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Mitigation Enabling Energy Transition in the MEDiterranean region

EN Testing standards for Air conditioners, heat pumps and liquid chilling packages
Space cooling/heating and domestic hot water applications

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Joint activity WP4: Study tour on EE in Appliances– meetMED II
2023/11/06

Contents

- EN 14511:2022 parts 1 to 4
  - Basic test methods
- EN 14825:2022
  - Testing at part load and calculations for SEER and SCOP
- EN 12102-1:2022
  - Sound power testing for AC/HP/LCP
- EN 16147:2017
  - DHW application testing for COP (among others)
- EN 12102-2:2019
  - Sound power testing for DHW production heat pumps

EN 14511:2022 Series

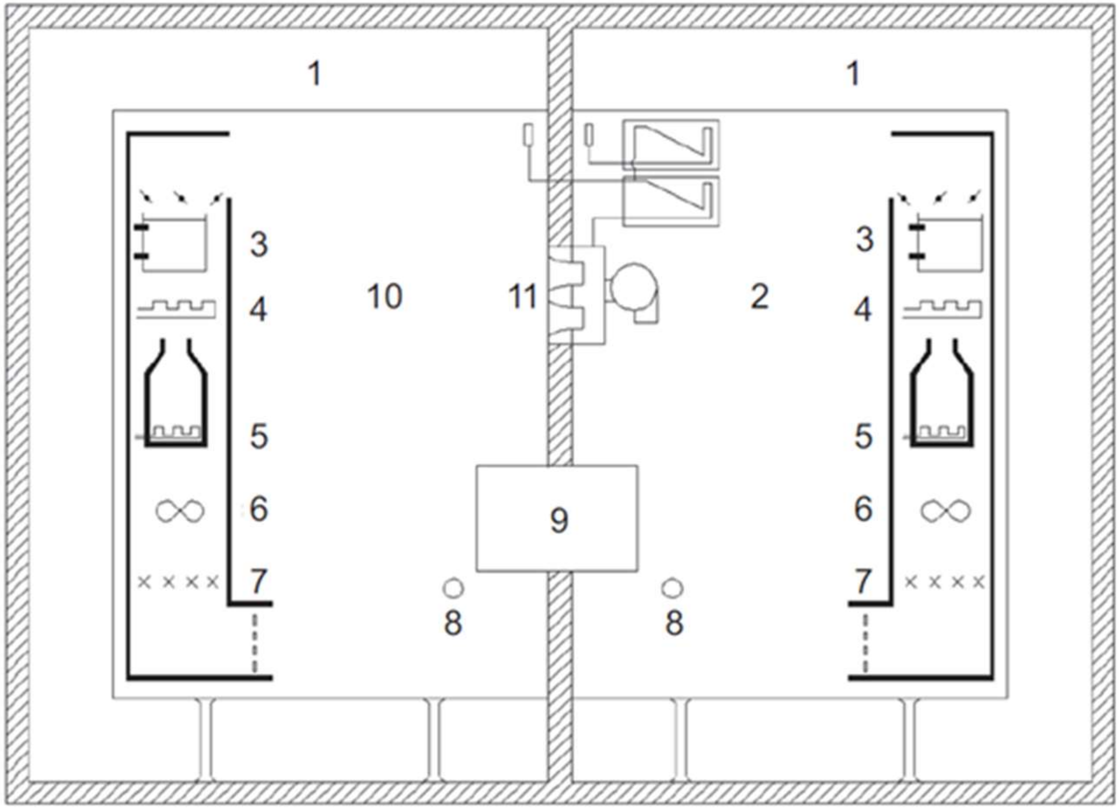
Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling.

Part 1: Terms and definitions
Part 2: Test conditions
Part 3: Test methods
Part 4: Requirements

Balanced calorimeter room method

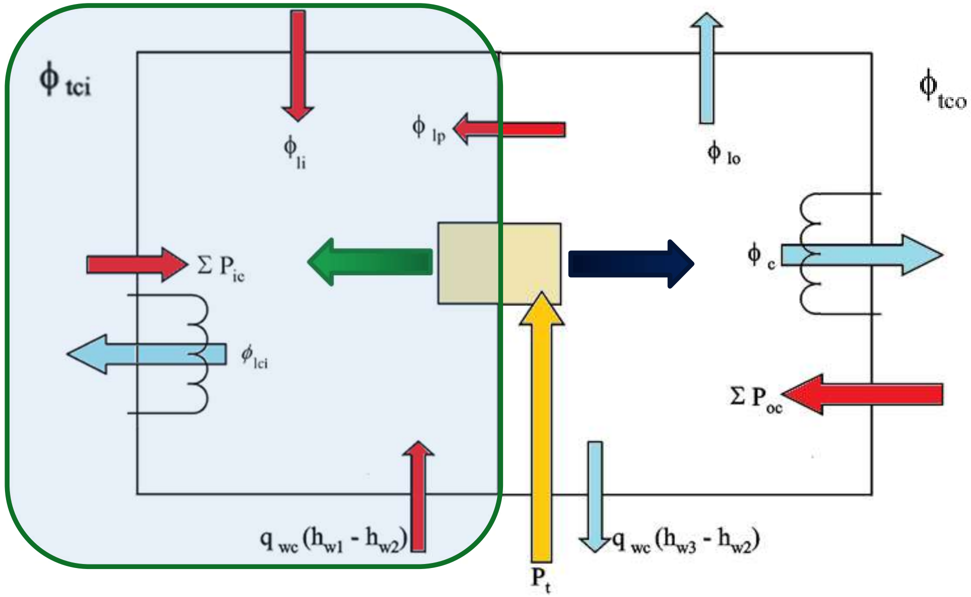
Raised view of a Balanced calorimeter

1 controlled-temperature air space
2 outdoor-side compartment
3 cooling coil
4 heating coil
5 humidifier
6 fan
7 mixer
8 air sampling tube
9 equipment under test
10 indoor-side compartment
11 pressure equalization device



Balanced calorimeter room method

Balanced calorimeter room method

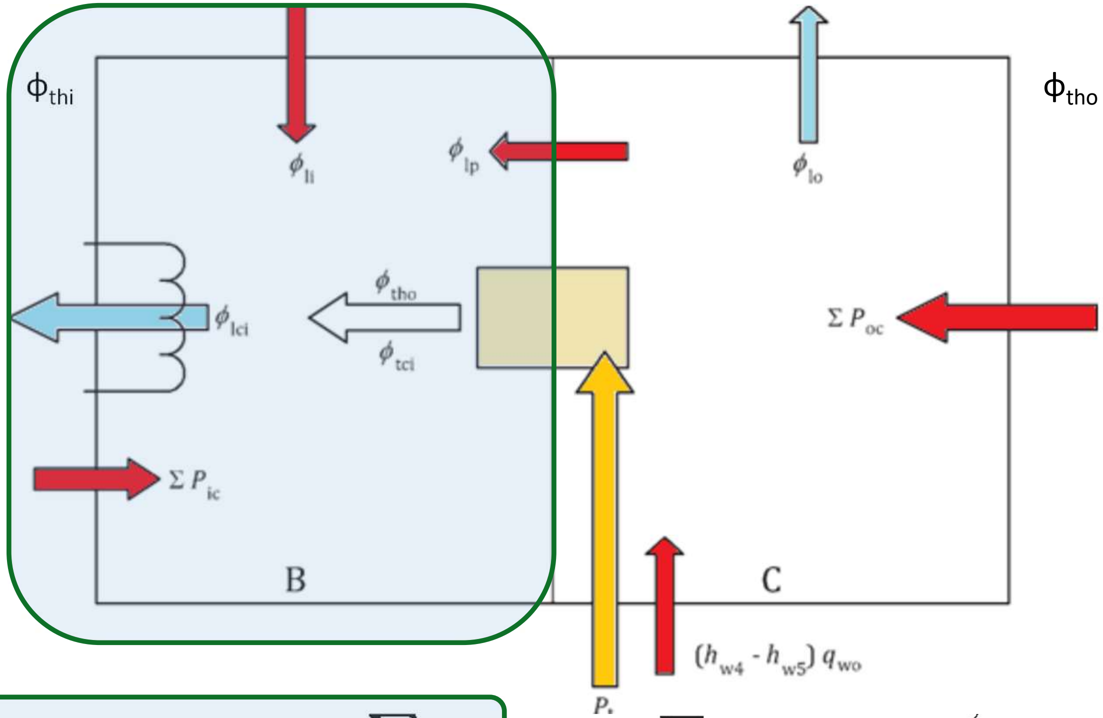


$$\phi_{tci} = \sum P_{ic} + q_{wc}\left(h_{w1} - h_{w2}\right) + \phi_{lp} + \phi_{li} - \phi_{lci}$$

$$\phi_{tco} = \phi_{c} - \sum P_{oc} - P_t + q_{wc}\left(h_{w3} - h_{w2}\right) + \phi_{lp} + \phi_{lo}$$

