Current possibilities of independent verification of qualities of HVAC units and validation of their power calculations

17.10.2017 | Mgr. Jan Mičan, Ing. Jaroslav Griner | Mandík a.s.

Introduction

In view of the requirements on the energy intensity of buildings and on the provision of the required condition of the internal environment, HVAC units are currently scrutinized by the authorities, which set the framework for their assessment, particularly from the perspective of energy management. The evaluation criteria have been becoming more and more strict and the manufacturers are forced to continuously improve the technical parameters and designs of their products. Furthermore, there is need to implement new components to ensure air filtration, transport and treatment, calculation algorithms, and to add new data to technical specifications. But the Commission of the European Union or any other authority either does not prescribe, or suggests only in general characteristics, the supervision over the observance of the rules and the verification of the technical parameters of the designed HVAC units by independent authorized bodies and by laboratory measurements, to give credibility to the manufacturers' technical specifications and calculations of essential parameters. Only calculations and specifications validated in the above stated manner will allow subsequent qualified decision-making about the selection of the supplier according to the required criteria.

The current status of some competitions resembles endless "one man's word against another" disputes, which do not have any solution, if not supported by evidence. The building investor and owner often do not ask the manufacturer of the relevant equipment to evidence the credibility of the values stated in the technical specification, thus debasing the meaning of the actual selection. However, it is substantial for them to choose the best products offered in the relevant competition.

This article aims at familiarizing the public with crucial qualitative characteristics and technical parameters of HVAC units, as well as with the current possibilities of their verification. The said possibilities consist in certifications, which guarantee valid technical parameters of the designed systems in compliance with European and international standards and regulations, including the possibility of issuing the respective energy labels. The article also describes the contents of the tests preceding the issue of individual certificates, for the investor and owner to get a picture of the supporting foundation of the certificate. Furthermore, the respective certificate logo is represented, together with some essential rules for its use in technical specifications.

Mandík, a.s. is well aware of the importance of verified and credible technical parameters. That is why it invests considerable effort and funds in certifications carried out by renowned associations and authorized bodies.

The HVAC unit parameters that always should be verified are the following:

From the perspective of design quality:

Assessment according to EN 1886 – Mechanical performance of HVAC unit casing.

- Test of mechanical strength of casing (without permanent deformations at overpressure and underpressure of +/-2500 Pa), measured max. deflection of casing (at overpressure / underpressure of +/- 1000 Pa), measured casing leakage (at overpressure of + 700 Pa / underpressure of - 400 Pa), measured filter frame leakage (determination of max. applicable filtration class), measured total thermal transmittance of casing (determination of thermal transmittance coefficient U [W/m2K]), measured thermal bridging of casing (determination of coefficient kb [-]), measured acoustic insulation of casing (determination of insulation [dB] in octave bands)

  The test are carried out at so called model box (M), consisting of two interconnected closed chambers. The model box must include all construction details of a common HVAC unit (corner, pillars, door and service panels, standard closing devices - door handles / hinges, etc.); it must include a standard design of chamber interconnection and standard gaskets without additional adaptations like cementing, etc.; and it must include a standard filter frame.

Fig. 1. Model box – tested sample

Fig. 2. Model box – acoustic chamber

The model box and its general test is carried out for one type of casing design; that means that if there are multiple designs within a HVAC unit product family (e.g. design with or without frame, two different panel insulations, different chamber connections, etc.), a separate model box must be individually made and tested for each design.

