	> 18	**0,8216**	**-26,38**	**214,8**

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user



Note: this coefficient is the one with the lowest trend but this has a small impact on the final result.

Now that the three functions have been determined the correction factors Δp_x, Δp_y, Δp_z can be assessed.

G.5.2. Reference table

The following reference is applicable for the calculation of the correction factors for summer application:

CLASS	All Units	Units for full or partial outdoor air at design summer: winter dry bulb temperature ≥ -3°C AND dry bulb temperature ≥ 30°C OR winter dry bulb temperature ≥ -3°C AND dew-point temperature ≥ 17°C OR dry bulb temperature ≥ 30°C AND dew-point temperature ≥ 17°C				
	Velocity	**Heat recovery system**				**Fan Efficiency Grade**
	v_{class} [m/s]	**$\eta_{class-T}$ [%]**	**$\Delta p_{class-T}$ [Pa]**	**$\eta_{class-H}$ [%]**	**$\Delta p_{class-H}$ [Pa]**	**$NG_{ref-class}$ [-]**
A+	1.4	83	167	81	222	64
A	1.6	78	160	73	213	62
B	1.8	73	155	65	207	60
C	2.0	68	151	58	202	57
D	2.2	63	147	50	197	52
E	No calculation required					No requirement

Table 6: Table for energy efficiency calculations (summer application)

G.5.3. Pressure correction due to HRS pressure drop; Δpy

$$\Delta P_y = [\Delta P_{s-HRS} - \Delta P_{class-T}] * f_{T-H} + [\Delta P_{s-HRS} - \Delta P_{class-H}] * (1 - f_{T-H}) \quad \textbf{(Eq. 1.1)}$$

Where:

ΔP_{s-HRS}, is the HRS pressure drop from real selection, (subscript “s” refers to selection values)

$\Delta P_{class-T}$ and $\Delta P_{class-H}$, are reference values from the reference table section 0

f_{T-H}, refer to section 0.

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

G.5.4. Pressure correction due to HRS efficiency; Δp_z

$$\Delta P_z = \left[\underbrace{(\eta_{class-T} - \eta_{s-T}) * f_{pe-DB} * f_{T-H}}_{a} + \underbrace{(\eta_{class-H} - \eta_{s-H}) * f_{pe-DewP} * (1 - f_{T-H})}_{b} - \left[\underbrace{\eta_{s-H} * \left({}^{1}/_{f_{T-H}} - 1\right)}_{c}\right]\right] * \left(1 - \frac{mr}{100}\right)$$

Where:

η_{s-T}, current selection temperature efficiency
η_{s-H}, current selection humidity efficiency* (cf note below)
$\eta_{class-T}$ and $\eta_{class-H}$, are reference values from the reference table section 0 f_{T-H}, refer to section 0
f_{pe-DB}, refer to section 0
$f_{pe-DewP}$, refer to section 0
mr, mixing ratio, as winter application

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

Note: Temperature wet efficiency is different than humidity efficiency. Temperature wet efficiency shall not be used for this calculation.

η_{s-T} and η_{s-H} must be set to 0 in case of supply only unit (no HRS).

And where:

a) Expresses the benefit or penalty, so the balance between the selection temperature efficiency and the class value multiplied by factor f_{pe-DB}, convert the efficiency to pressure. It is also multiplied by factor f_{T-H} to balance the dry and humidity Heat Recovery;

b) As the term a), expresses the balance between the real humidity efficiency and the class value, too;

c) Expresses the benefit of using humidity recovery, used only in the equation for the supply side.

Explanation of term **c)**

It is possible with the factor f_{T-H} to have a relation between Latent and Sensible capacity as shown below.

$$\left({}^{1}/_{f_{T-H}} - 1\right) = \frac{1}{f_{T-H}} - 1 = \frac{1 - f_{T-H}}{f_{T-H}} = \frac{1 - \frac{Qs}{Q_s + Q_L}}{\frac{Qs}{Q_s + Q_L}} = \frac{Q_s + Q_L - Q_s}{Q_s} = \frac{\boldsymbol{Q_L}}{\boldsymbol{Q_s}}$$

In the main equation, the factor $\left({}^{1}/_{f_{T-H}} - 1\right)$ needs to be multiplied by the humidity efficiency (η_{s-H}) to consider the latent capacity recovered.