Energy flows during Cooling capacity measurement

Balanced calorimeter room method



$$\phi_{\mathrm{thi}} = \phi_{\mathrm{lci}} - \phi_{\mathrm{lp}} - \phi_{\mathrm{li}} - \sum P_{\mathrm{ic}}$$

$$\phi_{\mathrm{tho}} = \sum P_{\mathrm{oc}} + P_{\mathrm{t}} + q_{\mathrm{wo}} \left(h_{\mathrm{w}4} - h_{\mathrm{w}5} \right) - \phi_{\mathrm{lp}} - \phi_{\mathrm{lo}}$$

Energy flows during Heting capacity measurement

Indoor Air enthalpy test method

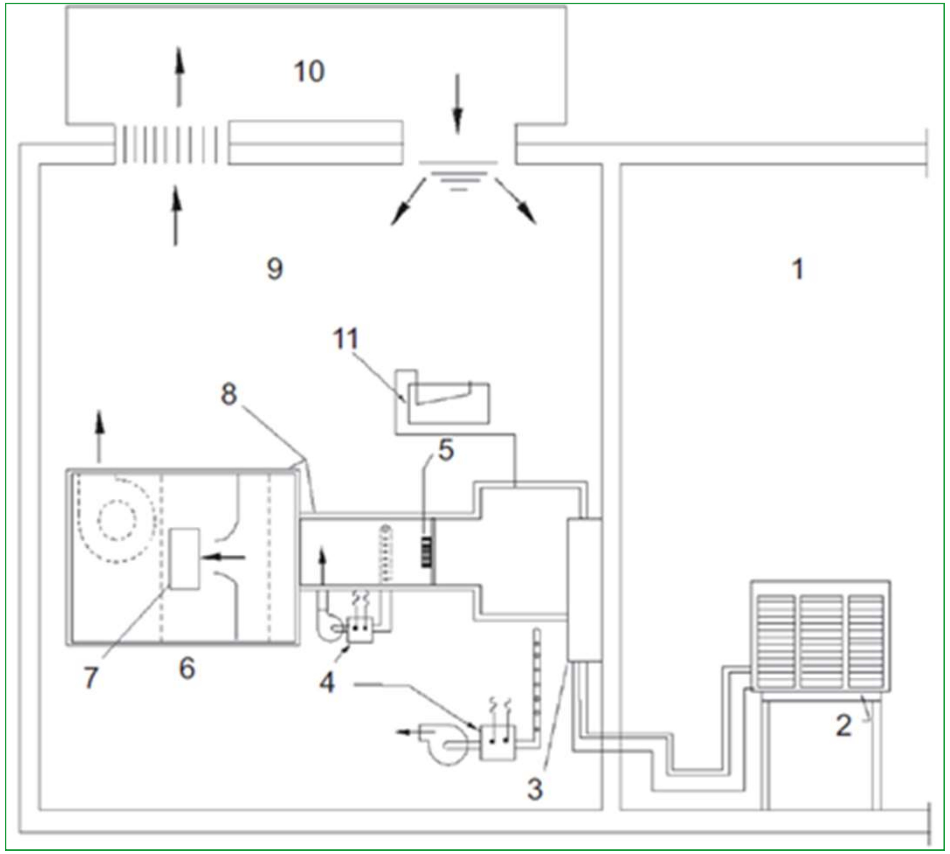
40kW Rooftop UUT ready for capacity testing

30kW total cooling capacity system set-up with 4 indoor ducted units

Indoor Air enthalpy test method

1 outdoor-side test room
2 outdoor unit of equipment under test
3 indoor-side coil section of equipment under test
4 air temperature and humidity measuring instruments
5 mixer
6 airflow measuring apparatus
7 door/window
8 insulation
9 indoor-side test room
10 room conditioning apparatus
11 apparatus for differential pressure measurement

Raised view of an air enthalpy test room



EN 14825:2022

Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling, commercial and process cooling.

Testing and rating at part load conditions and calculation of seasonal performance.

SCOPE

- **Air conditioners, heat pumps and liquid chillers, including comfort and process chilelrs**
- The document specifies the temperatures, part-load conditions and calculation methods for determining the seasonal energy efficiency **SEER** and SEERon, the seasonal space cooling energy efficiency **$\eta_{s,c}$**, the seasonal coefficient of performance **SCOP**, SCOPon and SCOPnet, the seasonal space heating energy efficiency **$\eta_{s,h}$** and the seasonal energy coefficient of performance SEPR.This document also applies to the hybrid units defined in this standard
- It applies to factory-made units as defined in EN 14511-1, except single-duct, double-duct, control cabinet and close control units. It also covers direct exchange heat pumps with water (brine) (DX with water (brine)) as defined in EN 15879-1
- Also applies to hybrid units as defined in the standard

Basic concepts I
Reference design conditions

- **Cooling mode(Tdesignc)** → **Pdesignc**

Outdoor temperature is 35 °C DB
-> For air-to-air units 24 °C WB required for units evaporating the condensate
Indoor temperature of 27 °C DB (19 °C WB)

- **Heating mode (Tdesignh)** → **Pdesignh**

Three climatic areas have been defined: Average, colder and warmer.

Design temperature conditions are as follows:

- **Average climate:** Outdoor temperature is -10 °C DB (-11ºC WB) and indoor temperature is 20 °C DB
- **Colder climate:** Outdoor temperature is -22°C DB and indoor temperature is 20 °C DB
- **Warmer climate:** Outdoor temperature is +2°C DB and indoor temperature is 20 °C DB

Basic concepts II
Declared conditions

- **Bivalent temperature (Tbivalent)**
  lowest outdoor temperature for which the heat pump is declared to have the capacity to compensate 100% of the heat load
  - for the **average climate**, it is **+2°C BS or lower**
  - for **colder climate**, it is **-7°C BS or lower**
  - for **warmer climate**, it is **+7°C BS or lower**
- **Temperature Operating Limit (TOL)**
  lowest outdoor temperature for which it is declared that the heat pump is still able to deliver heating capacity
  - for the **average climate**, it is **-7°C BS or below**
  - for **colder climate**, it is **-15°C BS or below**
  - for **warmer climate**, it is **+7°C BS or below**

Basic concepts III

- **Operating modes**
  - Active: when there is thermal load and the cooling or heating function of the unit remains active (compressor ON).
  - Standby mode: Waiting for input from the user
  - Thermostat off mode: Compressor is off because room target conditions are already achieved
  - Power Off mode: unit is disconnected from the power supply
  - Crankcase heater mode: electrical heater may be ON under certain circumstances

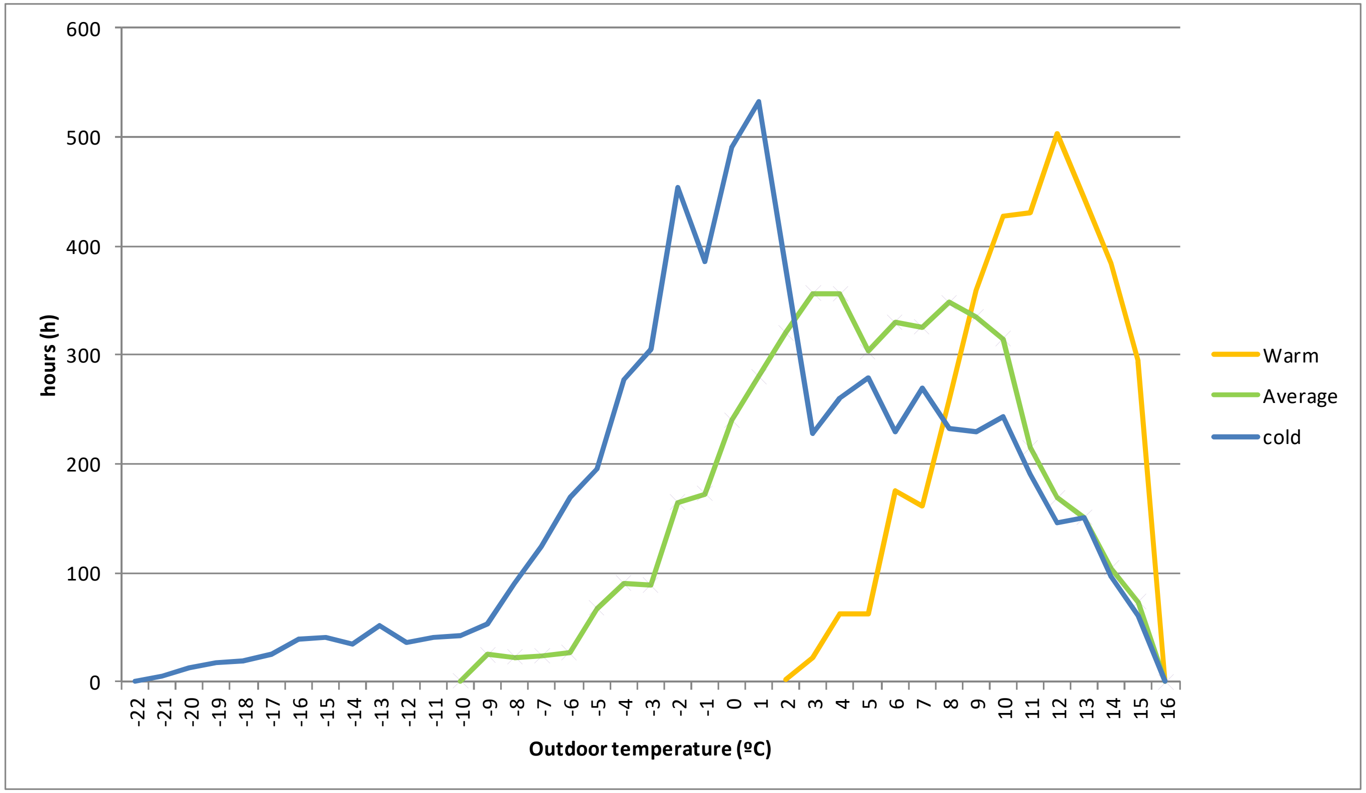
Non-active modes

- **Table bin**
  - Table describing the climate based on the outdoor temperature and the number of hours of occurrence in the season.

