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European Standards
Eurovent Certification AHU

April 2013

Abstract training course

Part 1

- European Standard EN 1886
- European Standard EN 13053

Break

Part 2

- Eurovent certification procedure for AHUs
- Eurovent Energy Labelling System for AHUs
- Advantages of Eurovent Certification

Frans de Wind
Eurovent WG6C

Part 1
European Standards

CEN

THE WORLD OF EUROPEAN STANDARDS

One European Standard = 30 National Standards

- National Standard Bodies adopt European Standard
- All national Standards identical

Heating, cooling, ventilation

- CEN Technical Committee 156
- CEN Working Group 5

EN 1886

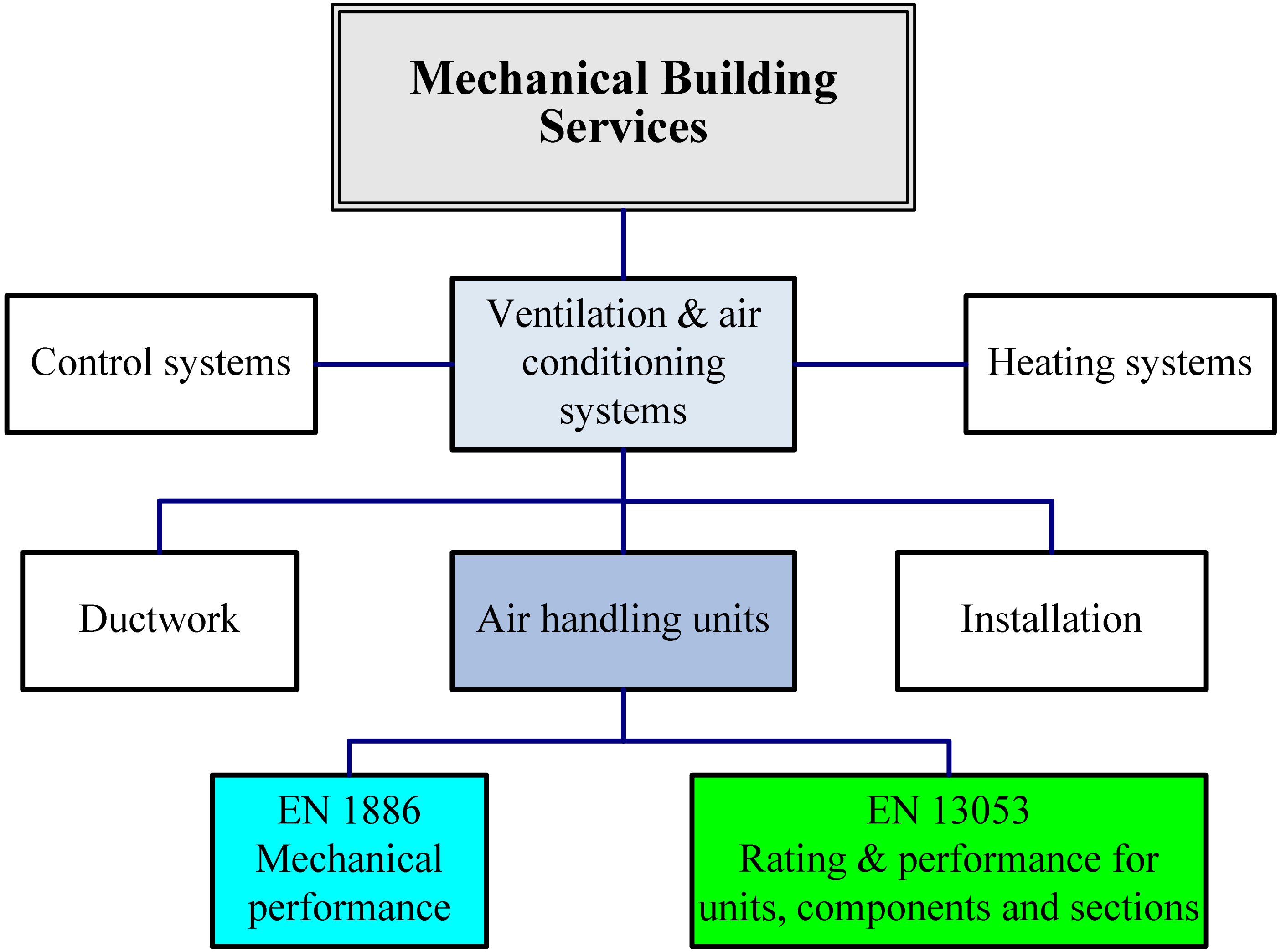
Ventilation for buildings – Air handling units –