G.6. Insert the internal decrease static pressure when HRS is on bypass mode on Energy Efficiency Class methodology (2nd step)

The internal decrease of the static pressure when the HRS is on bypass mode is considered only for the summer application.

G.6.1. Determination of the function $f_{Sp\text{-}bypass}$

$f_{Sp\text{-}bypass}$ is a factor (0< f < 1) that weighs the working period of HRS bypass on summer application. (Value 1 when 100% time works the bypass, value 0 when 100% time works the HRS)

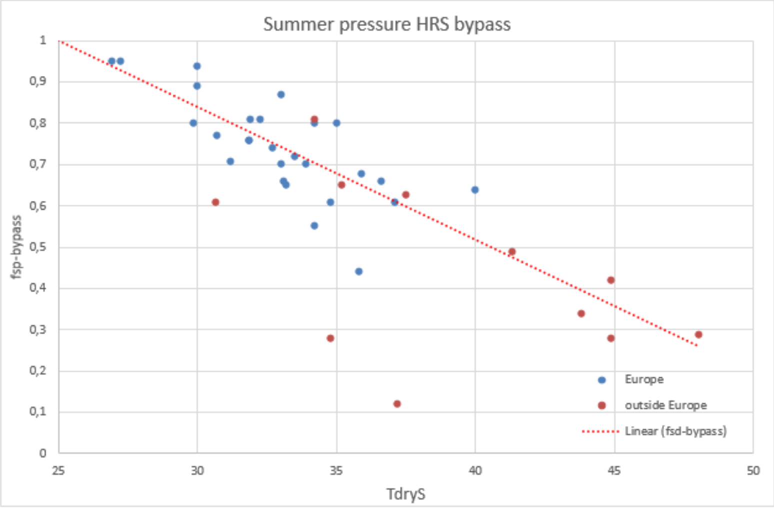
$$f_{SP-bypass} = a * X_{axis} + b$$

- Y-axis is the coefficient $f_{Sp-bypass}$
- X-axis is the Design Dry bulb temperature

$$X_{axis} = T_{DB}$$

Where:

	a	b
Coefficients	**-0,0322**	**1,8**



G.6.2. Pressure correction due to HRS pressure drop; Δp_y

Considering that $\Delta P_{s-bypass}$ is the pressure drop of current selection HRS bypass, the decrease of the static pressure drop when the HRS is on bypass mode is considered in the bypass circuit. In the heat recovery, there is no impact, it is then necessary to assess the two circuits separately:

- In the heat recovery circuit ΔP_{y-HRS}
- In the bypass circuit $\Delta P_{y-bypass}$

The two pressure drops will then be weighted to obtain Δp_y from both circuits.

G.6.2.1. In the Heat Recovery circuit

$$\Delta P_{y-HRS} = [\Delta P_{s-HRS} - \Delta P_{class-T}] * f_{T-H} + [\Delta P_{s-HRS} - \Delta P_{class-H}] * (1 - f_{T-H})$$ **(Eq. 1.2)**

Where:

ΔP_{s-HRS}, is the HRS pressure drop from real selection, (subscript "s" refers to selection values)
$\Delta P_{class-T}$ and $\Delta P_{class-H}$, are reference values from the reference table section 0
f_{T-H}, refer to section 0.

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

G.6.2.2. In the Bypass circuit

$$\Delta P_{y-bypass} = [\Delta P_{s-bypass} - \Delta P_{class-T}] * f_{T-H} + [\Delta P_{s-bypass} - \Delta P_{class-H}] * (1 - f_{T-H})$$ **(Eq. 1.3)**

Where:

$\Delta P_{s-bypass}$, is the pressure drop of current selection HRS bypass
$\Delta P_{class-T}$ and $\Delta P_{class-H}$, are reference values from the reference table section 0
f_{T-H}, refer to section 0.