j	#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T_j	°C	**17**	**18**	**19**	**20**	21	22	23	24	**25**	26	27	28	29	**30**	31	32	33	34	**35**	**36**	**37**	**38**	**39**	**40**
h_j	h	205	227	225	225	216	215	218	197	178	158	137	109	88	63	39	31	24	17	13	9	4	3	1	0

Reference bin table for air-to-air units
(Hot season - cooling mode)

Basic concepts IV



Climate definitions for the cold season

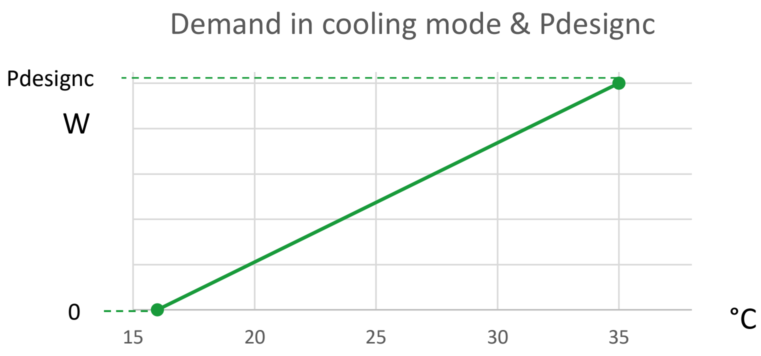
Basic concepts V

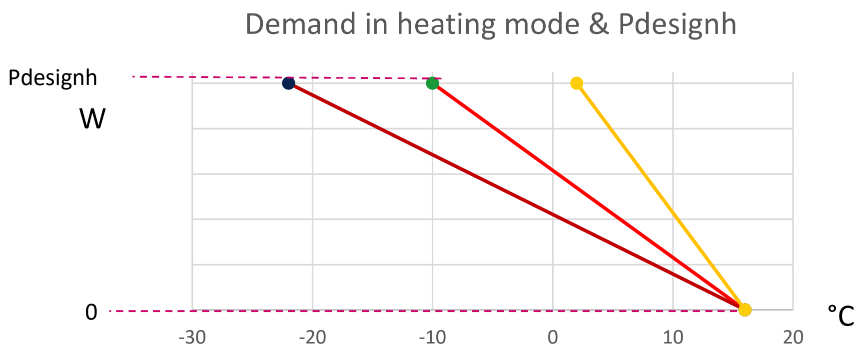
THERMAL LOAD in COOLING and HEATING modes

- Also referred to as building thermal load or building thermal demand
- Straight line defined from:
  - Thermal load = 0 at 16ºC (from definition) &

For cooling mode:
Thermal load = Pdesignc at 35ºC

For heating mode:
Thermal load = Pdesignh at -10ºC, -22ºC or 2ºC.





Seasonal Space cooling & heating efficiency

$$\eta_{s,c} = \frac{\boxed{SEER}}{CC} - F1 - F2\ ;\ \eta_{s,h} = \frac{\boxed{SCOP}}{CC} - F1 - F2$$

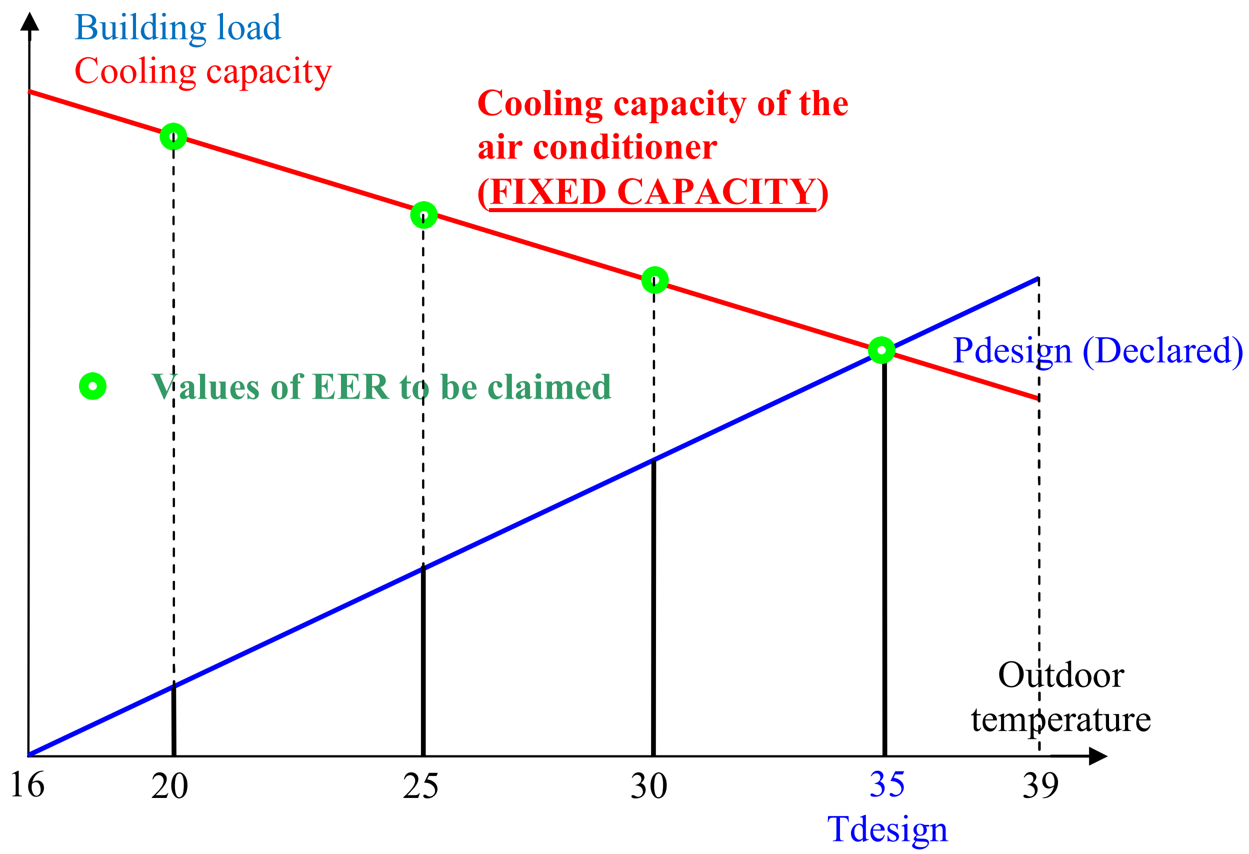
- CC is the primary energy correction coefficient to refer electricity consumption to the average efficiency of electricity generation in Europe
- The CC value must be checked in the product regulations
- F1 is a correction factor that takes into account inefficiencies due to thermostat management (3%)
- F2 is a correction factor that takes into account the effect of groundwater circulation pumps (5%)