Mechanical performance

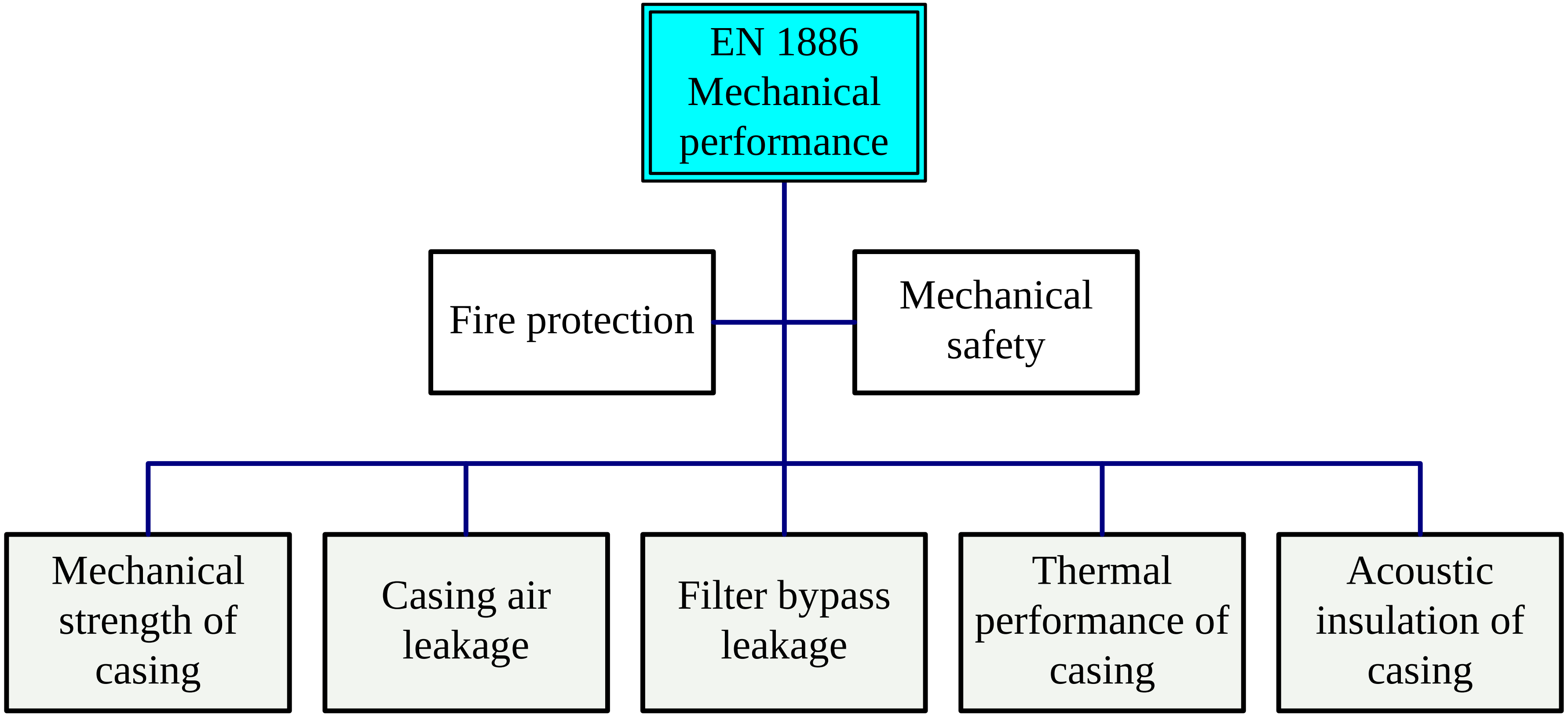
December 2007

Standard is a part of a series of standards for air handling units used for ventilation and air conditioning of buildings.

EN 1886


Mechanical Building Services
Ventilation & air conditioning systems
Control systems
Heating systems
Ductwork
Air handling units
Installation
EN 1886 Mechanical performance
EN 13053 Rating & performance for units, components and sections

EN 1886


EN 1886 Mechanical performance
Fire protection
Mechanical safety
Mechanical strength of casing
Casing air leakage
Filter bypass leakage
Thermal performance of casing
Acoustic insulation of casing

EN 1886

Scope

Test methods, test requirements and classifications for AHUs, Supplying and/or extracting air via ductwork and ventilating/conditioning a part or the whole of a building.

Not applicable for:

- units serving a limited area in the building (fan coil units)
- units for residential buildings
- units producing ventilation air for manufacturing process

EN 1886

TEST CRITERIA CASING	MODEL BOX*	REAL UNIT**
Mechanical strength	x	x
Air leakage	x	x
Filter bypass leakage	x	x
Thermal transmittance	x	–
Thermal bridging	x	–
Acoustic insulation	x	–

* General classification; marked (M)

** Particular classification; marked (R)

EN 1886

Model box

- empty enclosure with standard casing construction features
- internal height and width between 0,9 and 1,4 m
- total external surface between 10 and 30 m^2
- assembly of at least 2 sections
- each section shall have (at least) one access door
- filter frame installed without filter medium
- assembly in accordance with normal production procedures

Real unit

- factory made assembly comprising air handling functions

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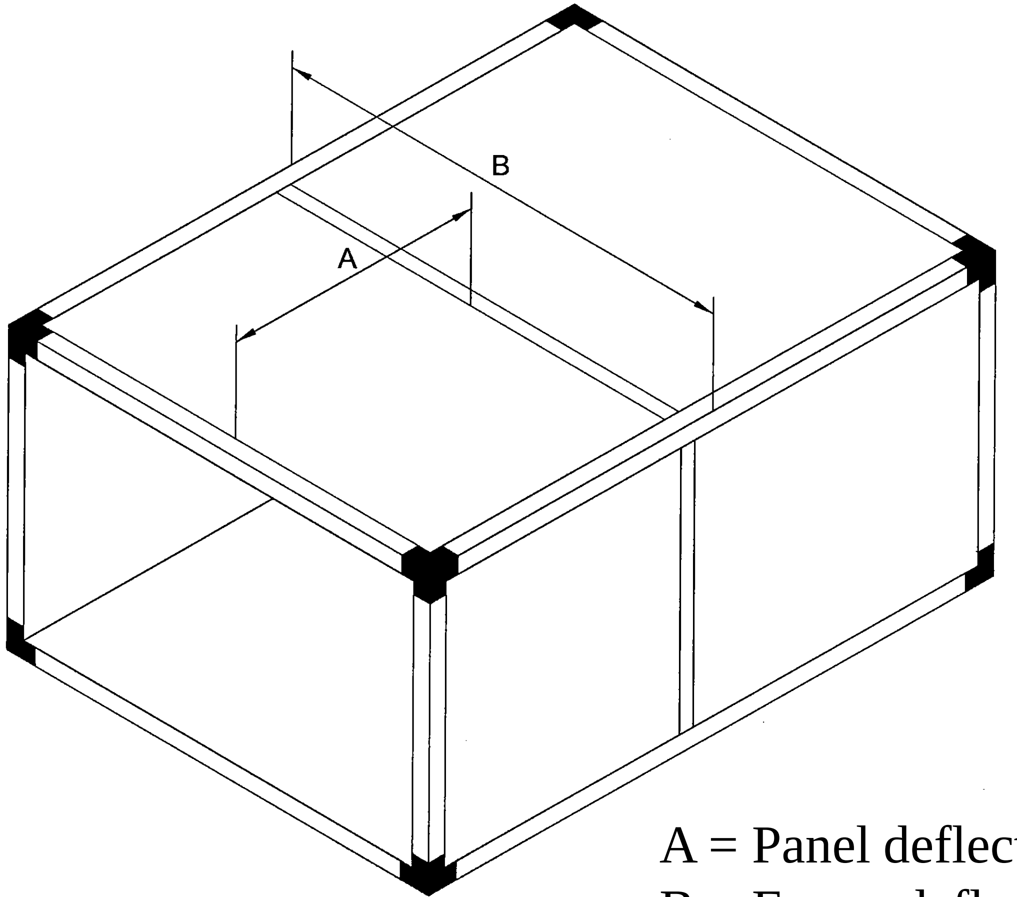
1. Mechanical strength of casing