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

G.6.2.3. Weighting ratio between both circuits

$$\Delta P_y = (\Delta P_{y-HRS}) * (1 - f_{Sp-bypass}) + (\Delta P_{y-bypass}) * (f_{Sp-bypass})$$ **(Eq. 1.4)**

Where:

ΔP_{y-HRS}, refer to section 0
$\Delta P_{y-bypass}$, refer to section 0
$f_{Sp-bypass}$, refer to section 0

G.7. Insert Indirect adiabatic cooling on Energy Efficiency Class methodology (3rd step)

The additional pressure drop of the indirect adiabatic cooling is considered only for the summer application. This additional pressure drop is added to the HRS pressure drop.

G.7.1. Determination of the function f_{IAC}

f_{IAC}, is a factor (multiplication) that reflect the increase on dry recovery, if doesn´t exist it will be equal to 1.

$$f_{IAC} = a * e^{b*X_{axis}}$$

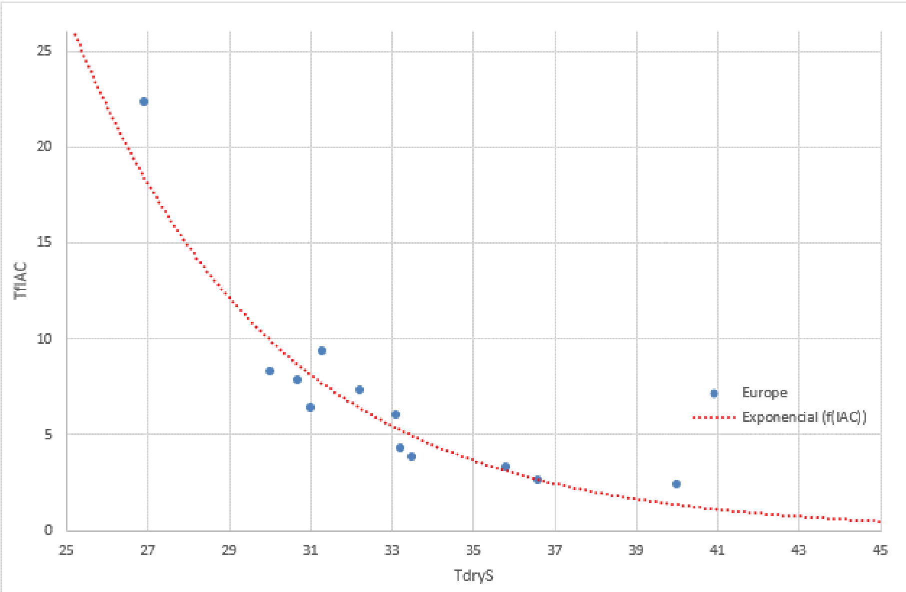
- Y-axis is the coefficient f_{IAC}
- X-axis is the Design Dry bulb temperature

$$X_{axis} = T_{DB}$$

Where:

	a	b
Coefficients	**4000**	**-0,2**

For more information about the calculations and how the coefficient has been obtained, refer to the end of this appendix – section […].



G.7.2. Pressure correction due to HRS pressure drop; Δp_y

Under section 02, it was defined as:

- In the Heat Recovery circuit

$$\Delta P_{y-HRS} = [\Delta P_{s-HRS} - \Delta P_{class-T}] * f_{T-H} + [\Delta P_{s-HRS} - \Delta P_{class-H}] * (1 - f_{T-H})$$

- In the Bypass circuit

$$\Delta P_{y-bypass} = [\Delta P_{s-bypass} - \Delta P_{class-T}] * f_{T-H} + [\Delta P_{s-bypass} - \Delta P_{class-H}] * (1 - f_{T-H})$$

G.7.2.1. In the Heat Recovery circuit

$$\Delta P_{y-HRS} = [\Delta P_{s} - \Delta P_{class-T}] * f_{T-H} + [\Delta P_{s} - \Delta P_{class-H}] * (1 - f_{T-H})$$ **(Eq. 1.5)**

Where:

$\Delta P_s = \Delta P_{s-HRS} + \Delta P_{s-IAC}$ (ΔP_{s-IAC} needs to be used in the equation only on the extract side)

ΔP_{s-HRS}, is the HRS pressure drop from real selection, (subscript "s" refers to selection values)

ΔP_{s-IAC}, is the indirect adiabatic cooling pressure drop (0 for supply side)

$\Delta P_{class-T}$ and $\Delta P_{class-H}$, are reference values from the reference table section 0

f_{T-H}, refer to section 0.