Test Conditions

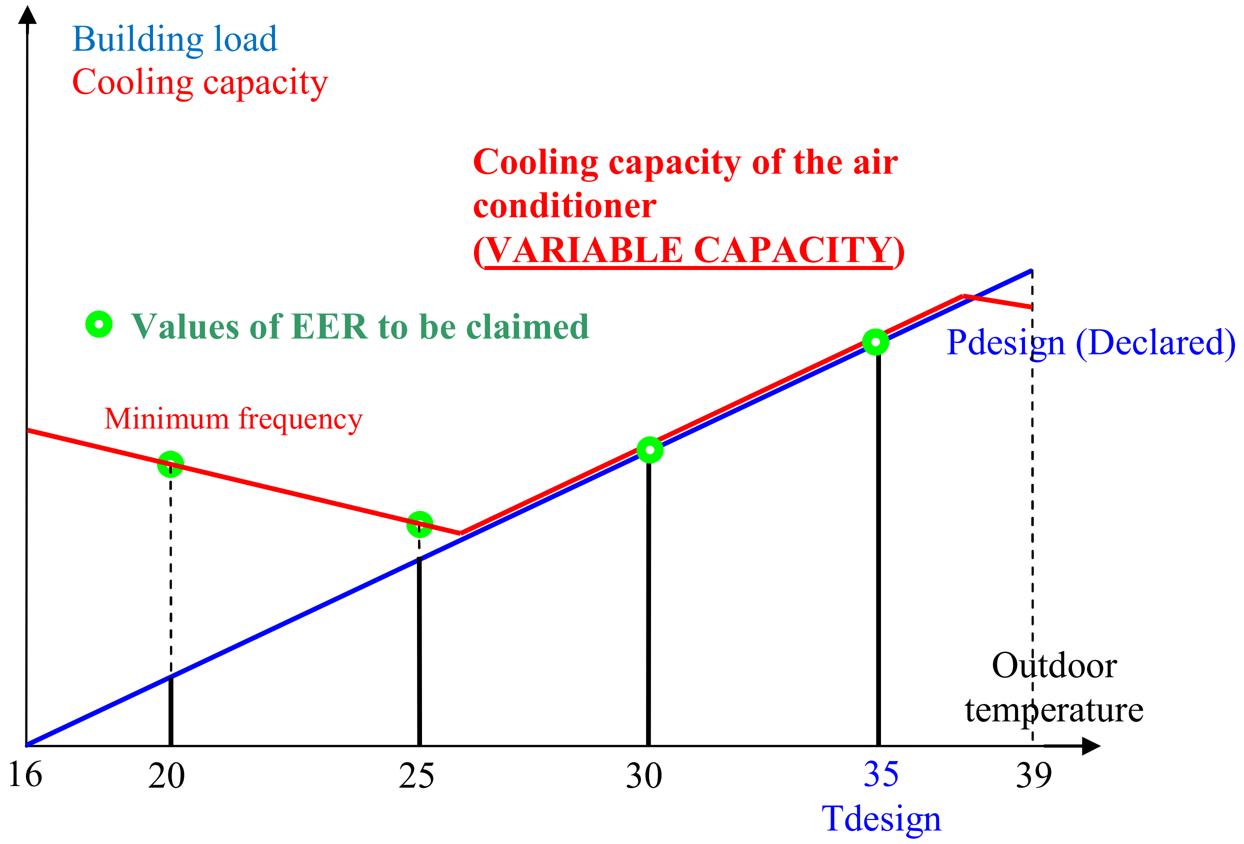
- Air/air units

	Part load	Part load	Outdoor air dry bulb temperature	Indoor air Dry bulb (wet bulb) temperatures
		%	°C	°C
A	(35-16)/($_{Tdesignc}$ -16)	100	35	27(19)
B	(30-16)/($_{Tdesignc}$ -16)	73,68	30	27(19)
C	(25-16)/($_{Tdesignc}$ -16)	47,37	25	27(19)
D	(20-16)/($_{Tdesignc}$ -16)	21,05	20	27(19)