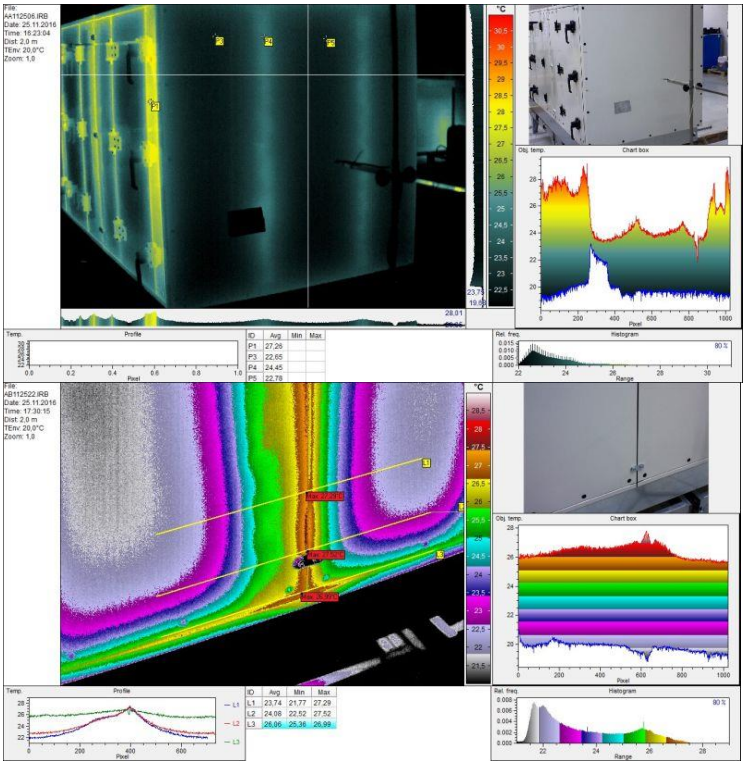


Fig. 3. Model box – measurement of thermal characteristics of casing in laboratory

The test results are interpreted by characteristic classes, arranged in ascending order from the best to the worst result achieved:

Table A1: Mechanical stability (EN 1886)

Casing class	max. relative deflection [mm/m]
D1	4
D2	10
D3	>10

Table A2: Casing leakage under negative pressure (EN 1886)

Leakage class	Max. leakage rate at -400 Pa test pressure [l/(sm²)]	Filter class as per EN 779
L1	0.15	better than F9
L2	0.44	F8–F9
L3	1.32	G1–F7 /no filter

Table A3: Casing leakage under positive pressure (EN 1886)

Leakage class	Max. air leakage rate at + 700 Pa test pressure [l/(sm²)]
L1	0.22
L2	0.63
L3	1.90

Table A4: Thermal transmittance (EN 1886)

Casing class	Thermal transmittance [W/(m²K)]
T1	$U \leq 0,5$
T2	$0.5 < U \leq 1.0$
T3	$1.0 < U \leq 1.4$
T4	$1.4 < U \leq 2.0$
T5	no requirements

Table A5: Thermal bridging factor (EN 1886)

Casing class	Thermal bridging factor k_b [-]
TB 1	$0.75 \leq k_b < 1.00$
TB 2	$0.60 \leq k_b < 0.75$
TB 3	$0.45 \leq k_b < 0.60$
TB 4	$0.30 \leq k_b < 0.45$
TB 5	no requirements

Classes D2, L3, T3, TB3 constitute the current standard for basic applications in internal and external environment like ventilation for commercial and industrial purposes. Units designed for sanitary environment or for clean rooms are subject to higher demands on casing leakage. They should correspond at least to class L2 for sanitary units and to class L1 for clean rooms.

Standard HVAC units do not achieve the thermal values like T1 and TB1, which guarantee the best possible values of total thermal resistance and the minimal thermal bridging of the casing. Such parameters are achieved by specially developed structures used in special applications like nuclear power stations and power engineering in general, military facilities, or required by national legislations, like the unit for placement in external environment in Switzerland.
The tests according to EN 1886 are carried out both at model boxes whose design copies incompletely the actual assembled HVAC unit and at a real chamber assembly. The parameters measured at the model box are marked with (M) after the value of the respective class and those measured at the real unit are marked with (R). As the model box design cannot fully depict the actual assembled HVAC unit, the credibility of some parameters like casing leakage and panel deflection is higher if the parameters are measured at the real unit. In that way, the manufacturer can provide the customer with evidenced values corresponding to the actual equipment.

Fig. 4. Real unit - measurement of mechanical characteristics of casing and of performance parameters in laboratory

From the perspective of validity of performance parameters:

Assessment according to EN 13053 - Rating and performance for units, components and sections, EN 308 - Heat exchangers - Test procedures for establishing of performance of air to air and flue gases heat recovery devices, EN 1751 - Air terminal devices - Aerodynamic testing of dampers and valves, EN 1216 - Heat exchangers - Test procedures for establishing the performance, EN ISO 5167 - Measurement of liquid flow by means of pressure differential devices.