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

G.7.2.2. In the Bypass circuit

$$\Delta P_{y-bypass} = [\Delta P_{circ-bypass} - \Delta P_{class-T}] * f_{T-H} + [\Delta P_{circ-bypass} - \Delta P_{class-H}] * (1 - f_{T-H}) \quad \textbf{(Eq. 1.6)}$$

Where:

$\Delta P_{circ-bypass} = \Delta P_{s-bypass} + \Delta P_{s-IAC}$ (ΔP_{s-IAC} needs to be used in the equation only on the extract side)

$\Delta P_{s-bypass}$, is the pressure drop of current selection HRS bypass

ΔP_{s-IAC}, is the indirect adiabatic cooling pressure drop (0 for supply side)

$\Delta P_{class-T}$ and $\Delta P_{class-H}$, are reference values from the reference table section 0

f_{T-H}, refer to section 0.

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

G.7.3. Pressure correction due to HRS efficiency; Δp_z

Under section 0 the impact of the humidity recovery was considered, resulting in Equation 2.1:

$$\Delta P_z = \left[(\eta_{class-T} - \eta_{s-T}) * f_{pe-DB} * f_{T-H} + (\eta_{class-H} - \eta_{s-H}) * f_{pe-DewP} * (1 - f_{T-H}) - \left[\eta_{s-H} * \left({}^{1}\!/_{f_{T-H}} - 1\right)\right]\right] * \left(1 - \frac{mr}{100}\right)$$

It needs to include the benefit of IAC, so the new equation is

$$\Delta P_z = \left[(\eta_{class-T} - \eta_{s-T}) * f_{pe-DB} * f_{T-H} + (\eta_{class-H} - \eta_{s-H}) * f_{pe-DewP} * (1 - f_{T-H}) - \left[\underbrace{\eta_{s-T} * f_{IAC}}_{d} + \eta_{s-H} * \left({}^{1}\!/_{f_{T-H}} - 1\right)\right]\right] * \left(1 - \frac{mr}{100}\right) \quad \textbf{(Eq. 1.7)}$$

Where:

η_{s-T}, current selection temperature efficiency

η_{s-H}, current selection humidity efficiency

$\eta_{class-T}$ and $\eta_{class-H}$, are reference values from the reference table section 0 f_{T-H}, refer to section 0

f_{pe-DB}, refer to section 0

$f_{pe-DewP}$, refer to section 0

f_{IAC}, refer to section G.7.1**Erreur ! Source du renvoi introuvable.** (0 supply side)

mr, mixing ratio, as winter application

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

η_{s-T} and η_{s-H} must be set to 0 in case of supply only unit (no HRS)

The term d) expresses the benefit of using IAC taking into consideration the HRS dry efficiency.

G.8. Final equations

The final equations include the influence of the three features defined in the sections above:

- Humidity Recovery
- Reduction in pressure drop in the Heat Recovery System (HRS) bypass

- Indirect adiabatic cooling (IAC)
- As for each feature it is the correction factors which are impacting, the rest methodology to determine the energy efficiency for summer application remaining the same.

G.8.1. Pressure correction; Δp_y

To consider the pressure drop in the bypass circuit Δp_y must be split into two sections:

- In the heat recovery circuit ΔP_{y-HRS}
- In the bypass circuit $\Delta P_{y-bypass}$

G.8.1.1. In Heat Recovery circuit

The final equation for ΔP_{y-HRS} is the following:

$$\boldsymbol{\Delta P_{y-HRS}} = [\Delta P_s - \Delta P_{class-T}] * f_{T-H} + [\Delta P_s - \Delta P_{class-H}] * (1 - f_{T-H})$$

Where:

$\Delta P_s = \Delta P_{s-HRS} + \Delta P_{s-IAC}$

ΔP_{s-HRS}, is the HRS pressure drop from real selection, (subscript "s" refers to selection values)

ΔP_{s-IAC}, is the indirect adiabatic cooling pressure drop

$\Delta P_{class-T}$ and $\Delta P_{class-H}$, are reference values from the reference table section 0

f_{T-H}, refer to section 0.