Cooling capacity and termal load for On/Off unit



Cooling capacity and termal load for variable capacity unit



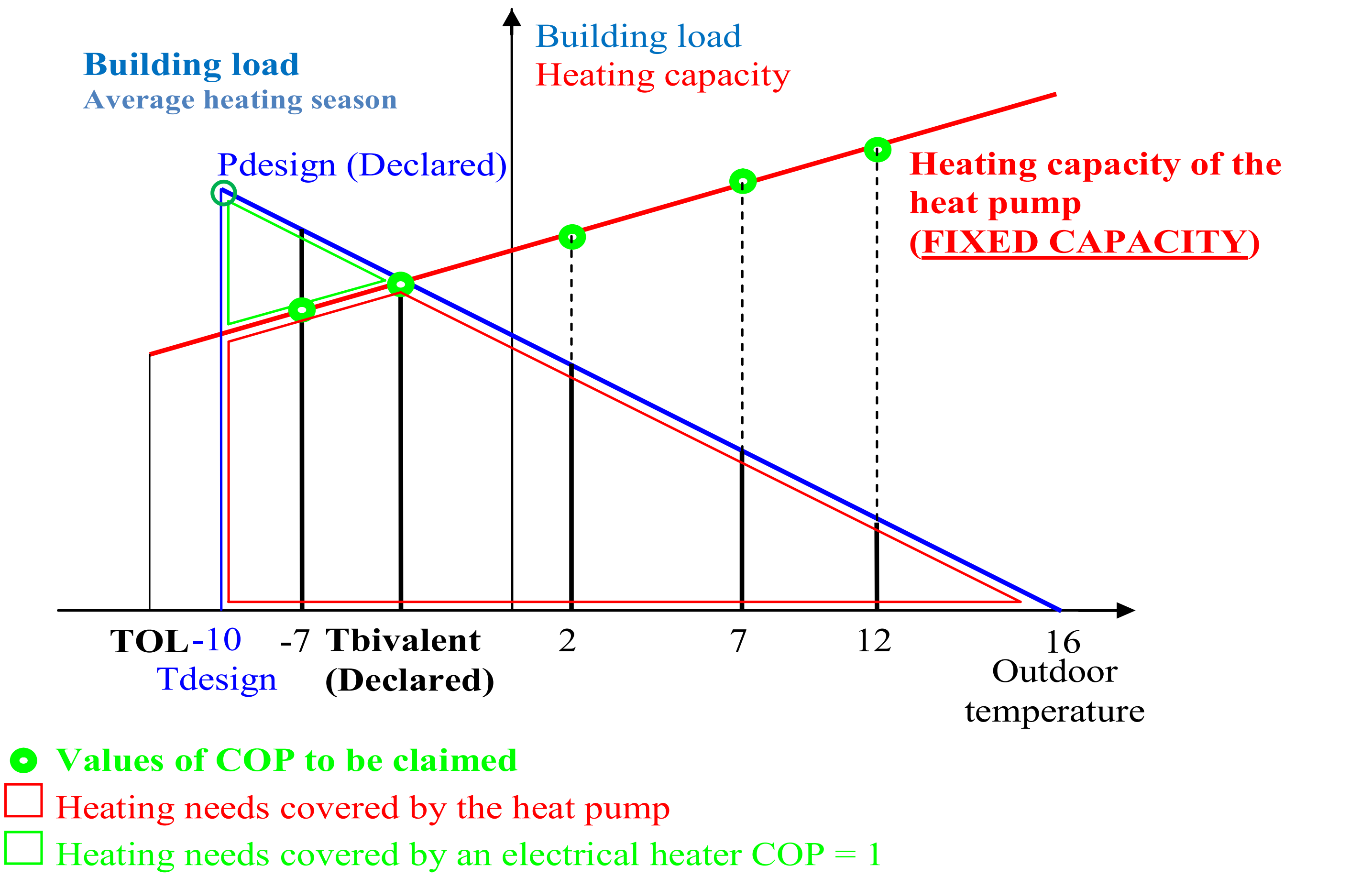
Test Conditions

- Air-to-air units

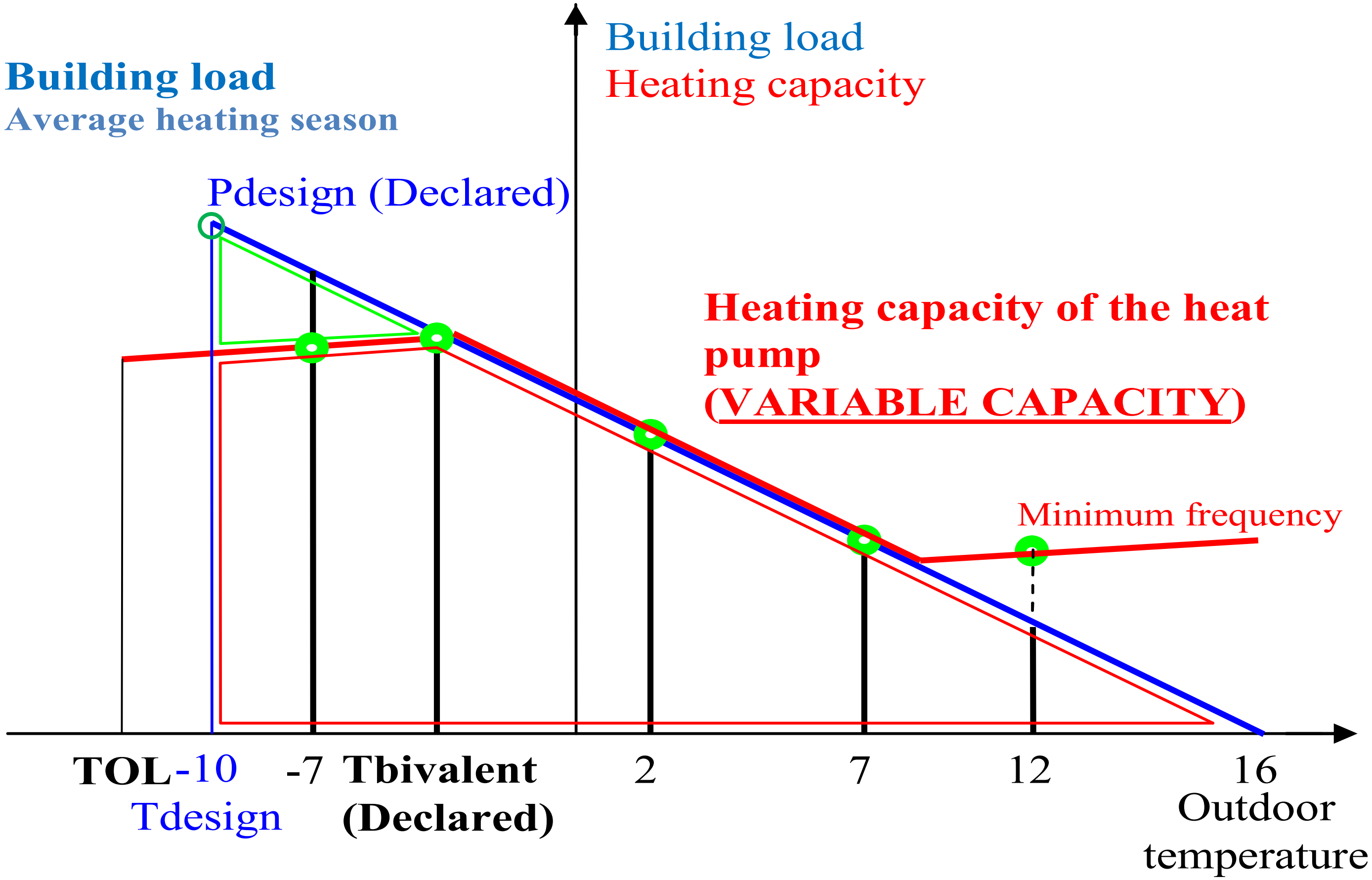
	Partial load in % of load				Outdoor heat exchanger	Internal heat exchanger
	Part load	Average	Warmer	Colder	Dry(wet) bulb temperatures °C	Dry bulb temperature °C
A	(-7 - 16) / ($T_{designh}$ -16)	88,46	n/a	60,53	-7(-8)	20
B	(+2 - 16) / ($T_{designh}$ -16)	53,85	100	36,84	2(1)	20
C	(+7 - 16) / ($T_{designh}$ -16)	34,62	64,29	23,68	7(6)	20
D	(+12 - 16) / ($T_{designh}$ -16)	15,38	28,57	10,53	12(11)	20
E	(TOL[a] - 16) / ($T_{designh}$ - 16)				TOL	20
F	(Tbivalent - 16) / ($T_{designh}$ - 16)				Tbivalent	20
G	(-15 - 16) / ($T_{designh}$ -16)	n/a	n/a	81,58	-15	20

[a] If TOL <Tdesignh replace TOL by Tdesignh

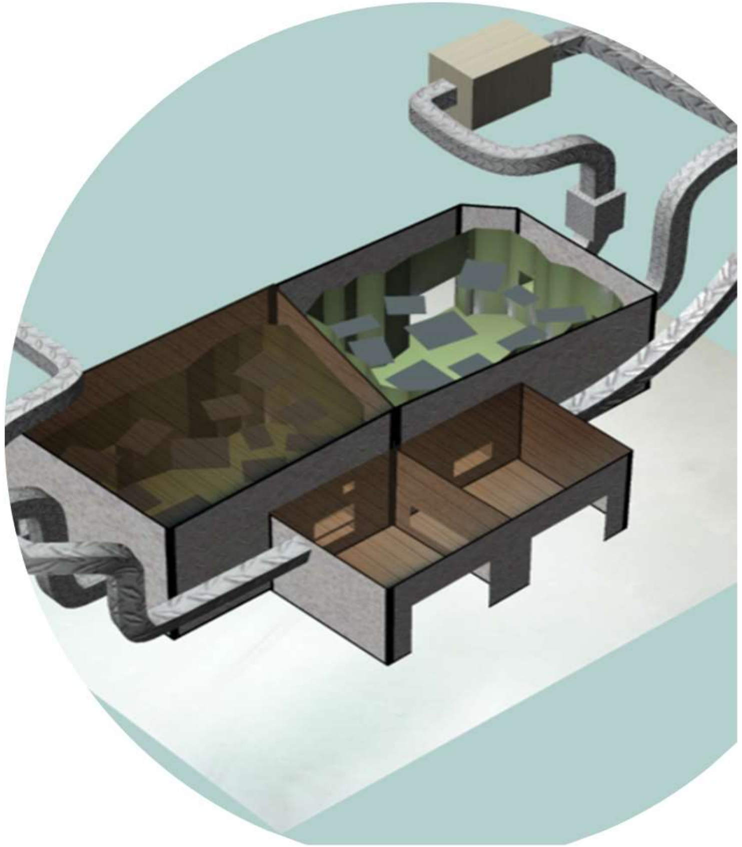
Heating capacity and Heat load for On/Off unit



Heating capacity and Heat load for variable capacity unit



EN 12102-1:2022



Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors.

Determination of the sound power level Air conditioners, liquid chilling packages, heat pumps for space heating and cooling, dehumidifiers and process chillers

Sound pressure and Sound power

❑ Sound pressure

The sound pressure, *p* (Pa) is defined as the instantaneous pressure difference due to noise (fluctuating) and the atmospheric pressure.
It depends on the sound source and environment of the sound source (location set-up)

❑ Sound power

The Sound power *P* (W) is the amount of acoustic energy radiated by a noise source. This is depedent on the noise source and independent from noise source location o distance at which the sound power is measured

Both parameters are usually expressed in dB or dB(A)

The dB reference for sound pressure is P_0 = 20*10^(-6) Pa = 20 µPa → $L_P = 20 \cdot Log \frac{P}{P_0}$

The dB reference for sound power is W_0 = 10*10^(-12) W = 1 pW → $L_W = 10 \cdot Log \frac{W}{W_0}$

EN 12102-1:2022 + EN ISO 3741:2010

❑ *Direct test method*

Sound power is obtained from measurements of sound pressure level in the reververant sound field and Sabine's absorption coefficient of the room with the unit under test installed in the test room.

❑ *Comparison method*

Sound power is obtained from comparison between the sound pressure levels in the room from the unit under test and a Reference Sound Source (RSS)

**Allowed test methods in EN 12102-1 are developed in:*

EN ISO 3741	*EN ISO 3744*	
EN ISO 3742	*EN ISO 3745*	*EN ISO 9614 series*
- Reverberant rooms	*- Free field conditions*	*- Intensimetry*

EN 12102-1:2022 + EN ISO 3741:2010

- Depending on the selected test method, we measure in the third octave range from 100Hz to 10,000Hz or from 100Hz to 6,300Hz (intensimetry methods)

Example of results for an equipment with VPD > 10

1/3 Octave	Final Result [dB]	
100Hz	47,5	
125Hz	42,6	51,2
160Hz	47,5	
200Hz	50,8	
250Hz	48,0	56,2
315Hz	53,6	
400Hz	50,9	
500Hz	51,8	56,6
630Hz	52,5	
800Hz	52,7	
1kHz	52,0	56,7
1.25kHz	50,9	
1.6kHz	50,3	
2kHz	48,8	53,7
2.5kHz	47,2	
3.15kHz	46,6	
4kHz	45,0	50,0
5kHz	43,7	
6.3kHz	40,4	
8kHz	40,1	44,5
10kHz	38,4	
Global	62,6	62,6

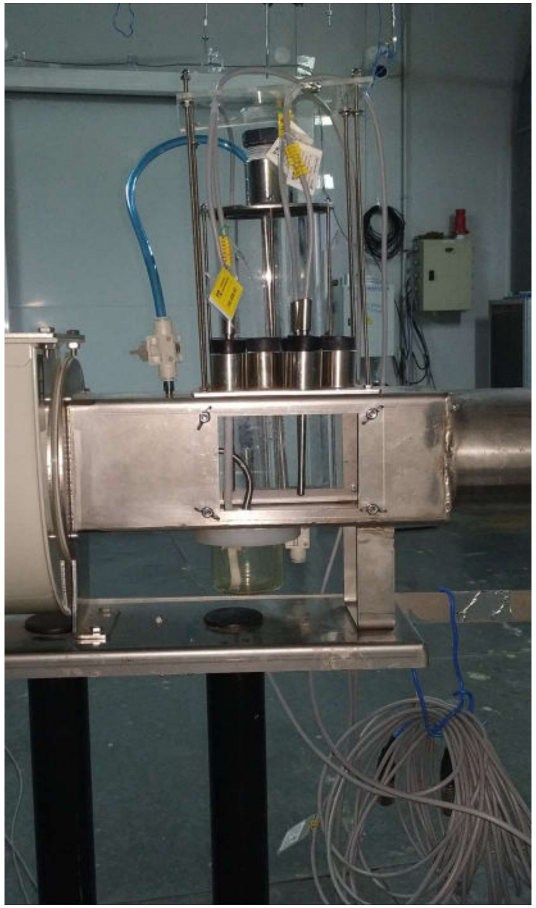
EN 16147:2017 + AC1:2017

Heat pumps with electrically driven compressors - Testing, performance rating and requirements for marking of domestic hot water units.