A = Panel deflection
B = Frame deflection

EN 1886

1. Mechanical strength of casing

Casing class	Maximum relative deflection [mm×m^{-1}]
D1	4
D2	10
D3	>10

Test criterion	Model box	Real unit
Deflection	± 1.000 Pa	Operating pressure at design
Withstand maximum pressure	± 2.500 Pa	Maximum fan pressure at design fan speed

EN 1886

2. Casing air leakage

Leakage classes based on leakage classification for ductwork

Leakage classification for ductwork	**Maximum leakage rate** $[l \times s^{-1} \times m^{-2}]$
A	$0{,}027 \times p^{0{,}65}$
B	$0{,}009 \times p^{0{,}65}$
C	$0{,}003 \times p^{0{,}65}$

EN 1886

2. Casing air leakage

Maximum leakage rate at 400 Pa negative pressure

Leakage class of casing	**Maximum leakage rate** [l×s^{-1}×m^{-2}]	**Filter class** (EN 779)
L1 (C)	0,15	Superior to F9
L2 (B)	0,44	F8 and F9
L3 (A)	1,32	G1 to F7

EN 1886

2. Casing air leakage

Maximum leakage rate at 700 Pa positive pressure

Leakage class of casing	**Maximum leakage rate** [$l \times s^{-1} \times m^{-2}$]	**Filter class** (EN 779)
L1 (C)	0,22	Superior to F9
L2 (B)	0,63	F8 and F9
L3 (A)	1,90	G1 to F7

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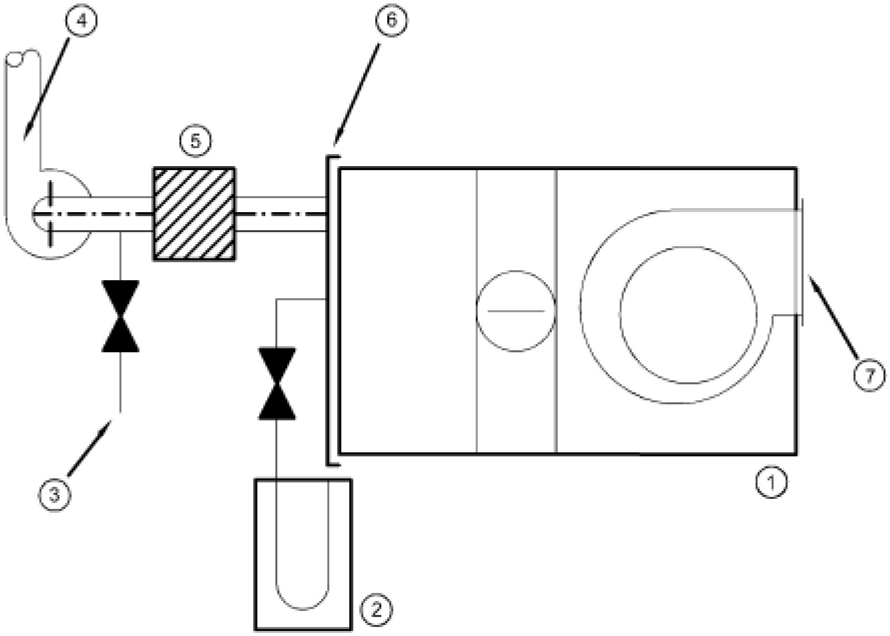
2. Casing air leakage

Basic test setup and test requirements



- highest filter class decisive
- positive pressure test required if operating pressure > 250 Pa
- positive test pressure 700 Pa, or actual operating pressure if >700 Pa

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3. Filter bypass leakage

- Filter bypass leakage is related to filter class
- Test pressure differential 400 Pa
- Leakage rate is a percentage of nominal air flow rate
- For model box nominal flow is 0,93 m^3/s for full filter (=2,5 m/s face velocity on 610 x 610 mm square)
- Bypass leakage is the total amount of unfiltered air supplied to the building; hence:
  - for upstream filters, bypass around filter cells + casing leakage between filter and fan
  - for downstream filters, only bypass around filter cells

EN 1886

3. Filter bypass leakage

Acceptable filter bypass leakage rates

Filter class	**G1-F5**	**F6**	**F7**	**F8**	**F9**
Maximum filter bypass leakage rate as % of nominal flow rate*	6	4	2	1	0,5