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

G.8.1.2. In Bypass circuit

The final equation for $\Delta P_{y-bypass}$ is the following:

$$\boldsymbol{\Delta P_{y-bypass}} = [\Delta P_{circ-bypass} - \Delta P_{class-T}] * f_{T-H} + [\Delta P_{circ-bypass} - \Delta P_{class-H}] * (1 - f_{T-H})$$

Where:

$\Delta P_{circ-bypass} = \Delta P_{s-bypass} + \Delta P_{s-IAC}$

$\Delta P_{s-bypass}$, is the pressure drop of current selection HRS bypass

ΔP_{s-IAC}, is the indirect adiabatic cooling pressure drop

$\Delta P_{class-T}$ and $\Delta P_{class-H}$, are reference values from the reference table section 0

f_{T-H}, refer to section 0.

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

G.8.1.3. Weighting ratio between both circuits

The final equation for $\Delta P_{y-bypass}$ is the following (balance between both circuits)

$$\boldsymbol{\Delta P_y} = (\Delta P_{y-HRS}) * (1 - f_{Sp-bypass}) + (\Delta P_{y-bypass}) * (f_{Sp-bypass})$$

Where:

ΔP_{y-HRS}, refer to section 0

$\Delta P_{y-bypass}$, refer to section 0

$f_{Sp-bypass}$, refer to section 0

G.8.2. Pressure correction due to HRS efficiency; Δp_z

The final equation for ΔP_z is the following:

$$\Delta P_z = \left[(\eta_{class-T} - \eta_{s-T}) * f_{pe-DB} * f_{T-H} + (\eta_{class-H} - \eta_{s-H}) * f_{pe-DewP} * (1 - f_{T-H}) - \left[\eta_{s-T} * f_{IAC} + \eta_{s-H} * \left({}^{1}/_{f_{T-H}} - 1\right)\right]\right] * \left(1 - \frac{mr}{100}\right)$$

Where:

η_{s-T}, current selection temperature efficiency
η_{s-H}, current selection humidity efficiency
$\eta_{class-T}$ and $\eta_{class-H}$, are reference values from the reference table section 0
f_{T-H}, refer to section 0
f_{pe-DB}, refer to section 0
$f_{pe-DewP}$, refer to section 0
f_{IAC}, refer to section G.7.1
mr, mixing ratio, as winter application

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

G.9. Fan reference power; $P_{sup-ref}$ if supply air side or $P_{ext-ref}$ if extract air side

The fan reference is then calculated just like the winter application using the following formula:

$$P_{airside-ref} = \frac{\left[\Delta P_{s-static} - (\Delta p_x + \Delta p_y + \Delta p_z)\right] \cdot q_{v-s}}{\left(a \cdot ln\left(\frac{P_{airside-ref}}{1000}\right) - b + NG_{ref}\right)/100}$$

Where: $P_{air\ side\text{-}ref}$ = fan reference power [W] (use $P_{sup-ref}$ for supply air side or $P_{ext-ref}$ for extract air side)
$q_{v\text{-}s}$ = air volume flow rate [m^3/s]
NG_{ref} = Fan Efficiency Grade corresponding to the class value *in %*
a, b = coefficients as per the table below.

$P_{air\ side\text{-}ref}$	a	b	NG_{ref}
≤ 10 kW	4,56	10,5	$NG_{ref\text{-}class}$
> 10 kW	1,1	2,6	$NG_{ref\text{-}class}$

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

The first iteration of $P_{air\ side\text{-}ref}$ is:

$$P_{airside-ref(1st\ iteration)} = \frac{\left[\Delta P_{s-static} - (\Delta p_x + \Delta p_y + \Delta p_z)\right] \cdot q_{v-s}}{NG_{ref}/100}$$

If the value of the $\left[\Delta P_{s-static} - (\Delta p_x + \Delta p_y + \Delta p_z)\right]$ *parameter is lower than zero, then the class of the unit is lower than the current one used for the calculation.*