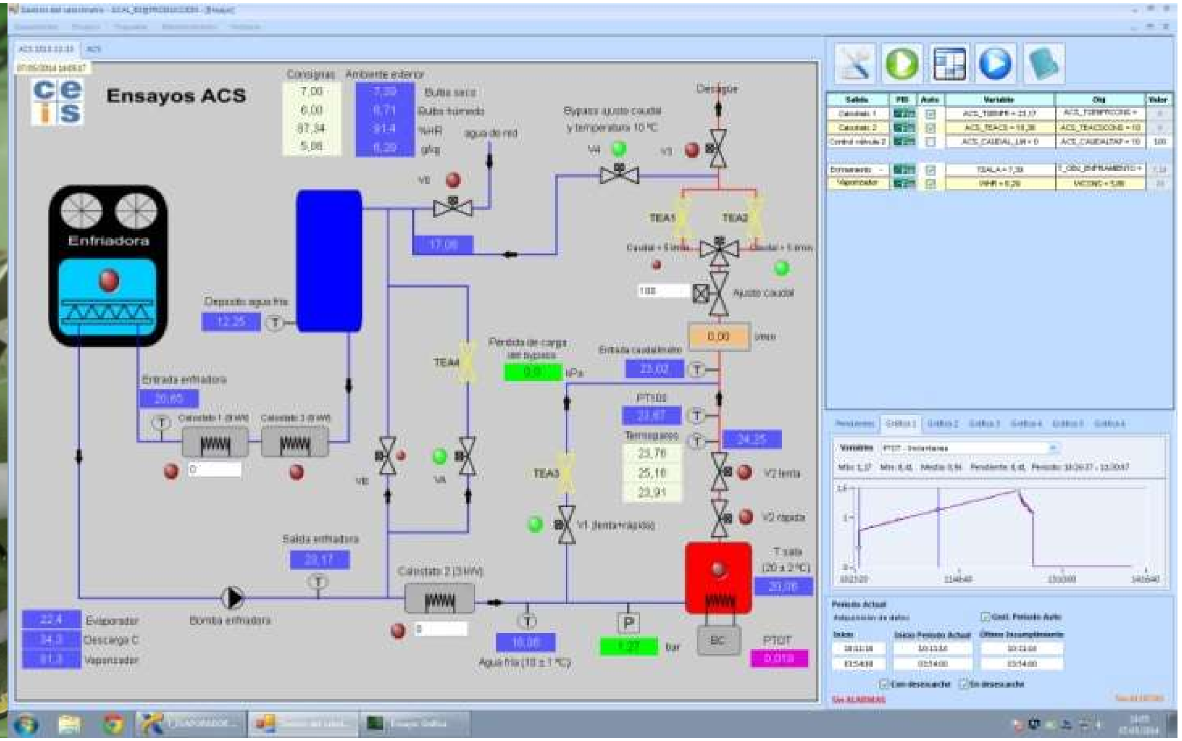
❑ *Scope*

- *Air-to-water, water(brine)-to-water and direct exchange heat pumps (DX)*
- *Only applies to DHW heat pumps rated as a single system, including a heat pump and a hot water storage tank*

EN 16147:2017 + AC1:2017




EN 16147:2017 + AC1:2017



EN 16147:2017 + AC1:2017

❑Test conditions

Type of heat source	Heat source Dry bulb(wet bulb) air temperature in °C	Heat source Inlet/outlet or bath temperature[a] in °C	Heat pump ambient temperature range in °C	Ambient temperature for storage tank in °C
Outdoor air-source heat pump (located indoors)		-	between 15 and 30	20
Average	7 (6)			
Colder	2 (1)			
Warmer	14 (13)			
Outdoor air-source heat pump (located outdoors)		-	temperature of the heat source	20
Average	7 (6)			
Colder	2 (1)			
Warmer	14 (13)			
Unheated air space	15 (12)	-	temperature of the heat source	15
Indoor air	20 (15)	-	temperature of the heat source	20
Extracted air	20 (12)	-	between 15 and 30	20
Water	-	10 / 7	between 15 and 30	20
Glycol water (brine)	-	0 / -3	between 15 and 30	20
Direct expansion	-	4	between 15 and 30	20

EN 16147:2017 + AC1:2017

- Test Stages
  - Stage B Filling and volume of the storage tank
    Only for units within EU 814/2013 scope up S tapping cycle only
  - Stage A Stabilisation (preconditioning)
  - Stage C Warm-up period
  - Stage D Steady state power consumption
  - Stage E Water tapping and COP determination
  - Stage F Mixed water at 40ºC and reference hot water temperature

EN 16147:2017 + AC1:2017

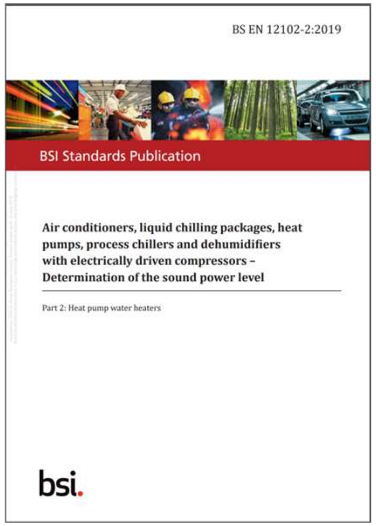
❑Test results from Stages B,C,D And F allows to calculate:

- Hot water tank Heat-up time
- Standby power input (= Pes*CC)
- **Qelec***
- COPDHW for the use profile declared by the manufacturer
- **Tank volume***
- **V40 (mixed water at 40ºC)***
- Reference temperature (required by the French regulation only)
- AEC - Annual energy consumption
- **ɳwh - Water heater energy efficiency***
- Prated - Declared heating power

*Checked during market surveillance

EN 12102-2:2019

Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors - Determination of the sound power level - Part 2: Heat pump water heaters



BS EN 12102-2:2019

BSI Standards Publication

Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors – Determination of the sound power level

Part 2: Heat pump water heaters

bsi.

BS EN 12102-2:2019

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 12102-2

May 2019

ICS 17.140.20; 91.140.65

English Version

Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors - Determination of the sound power level - Part 2: Heat pump water heaters

Climatiseurs, groupes refroidisseurs de liquide, pompes à chaleur, refroidisseurs industriels et déshumidificateurs avec compresseur entraîné par moteur électrique - Détermination du niveau de puissance acoustique - Partie 2: Pompe à chaleur pour la production d'eau chaude sanitaire

Luftkonditionierer, Flüssigkeitskühlsätze, Wärmepumpen, Prozesskühler und Entfeuchter mit elektrisch angetriebenen Verdichtern - Bestimmung des Schallleistungspegels - Teil 2: Wärmepumpen-Wassererwärmer

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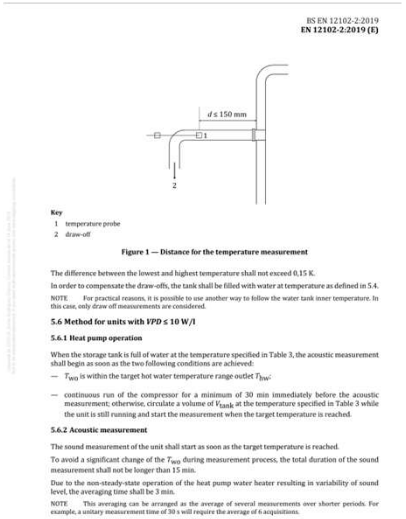


BS EN 12102-2:2019
EN 12102-2:2019 (E)

Key

1 temperature probe
2 draw-off

Figure 1 — Distance for the temperature measurement

The difference between the lowest and highest temperature shall not exceed 0,15 K.

In order to compensate the draw-offs, the tank shall be filled with water at temperature as defined in 5.4.

NOTE For practical reasons, it is possible to use another way to follow the water tank inner temperature. In this case, only draw off measurements are considered.

5.6 Method for units with $VPD \leq 10$ W/l

5.6.1 Heat pump operation

When the storage tank is full of water at the temperature specified in Table 3, the acoustic measurement shall begin as soon as the two following conditions are achieved:

— T_{wo} is within the target hot water temperature range outlet T_{hw};

— continuous run of the compressor for a minimum of 30 min immediately before the acoustic measurement; otherwise, circulate a volume of V_{tank} at the temperature specified in Table 3 while the unit is still running and start the measurement when the target temperature is reached.

5.6.2 Acoustic measurement

The sound measurement of the unit shall start as soon as the target temperature is reached.

To avoid a significant change of the T_{wo} during measurement process, the total duration of the sound measurement shall not be longer than 15 min.

Due to the non-steady-state operation of the heat pump water heater resulting in variability of sound level, the averaging time shall be 3 min.