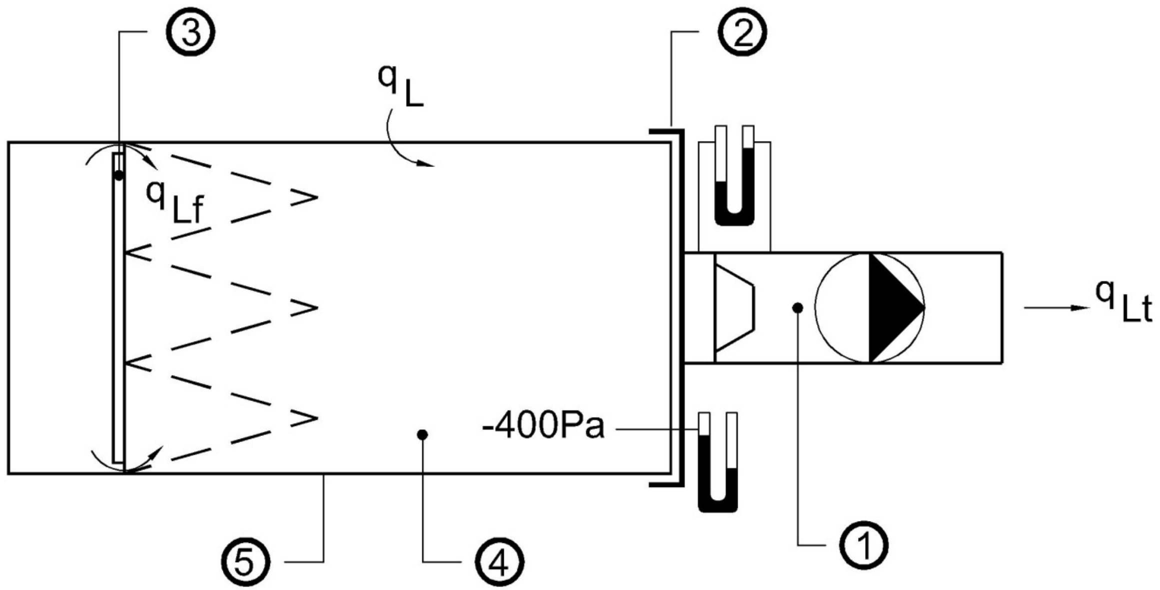
* leakage is the total amount of unfiltered air

EN 1886

3. Filter bypass leakage

Test setup for upstream bypass leakage test

$q_{Ltot} = q_L + q_{Lf}$ Bypass lekkage: q_{Lto}



EN 1886

4. Thermal transmittance

Mean heat loss coefficient (thermal transmittance "U") is only measured on model box and is calculated as:

$$U = \frac{P_{el}}{A \times \Delta t_{air}}$$

U = thermal transmittance [$W \times m^{-2} \times K^{-1}$]
Pel = electrical power input for heater(s) and circulating fans [W]
A = external surface area [m^2]
Δt_{air} = air to air differential temperature (ti-ta) [K]
ti = mean internal air temperature [°C]
ta = mean external air temperature [°C]

EN 1886

4. Thermal transmittance

Classification of thermal transmittance U

Thermal class	**Thermal transmittance U** [$W \times m^{-2} \times K^{-1}$]
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

EN 1886

5. Thermal bridging

Thermal bridging (bridging factor “k_b”) is only measured on model box and is calculated as:

$$k_b = \frac{\Delta t_{min}}{\Delta t_{air}} = \frac{t_i - t_{s-max}}{t_i - t_a}$$

k_b = bridging factor [-]

Δt_{min} = least differential temperature (internal air – casing) [K]

Δt_{air} = air to air differential temperature [K]

t_i = mean internal air temperature [°C]

t_{s-max} = measured maximum external surface temperature [°C]

t_a = mean external air temperature [°C]

EN 1886

5. Thermal bridging

Classification of thermal bridging factor k_b

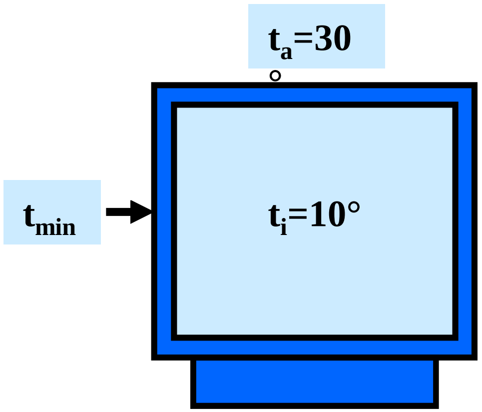
Thermal class	**Thermal bridging factor k_b**
TB1	$0{,}75 \leq k_b < 1{,}00$
TB2	$0{,}60 \leq k_b < 0{,}75$
TB3	$0{,}45 \leq k_b < 0{,}60$
TB4	$0{,}30 \leq k_b < 0{,}45$
TB5	No requirements

In class TB3 and TB4, 1% of the external surface may have lower bridging class

EN 1886

5. Thermal bridging

Practical application of bridging factor k_b



Risk of external condensation if internal temperature is lower than external temperature!
After conversion of formula the minimum external surface temperature is calculated with equation below

$$k_b = \frac{t_{min} - t_i}{t_a - t_i} \quad \Rightarrow \quad k_b \times (t_a - t_i) = t_{min} - t_i \quad \Rightarrow \quad t_{min} = t_i + k_b \times (t_a - t_i)$$

Example:

Bridging factor = 0,6
Internal air temperature 10°C
External air temperature 30°C

Result:

t_{min} = 10° + 0,6×(30° - 10°) = 22°C
no condensation if dewpoint t_a < 22°
maximum relative humidity 62%

EN 1886

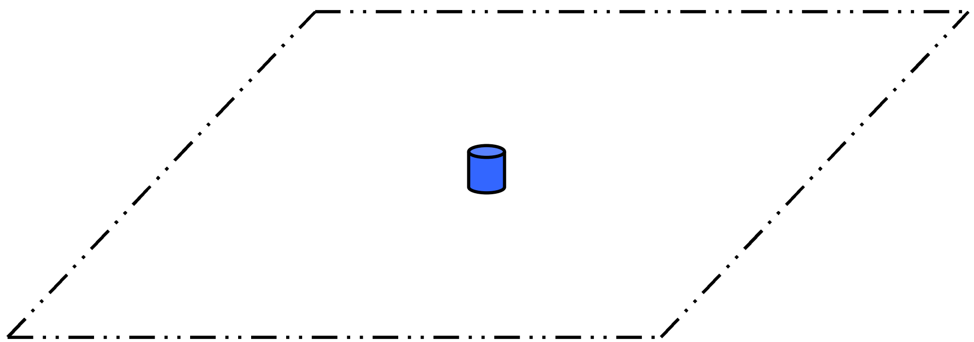
6. Acoustic insulation of casing

Measurement of sound insertion loss value D_p

D_p is the difference of the measured sound pressure level in a sound source-enveloping surface without and with model box around the source.
Values measured in octave bands 125 – 8000 Hz.

