RS 6/C/005-2018

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RATING STANDARD
for the
CERTIFICATION
of
AIR HANDLING UNITS

RS 6/C/005-2018

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EUROVENT CERTIFIED PERFORMANCE

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I. PURPOSE

The purpose of this Rating Standard is to establish definitions and specifications for testing and rating of Air Handling Units for the related Eurovent Certified Performance Programme, in accordance with Operational Manual OM-5.

II. SCOPE

See Operational Manual OM-5, § II.

III. DEFINITIONS

Air Handling Unit: A factory made encased assembly or flat-packaged 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 unit 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 manufacturer's literature, used to establish mechanical, thermal and acoustical performance according to the relevant EN standards.

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.

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

Deflection [mm/m]: The largest deformation of the sides of the unit under pressure, positive or negative, given as a difference in distance from a reference plane outside the unit to the external unit 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 exhaust 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 when on the basis of objective evidence:

- there is a significant risk to the product's conformity to specified requirements, or
- there is a significant risk on 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 critical when on the basis of objective evidence:

- there is no significant risk to the product's conformity to specified requirements, or
- there is no significant risk on 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.

IV. TESTING REQUIREMENTS

IV.1 Standards for testing of AHU

All performance ratings presented by manufacturers shall be verified by tests performed in the independent laboratory(ies) selected by Eurovent Certita Certification. The following standards shall be used as a basis for these tests:

- EN 1886:2007: "Ventilation for buildings – Air Handling Units – Mechanical performance
- EN 13053:2006: Ventilation for buildings – Air Handling Units – Rating and performance for unit's components and sections.

IV.2 Volume – pressure performance

For volume pressure performance, the laboratory sets airflow as a constant value, measures External Static Pressure (ESP), and rates Available Static Pressure (ASP).

IV.3 Air flow rate – pressure – fan power input

Air flow rate, pressure and fan power input shall be established for five points in the range of normal operation of the unit. Only supply air side shall be measured and certified.

IV.4 Heating and cooling capacity

Thermal test shall be performed at two conditions in cooling and in heating:

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

These conditions shall be chosen in the normal operating range of the unit selected for 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
- for heating:
  - air inlet temperature 10°C
  - water inlet temperature 60°C

The test shall be performed at the specified water flow rate and the specified air flow rate (by adjusting the ESP).

IV.5 Heat recovery

Testing for heat recovery shall be carried out with at least 20 K difference, only one measuring point will be performed.

The following systems could be tested:

a. Run-around coil system

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

1. Test on the complete system

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. Frequency of the pump shall be pre-set by the manufacturer but can be adjusted by the laboratory when provided by the manufacturer. Absorbed motor power of the circulation pump shall be measured if the pump is rated in the software output. Fluid side pressure drop and glycol percentage shall be measured. Tolerance on glycol content is +/-3%-points (in volume).

2. 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 in order 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 air flow across the coil).

- Different coils

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

b. Rotary heat exchanger system

c. Plate heat exchanger system.

IV.6 Sound power level

a. In duct sound power level

The test for determination of the in duct sound power level will be performed with free inlet and a duct with (at least) the length of one equivalent diameter at the inlet and at 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 in accordance with the relevant Standards (see below V.7).

b. <u>Airborne sound power level</u>

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

IV.7 Check of insulation material

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.

IV.8 Mechanical performances

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.

V. RATING REQUIREMENTS

V.1 Air velocity in the AHU

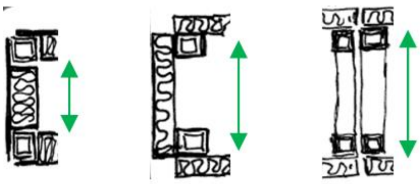


Figure 1: Several construction possibilities

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).

V.2 Fan pressure and absorbed power

Recalculation after update of software for fan external static pressure and absorbed power shall be based on nominal air flow and measured fan speed.

All five dry duty points shall be recalculated and evaluated. The five dry duty points have to be within the tolerances.