- Air volume flow [m3/h], total transport pressure [Pa], internal pressure losses of inbuilt units [Pa] (filters, exchangers, recuperators, dampers, …), external pressure losses [Pa]
- Input power [kW] and speed of fans [rpm]
- Input and output noise parameters [dB] in octave bands, noise to environment [dB]
- Heating and cooling performance of heat exchangers [kW], pressure losses of heating and cooling liquid [kPa]
- Temperature efficiency [%] and heating performance [kW] of heat recuperation

From the perspective of validity of calculation parameters:

- Implementation of requirements on Ecodesign of HVAC units according to the (EU) Commission Regulation No. 1253/2014
- Calculation of energy intensity and issue of energy label
- Correspondence of calculated parameters with measured results of real unit

From today's perspective, the only efficient tool for the development of a complete design of HVAC units consists in a software solution, i.e. a selection program including all technical solutions of a given manufacturer, algorithms for technical calculations according to valid standards and theories and output parameters of the final design in form of HVAC unit technical specification with all necessary performance parameters and drawing documentation. Two crucial certifications with a broad scope of monitored values are available at present for independent verification of the above stated parameters, evaluation of energy intensity and issue of energy labels.

Eurovent certification

The first of them is the Eurovent certification of Eurovent Certita Certification, a French company; the certification is worldwide recognized and leading manufacturers of HVAC units have it.

url: http://www.eurovent-certification.com, Eurovent Certita Certification, France

auditor: Eurovent, laboratories: model box – TÜV-SÜD Munich, real unit – TÜV-NORD Essen

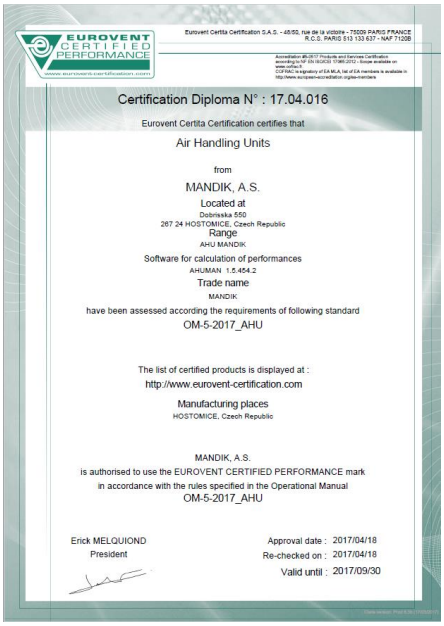
To achieve the certification, the manufacturer must meet the following conditions:

- become a regular member
- carry out laboratory measurements of characteristics of model box casing according to EN 1886

- carry out laboratory measurements of performance parameters of real unit and of selected characteristics of casing according to EN 1886
- succeed in the audit of selection program and its calculations
- succeed in the audit of production processes and quality policy

The successful certification results in:

- issue of the TÜV-SÜD certificate according to EN 1886 for casing characteristics
- issue of the Eurovent certificate for selection program and suggestion of energy classes of certified HVAC unit families


Certification Diploma N° : 17.04.016

Eurovent Certita Certification certifies that

Air Handling Units

from

MANDIK, A.S.

Located at

Dobrisska 550

267 24 HOSTOMICE, Czech Republic

Range

AHU MANDIK

Software for calculation of performances

AHUMAN 1.5.454.2

Trade name

MANDIK

have been assessed according the requirements of following standard

OM-5-2017_AHU

The list of certified products is displayed at :

http://www.eurovent-certification.com

Manufacturing places

HOSTOMICE, Czech Republic

MANDIK, A.S.

is authorised to use the EUROVENT CERTIFIED PERFORMANCE mark

in accordance with the rules specified in the Operational Manual

OM-5-2017_AHU

Erick MELQUIOND

President

Approval date : 2017/04/18

Re-checked on : 2017/04/18

Valid until : 2017/09/30

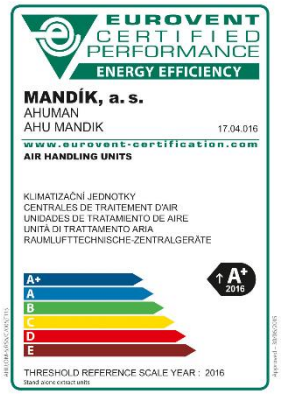


Fig. 5. Eurovent certificate + energy label

The values measured at testing of the real unit are compared in detail with its technical specification developed in the selection program. If any out-of-tolerance deviations are detected at the compared values, further steps follow, including re-design of the unit and a new test, correction of calculation, correction of results, etc. The process of so called re-calculation does not end until the output values of the technical specification of the selection program are identical with the actual status measured.