6. Acoustic insulation of casing

Sound source on reflecting floor

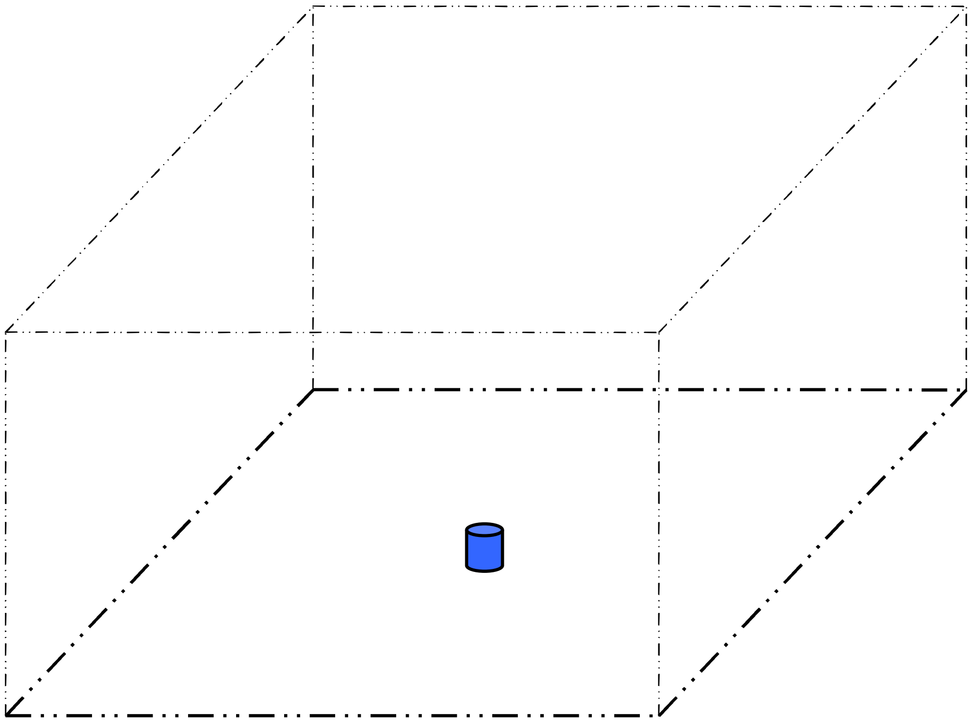


EN 1886

6. Acoustic insulation of casing

Enveloping surface around sound source

Measurement of $L_{P\text{-}SOURCE}$ in enveloping surface, averaged per octave band



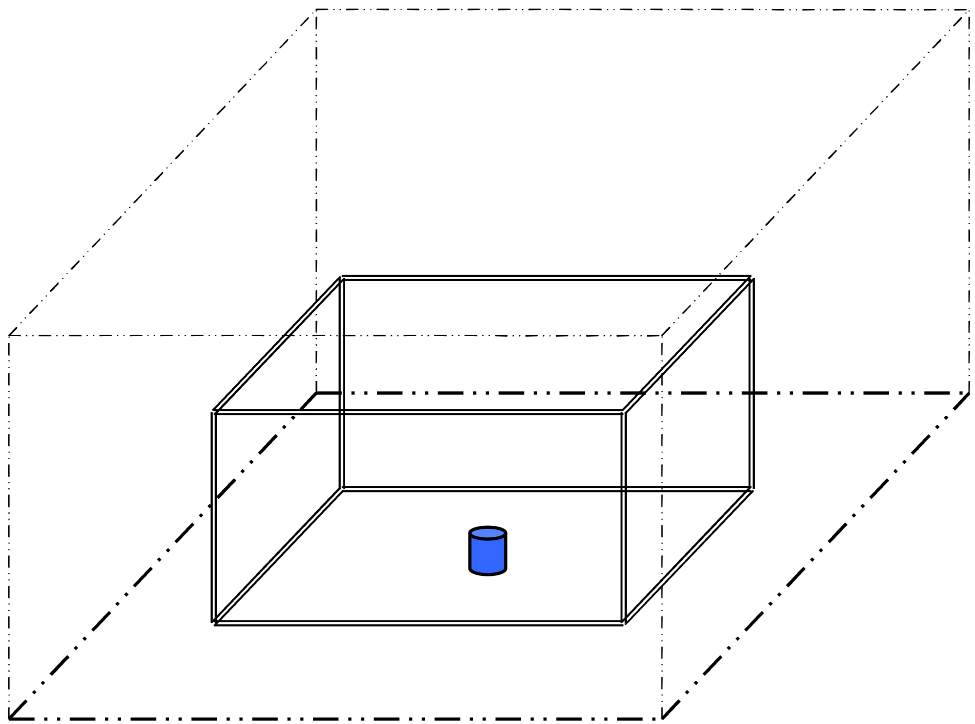
EN 1886

6. Acoustic insulation of casing

Enveloping surface around model box; sound source in model box

Measurement of $L_{P\text{-}ENCLOSURE}$ in enveloping surface, averaged per octave band

$D_p = L_{P\text{-}SOURCE} - L_{P\text{-}ENCLOSURE}$



EN 1886

7. Fire protection

Design and construction requirements; not relevant for Eurovent Certification

8. Mechanical safety

Design and construction requirements; not relevant for Eurovent Certification

EN 13053

Ventilation for buildings – Air handling units –

Rating and performance for units, components and

sections

August 2006

Revision prEN 13053rev – 2009®

Standard is a part of a series of standards for air handling units used for ventilation and air conditioning of buildings.