The recalculation and evaluation procedure will be as follows:

- 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 not exceed the corrected measured external static pressure by more than the tolerance (-4% or -15 Pa).
- Compare the measured power input with the power input obtained from the reselection. The measured value shall be within the allowable deviation (not higher than 3% of selection value).

V.3 Recalculation on sound power levels

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

V.4 Wet duty point

For recalculation of fan performance and absorbed motor power, the wet duty point shall not be considered. That means that, as a minimum, the dry conditions for the coil have to be specified.

V.5 Heating and 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).

V.6 Heat recovery

Consistency between DLL and stand alone software shall be checked by the auditor during the Annual Onsite Checking. The manufacturer software shall not give better performances than the HRS supplier's stand alone software. There shall be one digit after the decimal when displaying the heat recovery efficiency in the AHU selection software.

V.7 Sound power levels in unit openings - impact of end reflection

Low frequencies shall be corrected according to EN 12102:2012 duct end corrections.

V.8 Air density

Standard air density is set at 1.2 kg/m^3. If in printouts standard density is not used, then the actual density shall be stated and present in the printouts.

VI. CERTIFIED PERFORMANCE ITEMS

VI.1 Mechanical, thermal and acoustical performance

For each range and factory (except in the case of “sister factories”) one Real Unit shall be tested (see also OM-5, paragraph IV.10).

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

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

For each range and factory (except in the case of “sister factories”) as many Model Boxes as necessary to cover the worst cases (see table 1 below).

The CAL shall be tested according to EN1886:2007, but the positive pressure shall be adapted according to the OM-5.

Table 1: Table for selection of model boxes

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 construction			x			
Panel shape	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 (galvanized vs stainless steel)				worst case: galvanized	worst case: galvanized	
External finishing (galvanized vs coated)						
Hinge and /or latch		x		x		x
Gaskets (e.g. on doors)		x	x			

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

- **Casing strength class** for each variation of corner post, mullion, panel shape, 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 for the thinnest metal sheet.
- **Casing air leakage class** for each variation of corner post, mullion, panel shape, hinge and/or latch, gaskets, and for the thinnest panel.
- **Filter bypass leakage class** for each variation of corner post, filter construction ~~and~~ panel shape and gaskets.
- **Thermal transmittance class** for each variation of corner post, mullion, panel shape, hinge and/or latch, for each variation of conductivity of the insulation material out of +15 %, for galvanized sheet if available, for the thinnest panel and for the thickest metal sheet.
- **Thermal bridging factor class** for each variation of corner post, mullion, panel shape, for each variation of conductivity of the insulation material out of +15 %, for galvanized sheet if available, and for the thinnest panel and for the thickest metal sheet.
- **Acoustical insulation** for each variation of corner post, mullion, panel shape, 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 for the thinnest metal sheet.

No additional testing is required due to variations of external finishing.

VI.2 Other performances

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

- Air flow rate, external static pressure, power input at 5 conditions
- Octave band in-duct sound power level, at the inlet and outlet, with only supply air running
- Airborne sound power level, only with supply air running
- Heating capacity at 2 conditions, if standard feature of the range
- Cooling capacity at 2 conditions, if standard feature of the range

- Heat recovery: dry 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 water side at two conditions for cooling coil and heating coil
- Calculated Eurovent AHU Energy Efficiency Class (see APPENDIX C)

VI.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, Attenuator characteristics, Vibration level, Hygienic aspects, Weather protection, Mixing efficiency, Drain facilities.

VII. TOLERANCES

When tested by the Independent Laboratory, the measured performance values shall not differ from the claimed values by more than:

• Available External Static Pressure	-4 % or -15 Pa
• Absorbed motor power	+3 %
• Heat recovery efficiency	-3 %-points
• Heat recovery pressure drop (air side)	Maximum of +10 % or +15 Pa
• Water coil performances (heating/cooling)	-2 %
• Water coil pressure drop (water side)	Maximum of +10 % or +2 kPa
• Radiated sound power level casing	+3 dB(A)
• Sound power level unit openings	+5 dB @ 125 Hz +3 dB @ 250-8000 Hz
• Run-around coils, fluid side pressure drop for each coil	Maximum of +10 % or +2 kPa
• Absorbed motor power of circulation pump	+15%
• Casing Air Leakage	Same class or higher[1]

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 in accordance with test measurements (to claim better class on one performance data on MB configuration, another MB with the construction parameter variation shall be tested).