When auditing the selection program, the applied components (fans, recuperators, heat exchangers, etc.) and the credibility of their calculations are inspected.

Another main activity of the selection program audit consists in checking the implementation of algorithms for calculation of energy classes. The main criteria for determination of energy classes of the units are shown in the following table. The methodology of determination of the resulting class contains several formulas, which include mutual compensations between the monitored parameters, leading to slight defocusing of their borderlines.

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 output technical specification of the selection program is shown in the following figure. It includes the type and the resulting parameters of the model box, the basic parameters of the unit and the energy label based on the calculation of the designed unit.

Basic unit construction identical with **MODEL BOX M20-M100** **EUROVENT**
Energy Efficiency

EUROVENT Diploma Nr. **17.04.016**
Air Density used for calculations: standard 1.2 kg/m3
Operating conditons between -30°C and +40°C
Fan has been designed for wet condition of cooling coils

Unit main technical parameters		**Supply**	**Exhaust**
air flow	m3/h	**17130**	**16100**
External pressure loss	Pa	**400**	**400**
air velocityin free cross-section	m/s	**2.4**	**2.3**
Design winter outdoor temperature	°C	**0**	

Test according to EUROVENT RS 6/C/005-2017, casing with rock wool MM65

Mechanical strength of casing	**D1 (M)**
Casing air leakage	**L1 (M)**
Filter bypass leakage	**< 0,5% - F9 (M)**
Thermal transmittance	**T3**
Thermal bridging of the casing	**TB2**

Sound insertion loss in band	Hz	125	250	500	1000	2000	4000	8000
	dB	**17**	**21**	**25**	**36**	**39**	**42**	**46**

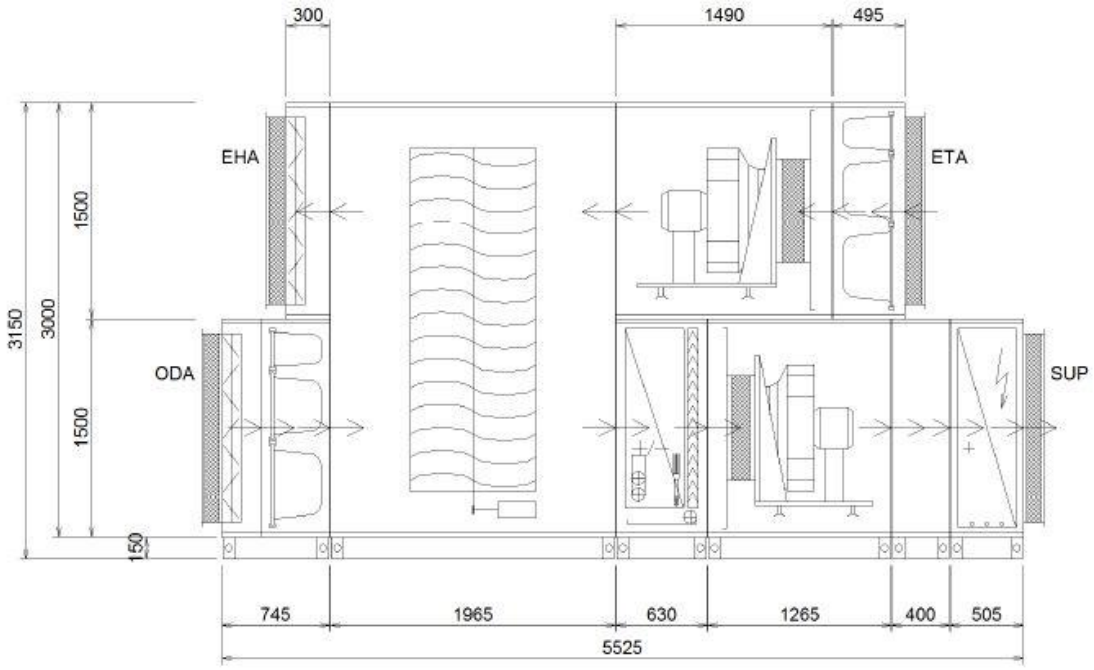


Fig. 6. Technical specification of HVAC unit with compulsory data according to Eurovent certification

RLT certification

Another recognized certification, used particularly in German speaking countries, is the RLT certification, issued by the Association of German manufacturers of HVAC units; all leading German manufacturers have it.