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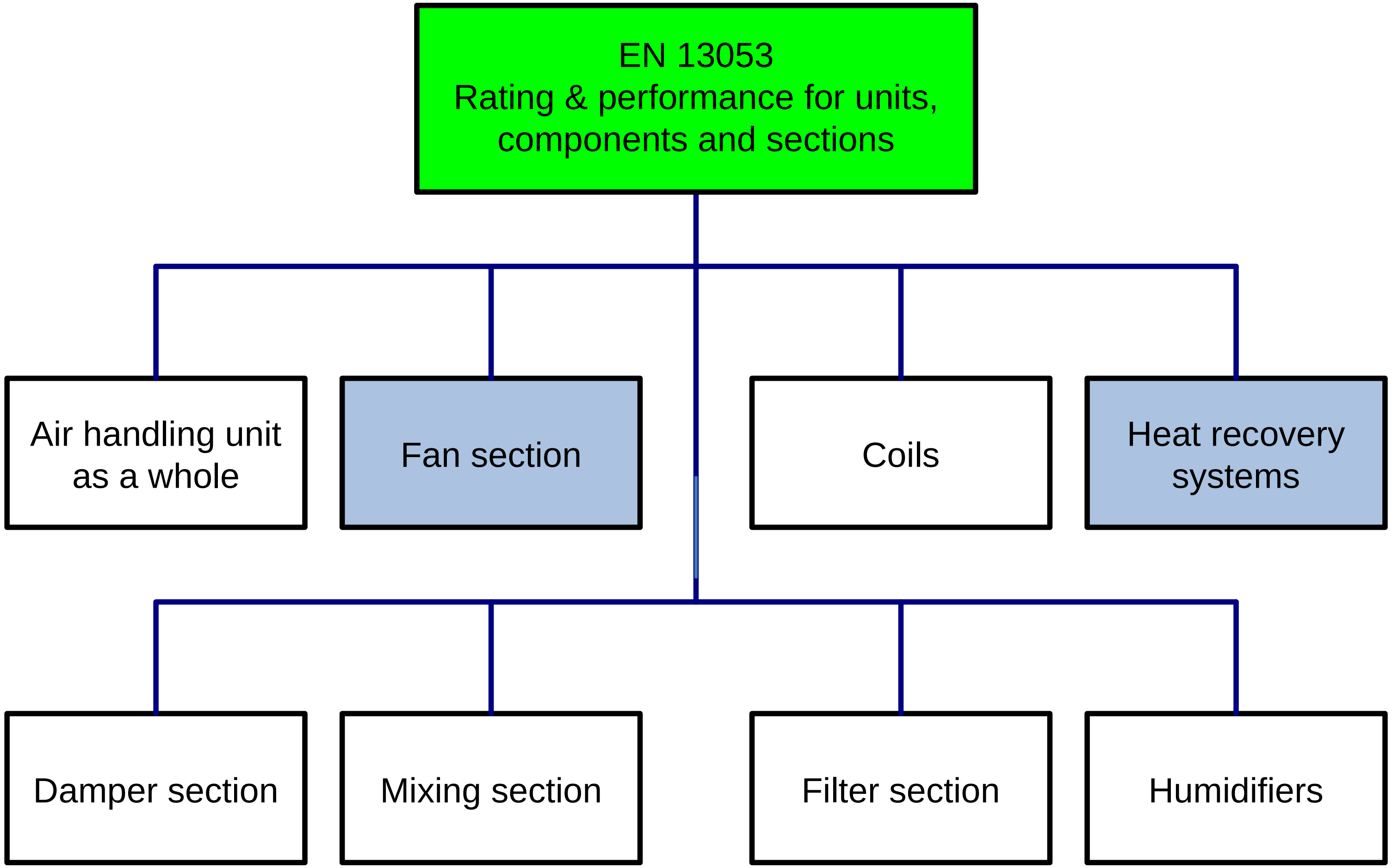
EN 13053



EN 13053
Rating & performance for units, components and sections
Air handling unit as a whole
Fan section
Coils
Heat recovery systems
Damper section
Mixing section
Filter section
Humidifiers

EN 13053

Scope

Test methods and requirements for ratings and performance of AHUs as a whole. Requirements, recommendations, classification and testing of specific components and sections of AHUs.

Applicable to standardised designs in a range of sizes and to custom-designed units.

Not applicable for:

- units serving a limited area in the building (fan coil units)
- units for residential buildings
- units producing ventilation air for manufacturing process

EN 13053

Ratings and performance of the entire AHU

1. Testing of aerodynamic performance

Air volume flow rate versus external total pressure

- $P_{total} = P_{total\text{-}outlet} - P_{total\text{-}inlet}$
- average filter pressure drop is simulated by increasing the external total pressure with a value (design – initial)
- if final filter pressure drop is design pressure drop the correction value on external pressure shall be (final – initial)
- testing is performed with dry cooling coils
- air volume flow rate measured in accordance with ISO 5801
- testing of a unit with heat recovery shall be performed taking the leakage into consideration
- characteristics shall be converted to standard air density 1,2 kg/m^3

EN 13053

Ratings and performance of the entire AHU

1. Testing of aerodynamic performance

Air volume flow rate versus absorbed motor power

- if fan speed control (e.g. frequency inverter) is required, the absorbed power shall include the losses in the speed control device
- characteristics shall be converted to standard air density 1,2 kg/m^3
- multiple measurements shall be presented for a stated nominal fan speed, but without corrections for inherent speed deviations caused by variable motor loads

EN 13053

Ratings and performance of the entire AHU

2. Testing of acoustic performance

<u>Duct borne noise tests</u> (sound levels in inlet and outlet duct)

- measurement in accordance with one of the EN ISO standards
- reverberation room (3741), free field (3744), in-duct (25136)
- measurements at specified duty point
- results shall not be affected by noise generation in throttling device (artificial external pressure)
- apply duct end correction where applicable (3741 & 3744)