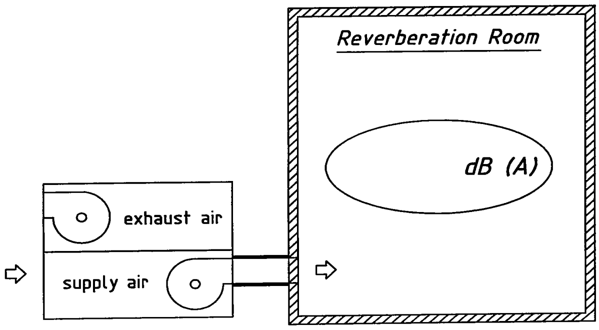
[1] See minutes of the Compliance Committee meeting held on 9 October 2015

APPENDIX A. IN DUCT SOUND POWER LEVEL MEASUREMENT

Reverberation room method

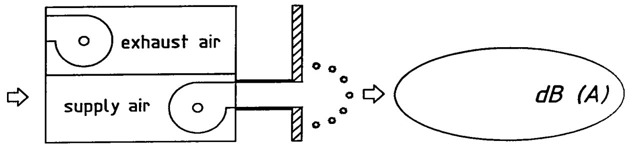
Supply air side fan = ON
Exhaust air side fan = OFF

set nominal running conditions



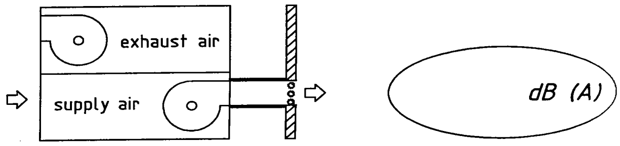
Free field method

Supply air side fan = ON set nominal running conditions
Exhaust air side fan = OFF



Sound intensity method

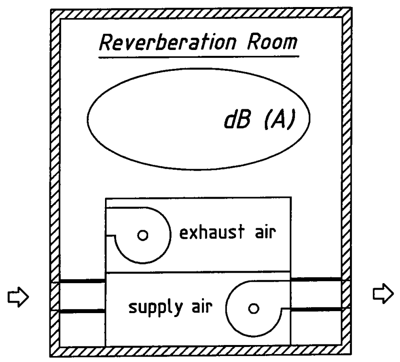
Supply air side fan = ON set nominal running conditions
Exhaust air side fan = OFF



APPENDIX B. AIRBORNE SOUND POWER LEVEL MEASUREMENT

Reverberation room method

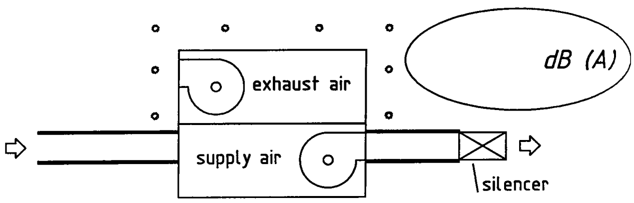
Supply air side fan = ON set nominal running conditions
Exhaust air side fan = OFF



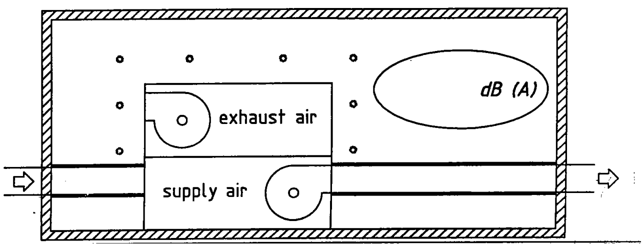
Free field or sound intensity method

Supply air side fan = ON set nominal running conditions
Exhaust air side fan = OFF

Outside a room



Inside a large room



APPENDIX C. ENERGY EFFICIENCY CLASS

C.I. 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 for 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 EN13053:2006: “Ventilation for buildings – Air handling units – Rating and performance for units, components and sections.”