NOTE This averaging can be arranged as the average of several measurements over shorter periods. For example, a unitary measurement time of 30 s will require the average of 6 acquisitions.

- It stablish the test methods to determine the sound power level for DHW products

EN 12102-2:2019 + EN ISO 3741:2010

- 3 different test methods
- The method depends on the VPD (volumic power density)
- VPD relates to the hot water tank heat-up speed and thus,
- How fast the running parameters of the heat pump change accross time.

EN 12102-2:2019 + EN ISO 3741:2010

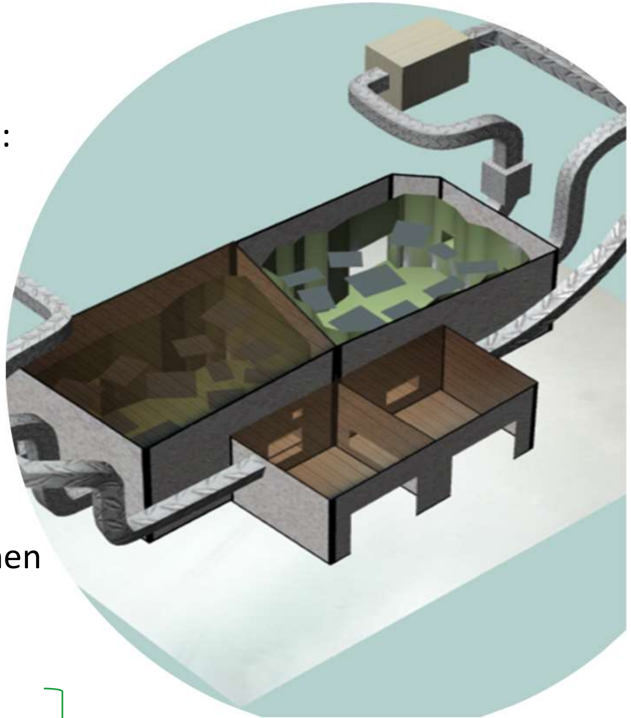
❑ The test is carried out under a permanently transient regime.

3 test procedures defined according to the *type* of equipment:

- VPD value ≤ 10
- VPD value > 10
- Direct cold water expansion (CO_2 equipment)

VPD - Volumetric Power Density

$$VPD = \frac{P_{rated}}{V_{tank}} \cdot 1000$$



❑ The test consists of determining the sound power levels when certain temperatures are reached in the DHW tank (ThW).

T_{hw}	25ºC	VPD
	$(T_{SET} + 25)/2$ ºC	
	$(T_{SET} - 5)$ ºC	

$$\frac{T_{wo} - T_{start}}{T_{set} - T_{start}} \times D_H$$

T_{wo} Final hot water temperature
D_H Duration of warm-up
T_{start} Initial DHW tank temperature (10±2K)
T_{set} DHW storage tank setpoint temperature

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This project is funded by the European Union

The value of testing ceis

Annex I

Equations from test methods in EN 14511-3:2022

Indoor Air enthalpy test method

Total cooling capacity

$$\phi_{tci} = \frac{q_{vi}\left(h_{\alpha 1} - h_{\alpha 2}\right)}{v'_n\left(1 + W_n\right)} 1\,000$$

Sensible capacity

$$\phi_s = \frac{q_{vi}\left(c_{pa1}t_{a1} - c_{pa2}t_{a2}\right)}{v'_n\left(1 + W_n\right)}$$

Latent capacity

For the cooling mode, it is recommended that the latent cooling capacity be determined using the cooling condensate flow rate measurement method.

$$\phi_d = \frac{K_1 q_{vi}\left(W_{i1} - W_{i2}\right)}{v'_n\left(1 + W_n\right)} 1000$$

$$\phi_d = K_1 q_{wc}$$

$$\phi_d = \phi_{tci} - \phi_s$$

Key	
qvi= Volumetric air flow rate (m^3/s)	v'n= specific air volume (m^3/kg)
K1 = Water vapour latent heat of vaporization = 2500,4 J/g at 0ºC	h = air enthalpy (kJ/kg)
qwc = condensate waterflow rate (kg/s)	Wi(1,2) = specific humidity of air entering(1)/leaving(2) the indoor unit's coil ((kg of water / kJ of dry air)

Indoor Air enthalpy test method

Heating capacity

$$\phi_{thi} = \frac{q_{vi}\left(h_{a2} - h_{a1}\right)}{v'_n\left(1 + W_n\right)}$$

$$\phi_{thi} = \frac{q_{vi}\left(c_{pa2} \times t_{a2} - c_{pa1} \times t_{a1}\right)}{v_n} = \frac{q_{vi}\left(c_{pa2} \times t_{a2} - c_{pa1} \times t_{a1}\right)}{v'_n \times \left(1 + W_n\right)}$$

Key	
qvi= Volumetric air flow rate (m^3/s)	v’n= specific air volume (m^3/kg)
h = air enthalpy (kJ/kg)	Wn = specific humidity at nozzles section (kg of water / kg of dry air)
Cp = specific heat of air	t = air temperature (dry bulb)

Indoor water enthalpy test method

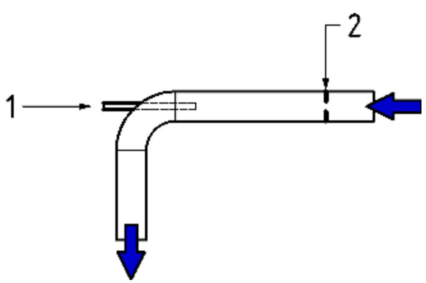
Cooling capacity

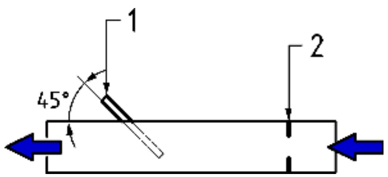
$$\phi_{tci} = -q_v \times \rho \times \left(c_{p\_out} \times t_{out} - c_{p\_in} \times t_{in}\right)$$

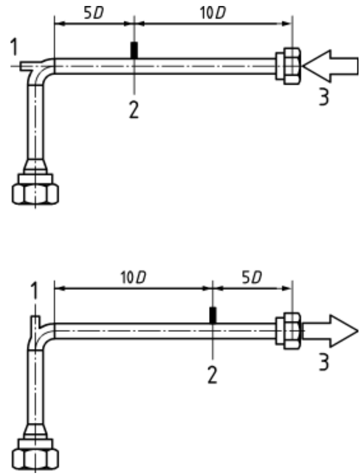
Heating capacity

$$\phi_{thi} = q_v \times \rho \times \left(c_{p\_out} \times t_{out} - c_{p\_in} \times t_{in}\right)$$

Key	
qv= Volumetric water flow rate (m^3/s)	ρ = Water density (kg/m^3)
Cp = specific heat of water (kJ/(kg/°C)	t = water temperature (dry bulb) (°C)







Annex II

Test conditions from EN 14825 in cooling mode

Test conditions for cooling mode

- Air-to-air units

	Part load	Part load	Outdoor air dry bulb temperature	Indoor air Dry bulb (wet bulb) temperatures
		%	°C	°C
A	$(35-16)/(T_{designc}-16)$	100	35	27(19)
B	$(30-16)/(T_{designc}-16)$	73,68	30	27(19)
C	$(25-16)/(T_{designc}-16)$	47,37	25	27(19)
D	$(20-16)/(T_{designc}-16)$	21,05	20	27(19)

Test conditions for cooling mode

- Water-to-air units

	Part load	Part load	Outdoor heat exchanger			Indoor heat exchanger
			Cooling tower or water loop [b] Water inlet and outlet temperatures	Geothermal (water or brine) Water inlet and outlet temperatures	Dry cooling Water inlet and outlet temperatures	Dry bulb temperature (wet bulb) indoor air
		%	°C	°C	°C	°C
A	$(35-16)/(T_{designc}-16)$	100	30 / 35	10 / 15	50 / 55	27(19)
B	$(30-16)/(T_{designc}-16)$	73,68	26 / [a]	10 / [a]	45 / [a]	
C	$(25-16)/(T_{designc}-16)$	47,37	22 / [a]	10 / [a]	40 / [a]	
D	$(20-16)/(T_{designc}-16)$	21,05	18 / [a]	10 / [a]	35 / [a]	

[a] Water flow rate as determined in the "A" test.

[b] If a cooling tower and a water-air unit are sold as a set, they must be tested as one air-air unit.