G.10. Absorbed power factor; f_{s-Pref}

$$f_{\text{s-Pref}} = \frac{P_{\text{s-sup}} + P_{\text{s-ext}}}{P_{\text{sup-ref}} + P_{\text{ext-ref}}} \leq 1$$

where: $f_{s\text{-}Pref}$ = absorbed power factor
$P_{s\text{-}sup}$ = active power supplied from the mains, including any motor control equipment, to selected supply air fan [kW]
$P_{s\text{-}ext}$ = active power supplied from the mains, including any motor control equipment, to select extract air fan [kW]
$P_{sup\text{-}ref}$ = supply air fan reference power [kW]

$P_{ext\text{-}ref}$ = extract air fan reference power [kW]

Data in green: input from the user
Data in blue: reference data from the tool
Data in orange: calculated based on input data from the user

G.11. Methodology and data used to define the different factors

G.11.1. List of countries used for the definition of the different factors

European place list

Country	Place	Country	Place	Country	Place
Greece	Andravida	Spain	Madrid	Denmark	Copenhagen
Greece	Athens	France	Marseille	Germany	Frankfurt
Bosnia and Herzegovina	BANJA LUKA	Italy	Milano	Finland	Helsinki
Spain	Barcelona	Italy	Naples	Lithuania	KAUNAS
Serbia	BELGRADE	France	Nice	Sweden	Kiruna
France	Bordeaux	Italy	Palermo	Poland	Krakow
Hungary	DEBRECEN	Spain	Palma	Slovenia	Ljubljana
Portugal	Faro	Montenegro	PODGORICA	Germany	Munich
Portugal	Funchal	Portugal	Porto	Norway	Oslo
Turkey	Istanbul	Italy	Rome	France	Paris
Turkey	Izmir	Spain	Seville	Czech	PRAGUE
Portugal	Lajes	Greece	Thessaloniki	Sweden	Stockholm
Cyprus	Larnaca	Netherlands	Amsterdam	Poland	Warsaw
Spain	Las Palmas	Turkey	Ankara		
Portugal	Lisbon	Germany	Berlin		

Winter extreme conditions

Country	Place
Russian	ARHANGELSK
Russian	Chita
USA	Fort Yukon
Canada	Resolute

Humid extreme conditions

Country	Place
Thailand	Bangkok
Brazil	Manaus

Dry and hot extreme conditions

Country	Place	Country	Place
UAE	Abu Dhabi	Tunisia	Tunis
Algeria	Algiers	Egypt	Kharga
Morocco	Casablanca	Kuwait	Kuwait
Israel	Tel Aviv	Saudi Arabia	Riyadh
Libya	Tripoli		

G.11.2. Climate data

The climate source data used to plot the graph and determine the different factors was the energyplus weather.

Climate source data: https://energyplus.net/weather

The climate data type is “IWEC – International Weather for Energy Calculations”, more information on: https://energyplus.net/weather/sources#IWEC

G.11.3. Season of the year (Summer or Winter)

The determination of the season is based on **HDD** and **CDD** “Heating and Cooling degree days”.

Source method **European Environment Agency:** https://www.eea.europa.eu/data-and-maps/indicators/heating-degree-days/assessment

G.11.4. Heat recovery simulation

The simulations were hourly and all over the year.

Two situations were made:

- Dry system with temperature control
- Humidity recovery with enthalpy control

The extract air conditions were:

- Winter 18 °C dry bulb temperature and 11 °C dew-point temperature (relative humidity 63%)
- Summer 25 °C dry bulb temperature and 14 °C dew-point temperature (relative humidity 50%)
- Summer with Indirect Adiabatic Cooling (IAC) 19 °C dry bulb temperature and 17,5 °C dew-point temperature (relative humidity 90%), same Enthalpy than 25 °C / 50%

Criterion to recovery active:

- On dry system was external temperature vs extract air conditions
- On wet system was external enthalpy vs extract air conditions

G.11.5. Temperature design reference

The reference dry temperature and dew-point temperature derivate from ASHRAE 2013 Monthly design Dry Bulb 2% data (database 2017 was not available at the time of the simulations, the year 2013 was then used).

Source: http://ashrae-meteo.info/index.php

APPENDIX H. *HYGIENIC OPTION FOR AIR HANDLING UNITS*

Refer to 2023-10.2 ECP-05-2023 Appendix H for HAHU.

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