url: http://www.rlt-geraete.de, Association of German manufacturers of HVAC units

auditor: TÜV-SÜD Munich; laboratories: Model box – TÜV-SÜD Munich

To achieve the certification, the manufacturer must meet the following conditions:

- become a regular member of RLT Association
- carry out laboratory measurements of characteristics of casing according to EN 1886
- succeed in the audit of selection program and its calculations
- succeed in the audit of production processes and quality policy

The successful certification results in:

- issue of the TÜV-SÜD certificate according to EN 1886 for casing characteristics
- issue of the TÜV-SÜD certificate according to RLT Guideline for selection program and suggestion of energy classes of certified HVAC unit families


ZERTIFIKAT ◆ CERTIFICATE ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

We confirm to the company

MANDÍK, a.s.

in

CZ-267 24 Hostomice

based on the positive results of the tests on the

Model Box
Typ „M" and „P"

according to the standard

DIN EN 1886 (07/2009)

that the requirements of the certification program of the TÜV SÜD Industrie Service GmbH are fulfilled.

The manufacturer is entitled to use the following test mark:

This certificate is valid from: 18.02.2014 Day of initial certification: 18.02.2014

This certificate is valid until: 31.03.2020 Certificate-Registration-No.: 14/21/55

Refrigeration and air conditioning
Munich, the 18.02.2014

The Expert

TÜV SÜD INDUSTRIE SERVICE GMBH, WESTENDSTRASSE 199, D-80686 MÜNCHEN
klima@tuev-sued.de

Fig. 7. TÜV-SÜD certificate for mechanical characteristics of casing according to EN 1886


ZERTIFIKAT ◆ CERTIFICATE ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Wir bestätigen der Firma

MANDÍK, a.s.

in

CZ-26724 Hostomice

aufgrund der mit positivem Ergebnis abgeschlossenen Prüfungen der

RLT-Geräteauslegungs-Software
AHUMAN
Version x.x.xxx.2

dass die Anforderungen gemäß dem Prüf- und Zertifizierungsprogramm „RLT-RICHTLINIE Zertifizierung" der TÜV SÜD Industrie Service GmbH erfüllt sind.

Der Hersteller ist berechtigt folgende Prüfzeichen zu benutzen:

Energieeffizienzklasse A+ | Energieeffizienzklasse A | Energieeffizienzklasse B

Das Zertifikat ist gültig bis einschließlich 31.03.2018

Zertifikat-Registrier-Nr.: 14/10/19

Zertifizierungsstelle für Produkte Kälte- und Klimatechnik
München, den 21.03.2018

TÜV SÜD INDUSTRIE SERVICE GMBH, WESTENDSTRASSE 199, D-80686 MÜNCHEN
klima@tuev-sued.de

Fig. 8. TÜV-SÜD certificate for selection program according to RLT Guideline

However, the mere membership in the RLT Association and measuring of mechanical characteristics of the casing according to EN 1886 by the TÜV-SÜD testing laboratory does not automatically imply a certification according to the RLT Guidelines, as is mistakenly stated in the articles of some manufacturers; the selection program must be also certified in the first place. Even the actual membership in the RLT Association is only temporary, according to the statutes, if not completed by a successful certification of the selection program.

It must be pointed out here that the certification of the selection program according to the RLT Guidelines includes also the inspection of the implementation of Ecodesign according to the EU Commission Regulation 1253/2014. At present, TÜV-SÜD is the only authorized person that, within the certification according to the RLT Guidelines, carries out a detailed inspection of all calculation results and calculation algorithms according to the said Regulation. Furthermore, TÜV-SÜD requires and checks strict observance of the obligation to provide all information on the ventilation units specified in *ANNEX V* to the EU Regulation 1253/2014.

TÜV-SÜD also checks the use of the components (recuperators, fans, …), which must be verified by laboratory measurement and certified by TÜV-SÜD. The said certified components are indispensable for the calculation and issue of the energy label of classes A+, A and B whose calculation algorithm is also checked within the certification. The above stated checks are carried out, according to the RLT Guidelines, by an auditor from TÜV-SÜD Munich who supervises the strict observance of the rules. Only after a successful audit of the selection program, the manufacturer becomes a regular RLT member and gets the RLT-Geräteauslegungs-Software Certificate.