EN 13053

Ratings and performance of the entire AHU

2. Testing of acoustic performance

Casing radiated noise tests (emitted sound levels through casing)

- measurement in accordance with one of the EN ISO standards
- reverberation room (3741), free field (3744 or 3746)
- measurements at specified duty point
- results shall not be affected by duct break out noise
- results shall not be affected by noise generation in throttling device (artificial external pressure)

EN 13053

Ratings and performance of the entire AHU

3. Tolerances and deviations

Aerodynamic and acoustic performances

- tolerance range of duty point (**t**)
- uncertainty range of measured data (**u**)
- admissible deviation (△)
- measured value e.g. ($\mathbf{V_m}$)
- specified (design) value ($\mathbf{V_s}$)

Allowable: $\triangle V \leq t \times V_s + u \times V_m$

EN 13053

Ratings and performance of the entire AHU

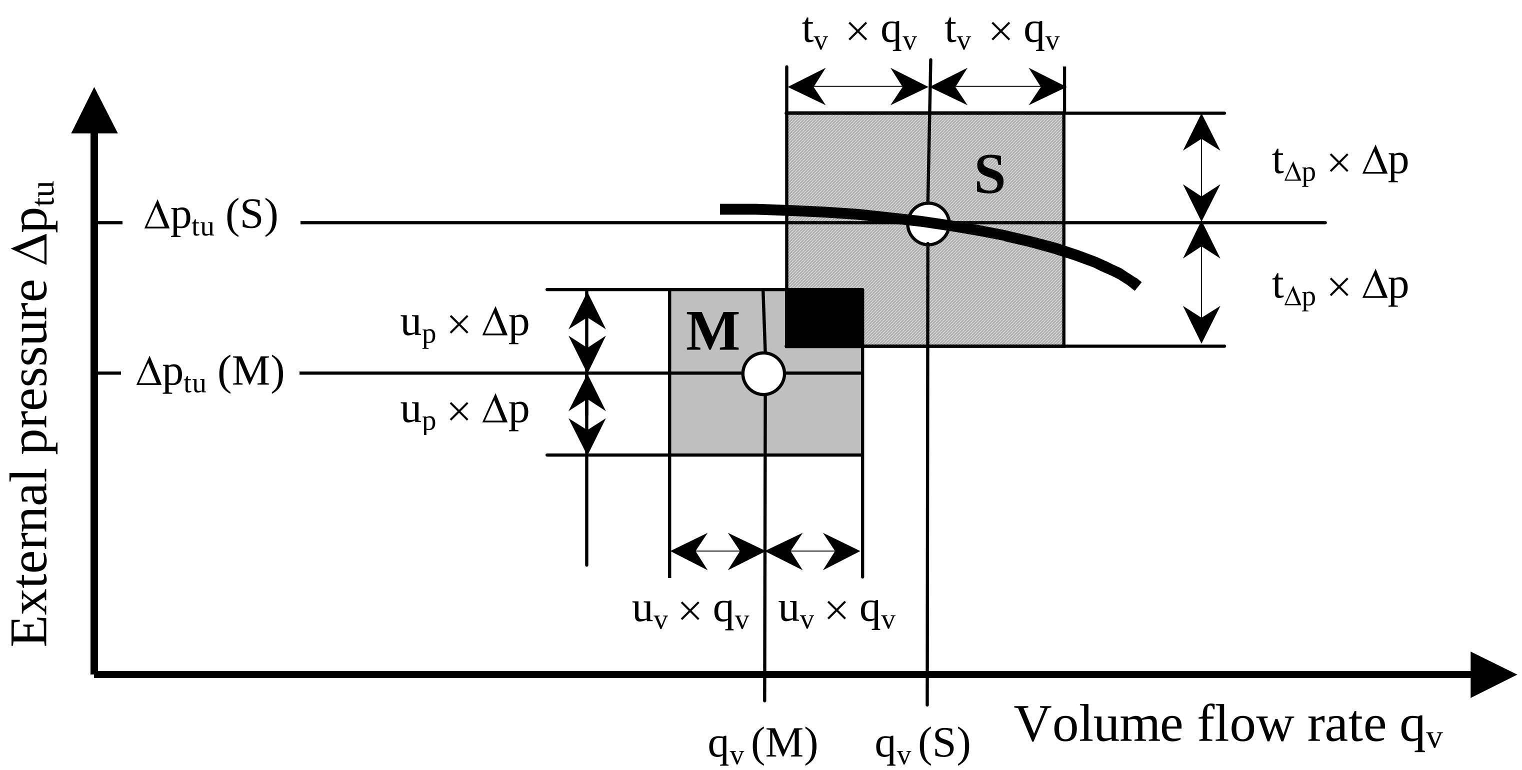
3. Admissible tolerances

Characteristic	Tolerance [t]	Comments
Air volume flow [m3/s]	± 5%	Measuring uncertainty not included
External total pressure [Pa]	± 5%	Measuring uncertainty not included
Absorbed motor power [kW]	+ 8% *	Measuring uncertainty not included
Total sound power levels in duct and radiated casing [dB(A)]	4 dB	Measuring uncertainty not included
Simultaneous tolerance of 5% on air flow rate and external pressure is allowed. For absorbed motor power 8% tolerance at rated performance is permitted*		

EN 13053

Ratings and performance of the entire AHU

3. Admissible tolerances



EN 13053

Requirements & performance rating for components

1. Casing air handling unit

   Design, construction and maintenance requirements; not relevant for Eurovent Certification

2. Fan section

   Design, construction and maintenance requirements; not relevant for Eurovent Certification.

   Fan selection shall be based on average of initial and final filter pressure drop unless otherwise agreed (e.g. final pressure drop).

   For cooling coil pressure drop, the dry value shall be used unless specified otherwise.