C.II. Prerequisites

- 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 velocities in the calculations are the air velocities in the AHU cross-section based on the inside unit area for supply, respectively 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:

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

- 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.
- Weighting ratio between electric energy and thermal energy is 2 (1 kWh 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 2 below): $f_{pe} = (-\ 0.0035 \times t_{ODA} - 0.79) \times t_{ODA} + 8.1$ [Pa/%]

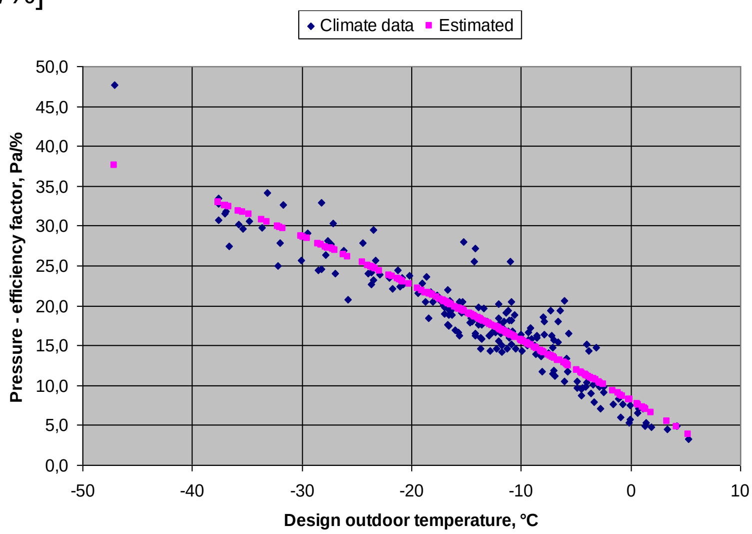


Figure 2: Equivalence Efficiency / Pressure Drop

C.III. Air Handling Unit subgroups

Three subgroups, with different label signs, are defined:

1) <u>Units for full or partial outdoor air at design winter temperature ≤ 9°C.</u>
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 ≤ 9°C. The unit can be ~~extract only,~~ 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 a 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}.
2) <u>Recirculation units or units with design inlet temperatures always > 9°C.</u>

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 > 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.

3) <u>Stand-alone extract air units.</u>

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 (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).

C.IV. Reference table

Table 2: Table for energy efficiency calculations

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

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

C.V. 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 2.

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 2:
   - 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 air flow, 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 (see C.VI)

   If subgroup 1, then calculate:
   - pressure correction due to HRS pressure drop Δp_y (see C.VII)
   - pressure correction due to HRS efficiency Δp_z (see C.VIII)
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 C.IX).

Final check consists in 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 C.X). If the value $f_{s\text{-}Pref}$ is equal 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.

C.VI. Pressure correction due to velocity; Δpx

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

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 2 [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!

C.VII. Pressure correction due to HRS pressure drop; Δpy

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

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 2 [Pa] (0 if subgroup 2 or 3)

C.VIII. Pressure correction due to HRS efficiency; Δpz

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

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 2 [%] (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 electrical heater (reheater, i.e. heater downstream the HRS).
= 0 when there is no electrical heater
= 1 when there is an electrical heater

C.IX. 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 would be. For a positive pressure value it is just the other way round. 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.

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

where: $P_{air\ side\text{-}ref}$ = fan reference power [kW] (use $P_{sup\text{–}ref}$ for supply air side or $P_{ext\text{–}ref}$ 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 (see Table 2
a, b = coefficients as per Table 3 below.

Table 3: Coefficients for the calculation of $P_{air\ side\text{-}ref}$

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

C.X. 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:
- $f_{s\text{-}Pref}$ = 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 selected extract air fan [kW]
- $P_{sup\text{-}ref}$ = supply air fan reference power [kW]
- $P_{ext\text{-}ref}$ = extract air fan reference power [kW]

C.XI. Heat recovery for run around coil systems

The following applies for 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 using 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) air flow [kg/s]
- $\dot{m}_{ETA}$ = extract air flow [kg/s]

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