At this point, attention must be drawn to the misleading utilization of the TÜV-SÜD logo in the technical specifications of some manufacturers. The TÜV-SÜD logo, situated next to the values stating the casing characteristics according to EN 1886, must contain the text "EN 1886" in its lower part, the text „Type tested“ in the upper left oblique part and the „Production monitored“ in its upper right oblique part. The logo in such form is subject to a licence to use and it confirms that the manufacturer 1) has passed the measurement of casing characteristics according to EN 1886 in TÜV-SÜD and 2) has committed itself to permanent supervision by TÜV-SÜD in Munich.

Test according to EN 1886 (07/2009)

Mechanical strength of casing	**D1 (M)**							
Casing air leakage	**L1 (M)**							
Filter bypass leakage	**< 0,5% - F9 (M)**							
Thermal transmittance	**T3**							
Thermal bridging of the casing	**TB2**							
Sound insertion loss in band	Hz	125	250	500	1000	2000	4000	8000
	dB	**15.8**	**23.6**	**31.3**	**37.3**	**39.5**	**39.7**	**43.2**

according EU Directive No 1253/2014: Non residential ventilation unit (NRVU) ErP 2016, 2018 comply

Unit type:		**bidirectional ventilation unit (BVU)**		
Type of drive:		**variable speed drive**		
type of heat recovery system:		**recuperative heat exchanger**		
External leakage rate at - 400 Pa		**0.81%**		
External leakage rate at +400 Pa		**0.87%**		
Internal leakage rate at 250 Pa		**0.50%**		
thermal efficiency of HRS	ηH1:1	/ ηH_limit 2018	%	**78.3 / 73.0**
Supply: fan static efficiency:	ηHan	/ ηHan_limit 2018	%	**54.2 / 43.9**
Supply: fan static efficiency acc. Reg. (EU) No 327/2011:	ηstatA		%	**66.5**
Exhaust: fan static efficiency:	ηHan	/ ηHan_limit 2018	%	**51.5 / 43.3**
Exhaust: fan static efficiency acc. Reg. (EU) No 327/2011:	ηstatA		%	**66.5**
internal SFP of ventilation components:	SFP int	/ SFP int_limit 2018	W/(m3/s)	**957 / 1092**
Int.press.drop of vent.components: supply / exhaust	qPs int sup	/ qPs int exh	Pa	**245 / 260**
Int.press.drop of add.components: supply / exhaust	qPs add sup	/ qPs add exh	Pa	**169 / 64**

Regularly filter change is very important for performance and energy efficiency of the unit. Maximal recomended final pressure loss according EN13053 mentioned in technical specification is not to exceed. Use visual or acoustic pressure warning device on filters.

Equipment is included in the energy class A+ according RLT-certification guideline .

		Supply	Exhaust
SFP	W/(m3/s)	**1130**	**1038**
SFP class EN13779		**SFP3**	**SFP2**
Class of power input of drive acc. EN13053		**P1**	**P1**
Class of average air velocity acc. EN13053		**V2**	**V2**
efficiency class acc.EN13053		**H1**	

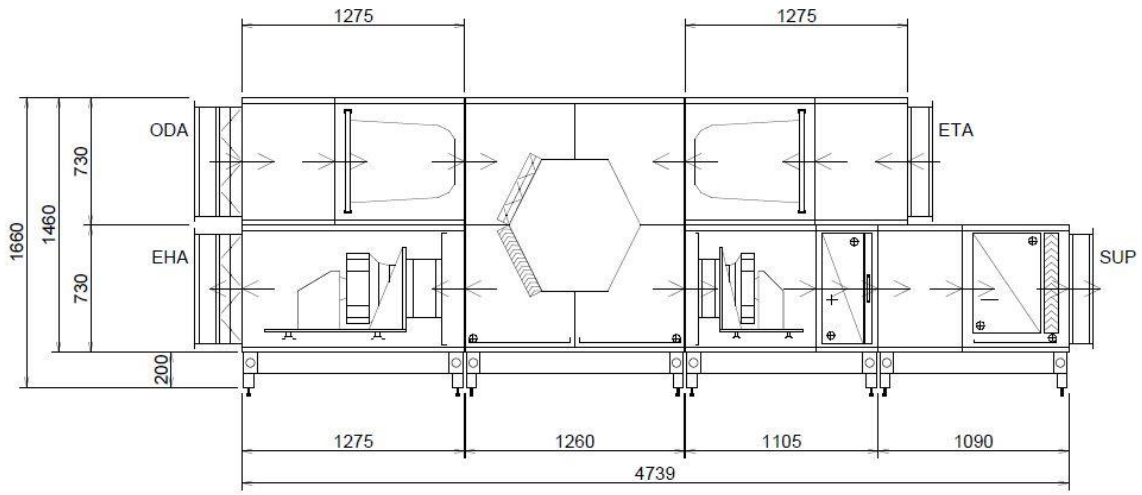


Fig. 9. Technical specification of HVAC unit with compulsory data according to RLT certification