EN 13053

Requirements & performance rating for components

2. Fan section: classes of average velocity®
   Velocities based on internal filter -or fan cross section!

Class	Air velocity [m/s]
V1	≤ 1,6
V2	1,6 < v ≤ 1,8
V3	1,8 < v ≤ 2,0
V4	2,0 < v ≤ 2,2
V5	2,2 < v ≤ 2,5
V6	2,5 < v ≤ 2,8
V7	2,8 < v ≤ 3,2
V8	3,2 < v ≤ 3,6
V9	v > 3,6
Proportional steps	*ISO 3: R20 series*

EN 13053

Requirements & performance rating for components

2. Fan section: absorbed motor power®

Reference value for absorbed motor power fan + drive

$$Pm_{ref} = \left(\frac{\Delta p_{stat}}{450}\right)^{0,925} \times (q_v + 0,08)^{0,95}$$

Pm_{ref}	= reference value absorbed power	[kW]
$\triangle p_{stat}$	= available static pressure ($p_{internal} + p_{external}$)	[Pa]
q_v	= air flow rate of the fan	[m^3/s]

EN 13053

Requirements & performance rating for components

2. Fan section: classification of power consumption fan®

Class	P_m max [kW]
P1	$\leq Pm_{ref}$ x 0,85
P2	$\leq Pm_{ref}$ x 0,90
P3	$\leq Pm_{ref}$ x 0,95
P4	$\leq Pm_{ref}$ x 1,00
P5	$\leq Pm_{ref}$ x 1,06
P6	$\leq Pm_{ref}$ x 1,12
P7	$> Pm_{ref}$ x 1,12
Proportional steps	*ISO 3: R40 series*

EN 13053

Requirements & performance rating for components

3. Heating and cooling coils

Design, construction and maintenance requirements; not relevant for Eurovent Certification.
Coils shall be rated in accordance with EN 1216 (maximum 5% deviation between measured performance on air- and waterside).
Hygienic requirements adapted from VDI 6022/3803; however not relevant for Eurovent Certification.

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EN 13053

Requirements & performance rating for components

4. Heat recovery sections

   Categories as defined in EN 308.

   Performances always based on balanced mass flows (mass flow ratio 1:1) and no condensation in exhaust air

- Category I : Recuperators
- Category II : With intermediate heat transfer medium
  - IIa – without phase change
  - IIb – with phase change
- Category III : Regenerators (accumulating mass)
  nowadays 3 sub categories (Eurovent certification)

EN 13053

Requirements & performance rating for components

4. Heat recovery sections

Fundamental table for energy efficiency of heat recovery ®

Class	η_t	Δp_{HRS} [Pa]	ε	η_e
H1	0,75	2 x 280	19,5	0,71
H2	0,67	2 x 230	21,2	0,64
H3	0,57	2 x 170	24,2	0,55
H4	0,47	2 x 125	27,3	0,45
H5	0,37	2 x 100	26,9	0,36

EN 13053

Requirements & performance rating for components

4. Heat recovery sections

Defined characteristic values in the revised standard ®

- Temperature efficiency : $\eta_t = \frac{t_{SUP} - t_{ODA}}{t_{ETA} - t_{ODA}}$
- Pressure drop HRS : $\Delta p_{HRS} = \Delta p_{supply} + \Delta p_{exhaust}$
- Electric power consumption : $P_{el} = \frac{q_v \times \Delta p_{HRS}}{\eta_{el}} + P_{extra}$

Standard value for η_{el} = 0,6. $\triangle p_{HRS}$ = according to table.

EN 13053

Requirements & performance rating for components

4. Heat recovery sections

Defined characteristic values in the revised standard ®

- Performance HRS : $Q_{HRS} = q_v \times \rho \times c_p \times \eta_t (t_{ETA} - t_{ODA})$

  standard value for t_{ETA} and t_{ODA} according EN 308 (25°C and 5°C)

- Coefficient of performance : $\varepsilon = \frac{Q_{HRS}}{P_{el}}$

- Energy efficiency : $\eta_e = \eta_t \times \left(1 - \frac{1}{\varepsilon}\right)$

EN 13053

Requirements & performance rating for components

4. Heat recovery sections

<u>Classes of heat recovery obtained with defined characteristics</u>®

Class	ηe [min %]
H1	≥ 71
H2	≥ 64
H3	≥ 55
H4	≥ 45
H5	≥ 36
H6	No requirement
Proportional steps in heat exchange surface	

EN 13053

Requirements & performance rating for components

5. Mixing sections

Dampers, mixing efficiency and mixing temperature

• dampers shall be tested according to EN 1751

• mixing efficiency shall be measured with recirculation damper 90%, 50% and 20% open

$$\eta_{mix} = \left(1 - \frac{t_{max} - t_{min}}{t_H - t_L}\right) \times 100\%$$

• mixing temperature can be calculated with

$$t_M = \frac{t_H \times \rho_H \times q_{vH} + t_L \times \rho_L \times q_{vL}}{\rho_{tot} \times q_{vtot}}$$

EN 13053

Requirements & performance rating for components

5. Mixing sections

Classification mixing temperature efficiency

Class	**Mixing efficiency [%]**
M1	≥ 95
M2	$85 \leq \eta_{mix} < 95$
M3	$70 \leq \eta_{mix} < 85$
M4	$50 \leq \eta_{mix} < 70$
M5	< 50

EN 13053

Requirements & performance rating for components

6. Humidifiers

   Design, construction and maintenance requirements; not relevant for Eurovent Certification.

   Hygienic requirements adapted from VDI 6022/3803; however not relevant for Eurovent Certification.

7. Filter sections

   Design, construction and maintenance requirements; not relevant for Eurovent Certification.

   Hygienic requirements adapted from VDI 6022/3803; however not relevant for Eurovent Certification.

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EN 13053

Requirements & performance rating for components

7. Filter sections

<u>Maximum final pressure drop for filters</u>

Filter class	Final pressure drop
G1 – G4	150 Pa
F5 – F7	200 Pa
F8 – F9	300 Pa

End of presentation part 1

THANK YOU FOR YOUR ATTENTION