The energy label is issued based on the criteria stated below. To be placed in a specific class, all conditions must be fully met; mutual compensation among individual parameters is inadmissible.

Class of electric power fan drives according to DIN EN 1353: 2012		
Class	**electric power (kW)**	
P1	≤ Pm ref * 0,85	
P2	≤ Pm ref * 0,90	A+
P3	≤ Pm ref * 0,95	A
P4	≤ Pm ref * 1,00	B
P5	≤ Pm ref * 1,06	
P6	≤ Pm ref * 1,12	
P7	≤ Pm ref * 1,12	
$Pm\ ref = (\Delta pstat/450)^{0,95}.(qv + 0,08)^{0,95}$		
Pm ref	(kW) electric power	
Δpstat	(Pa)static increasing fan pressure	
qv	(m3/s) air flow	

Flow velocities in the light section of the device relative to the filter unit or fan unit if the filter is not used		
Class	**Velocity (m/s)**	
V1	≤ 1,6	
V2	> 1,6 - 1,8	A+
V3	> 1,8 - 2,0	A+
V4	> 2,0 - 2,2	
V5	> 2,2 - 2,5	B
V6	> 2,5 - 2,8	
V7	> 2,8 - 3,2	
V8	> 3,2 - 3,6	
V9	> 3,6	

Efficiency classes based on DIN EN 13053: 2012			
Device design / Classes	A+	A	B
Without thermodynamic air treatment	V5	V6	V7
With air heating	V4	V5	V6
With additional features	V2	V3	V5
Electric fan power	P2	P3	P4
Heat Recovery	H1	H2	H3

Heat recovery classes based on DIN EN 13053:2012		
Class	**Energy efficiency ηe 1:1 (%)**	
H1	≥ 71	A+
H2	≥ 64	A
H3	≥ 55	B
H4	≥ 45	
H5	≥ 36	
H6	no requirement	

Conclusion

The issue of the certificates does not terminate the activities in the development of HVAC units. Due to more and more new requirements of the regulatory authorities or due to the fast development and innovations in the branch of environmental technology, the component suppliers strive to extend the borders of utilizability of their products. Such innovations, like more advanced designs of electric motors of fans together with new types of fan propellers with higher efficiency or more efficient power management, more efficient geometry of recuperators, as well as their new types covering even higher air volume flows, more efficient heat exchangers, etc., must be continuously implemented by the HVAC unit manufacturer into the selection program and into the products, to ensure the permanent ability to offer the most efficient solution and the best price/performance proportion as possible. That goes hand in hand with the maintenance of the certification: the authorized person properly supervises the changes in the selection program (updates of component libraries, new types, etc.) and asks for their updates, issues expert's reports or orders new laboratory measurements. The certification includes also repeated regular measurements of

the model boxes and of real units, which entail considerable expenses to the manufacturers, but guarantee a stable quality of the technical parameters of the HVAC units and reassure the user of good choice and use of the products certified in such manner.

A positive feature of both certifications consists in new business opportunities for the manufacturers with respect to the deliveries of HVAC units to the markets requiring the said certifications, like France, Belgium, Sweden, Denmark, Finland, Germany, Austria, Switzerland, Liechtenstein, etc. Thanks to the adaptation to the high technical standards and requirements of those countries, the quality and design of the Mandík HVAC units move up to higher and higher levels.

In 2017, after several years of development efforts, Mandík, a.s. joined the few companies holding the two certifications, both Eurovent and RLT. The design of the certified Mandík HVAC units is based on the AHUMAN selection software that can be downloaded at http://www.mandik.cz/ke-stazeni/programy.

Mandík, a.s. plans to invest further funds in research and development in the following years, to offer state-of-the-art solutions in the area of HVAC units.