Test conditions for cooling mode

- Air-to-water units

	Part load	Part load	Outdoor heat exchanger		Indoor heat exchanger		
			Dry bulb outside air	Dry bulb exhaust air	Fan coil application		Application Refrigerated floor
					Water temperatures (brine) Inlet/Outlet		Water temperatures (brine) Inlet/Outlet
					Fixed output	Variable output[b]	
		%	°C	°C	°C	°C	°C
A	(35-16)/($T_{designc}$ - 16)	100	35	27	12 / 7	12 / 7	23 / 18
B	(30-16)/($T_{designc}$ - 16)	73,68	30	27	[a] / 7	[a] / 8,5	[a] / 18
C	(25-16)/($T_{designc}$ - 16)	47,37	25	27	[a] / 7	[a] / 10	[a] / 18
D	(20-16)/($T_{designc}$ - 16)	21,05	20	27	[a] / 7	[a] / 11,5	[a] / 18

[a] With the water flow rate determined during test "A" for units with fixed flow rate or with 5K temperature difference for units with variable flow rate. If in a test condition the resulting flow rate is less than the mínimum allowed by the unit, then the minimum flow rate and the required outlet temperature is used.

[b] If the variable output temperature is above the maximum output temperature (of the unit), the maximum value allowed by the unit is used.

Test conditions for cooling mode

- Water(brine)-to-water(brine) units

	Part load	Part load	Outdoor heat exchanger				Internal heat exchanger		
			Cooling tower or water loop (brine) Inlet/outlet temperatures of water (brine)	Geothermal application Inlet/outlet water temperatures (brine)	Dry cooler application Inlet/outlet water (brine) temperatures	DX Bath temperature	Fan coil application		Application Refrigerated floor
							Water temperatures (brine) Inlet/Outlet		Water temperatures (brine) Inlet/Outlet
							Fixed output	Variable output[b]	
		%	°C	°C	°C	°C	°C	°C	°C
A	(35-16)/ ($T_{designc}$ - 16)	100	30 / 35	10 / 15	50 / 55	30	12 / 7	12 / 7	23 / 18
B	(30-16)/ ($T_{designc}$ - 16)	73,68	26 / [b]	10 / [b]	45 / [b]	30	[a] / 7	[a] / 8,5	[a] / 18
C	(25-16)/ ($T_{designc}$ - 16)	47,37	22 / [b]	10 / [b]	40 / [b]	30	[a] / 7	[a] / 10	[a] / 18
D	(20-16)/ ($T_{designc}$ - 16)	21,05	18 / [b]	10 / [b]	35 / [b]	30	[a] / 7	[a] / 11,5	[a] / 18

[a] With the water flow rate determined during test "A" for units with fixed flow rate or with 5K temperature difference for units with variable flow rate. If in a test condition the resulting flow rate is less than the minimum, then the minimum flow rate and the required outlet temperature is used.

[b] With the water flow rate determined during test "A" for units with fixed flow rate or with 5K temperature difference for units with variable flow rate. If in a test condition the resulting flow rate is less than the minimum, then the minimum flow rate and the required inlet temperature is used.

[c] If the varaible output temperature is above the maximum output temperature (of the unit), the maximum value allowed by the unit is used.

Annex II

Test conditions from EN 14825 in Heating mode

Test Conditions

- Air-to-air units

	Partial load in % of load				Outdoor heat exchanger	Internal heat exchanger
	Part load	Average	Warmer	Colder	Dry(wet) bulb temperatures °C	Dry bulb temperature °C
A	(-7 - 16) / (Tdesignh -16)	88,46	n/a	60,53	-7(-8)	20
B	(+2 - 16) / (Tdesignh -16)	53,85	100	36,84	2(1)	20
C	(+7 - 16) / (Tdesignh -16)	34,62	64,29	23,68	7(6)	20
D	(+12 - 16) / (Tdesignh -16)	15,38	28,57	10,53	12(11)	20
E	(TOL[a] - 16) / (Tdesignh - 16)				TOL	20
F	(Tbivalent - 16) / (Tdesignh - 16)				Tbivalent	20
G	(-15 - 16) / (Tdesignh -16)	n/a	n/a	81,58	-15	20

[a] If TOL <Tdesignh replace TOL by Tdesignh

Test conditions for heating mode

- Water(brine)-to-air units

	Part load				Outdoor heat exchanger			Indoor heat exchanger
	%				Input/output temperatures			
	Formula	Average	Warmer	Colder	Water	Brine	Water loop	Dry bulb
					°C	°C	°C	°C
A	(-7 - 16) / ($T_{designh}$ - 16)	88,46	n.a.	60,53	10 / [a]	0 / [a]	20/[a]	20
B	(+2 - 16) / ($T_{designh}$ - 16)	53,85	100	36,84	10 / [a]	0 / [a]	20/[a]	20
C	(+7 - 16) / ($T_{designh}$ - 16)	34,62	64,29	23,68	10 / [a]	0 / [a]	20/[a]	20
D	(+12 - 16) / ($T_{designh}$ - 16)	15,38	28,57	10,53	10 / [a]	0 / [a]	20/[a]	20
E	(TOL^b - 16) / ($T_{designh}$ - 16)				10 / [a]	0 / [a]	20/[a]	20
F	(T_{biv} - 16) / ($T_{designh}$ - 16)				10 / [a]	0 / [a]	20/[a]	20

a With the water flow rate determined at the standard conditions given in table 5 of EN 14511-2:2018 for fixed flow units or with a temperature difference of 3K for variable flow units. If in any test condition the required flow rate is lower than the minimum flow rate of the unit, the minimum flow rate with the inlet temperature for that condition is used.

b If TOL <Tdesignh replace TOL by Tdesignh

Test conditions for heating mode

- Air-to-water(brine) units -Low temperature application

	Partial Load				Outdoor heat exchanger		Indoor heat exchanger			
	%				Dry Bulb (Wet Bulb) temperatures		Fixed output	Variable Output[d]		
					°C		°C	°C		
	Formula	Average	Warmer	Colder	Outdoor air	Exhaust air		Average	Warmer	Colder
A	(-7 - 16) / (Tdesignh - 16)	88,46	n.a.	60,53	-7(-8)	20(12)	[a] / 35	[a] / 34	n.a.	[a] / 30
B	(+2 - 16) / (Tdesignh - 16)	53,85	100	36,84	2(1)	20(12)	[a] / 35	[a] / 30	[a] / 35	[a] / 27
C	(+7 - 16) / (Tdesignh - 16)	34,62	64,29	23,68	7(6)	20(12)	[a] / 35	[a] / 27	[a] / 31	[a] / 25
D	(+12 - 16) / (Tdesignh - 16)	15,38	28,57	10,53	12(11)	20(12)	[a] / 35	[a] / 24	[a] / 26	[a] / 24
E	(TOL[e] - 16) / (Tdesignh - 16)				TOL[e]	20(12)	[a] / 35	[a] / [b]	[a] / [b]	[a] / [b]
F	(T_{biv} - 16) / (Tdesignh - 16)				T_{biv}	20(12)	[a] / 35	[a] / [c]	[a] / [c]	[a] / [c]
G	(-15 - 16) / (Tdesignh - 16)	n.a.	n.a.	81,58	-15	20(12)	[a] / 35	n.a.	n.a.	[a] / 32

[a] With the flow rate determined at the nominal conditions in Table 12 of EN 14511-2:2018 at conditions 30/35 for fixed flow units, and with a water temperature difference of 5K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate for the unit, the minimum flow rate is used together with the outlet water temperature.
[b] The variable outlet temperature is calculated by interpolation from Tsedign to the temperature closest to TOL.
[c] The variable outlet temperature is calculated by interpolation from the temperatures immediately above and below Tbivalent.
[d] If the output temperature is below the unit minimum, the unit minimum is used.
[e] If TOL < Tdesignh then TOL is replaced by Tdesignh.

Test conditions for heating mode

- Air-to-water(brine) units - Intermediate temperature application

	Partial Load				Outdoor heat exchanger		Indoor heat exchanger			
	%				Dry Bulb (Wet Bulb) temperatures		Fixed output	Variable Output[d]		
					°C		°C	°C		
	Formula	Average	Warmer	Colder	Outdoor air	Exhaust air		Average	Warmer	Colder
A	(-7 - 16) / ($T_{designh}$ - 16)	88,46	n.a.	60,53	-7(-8)	20(12)	[a] / 45	[a] / 43	n.a.	[a] / 38
B	(+2 - 16) / ($T_{designh}$ - 16)	53,85	100	36,84	2(1)	20(12)	[a] / 45	[a] / 37	[a] / 45	[a] / 33
C	(+7 - 16) / ($T_{designh}$ - 16)	34,62	64,29	23,68	7(6)	20(12)	[a] / 45	[a] / 33	[a] / 39	[a] / 30
D	(+12 - 16) / ($T_{designh}$ - 16)	15,38	28,57	10,53	12(11)	20(12)	[a] / 45	[a] / 28	[a] / 31	[a] / 26
E	(TOL[e] - 16) / ($T_{designh}$ - 16)				TOL[e]	20(12)	[a] / 45	[a] / [b]	[a] / [b]	[a] / [b]
F	(T_{biv} - 16) / ($T_{designh}$ - 16)				T_{biv}	20(12)	[a] / 45	[a] / [c]	[a] / [c]	[a] / [c]
G	(-15 - 16) / ($T_{designh}$ - 16)	n.a.	n.a.	81,58	-15	20(12)	[a] / 45	n.a.	n.a.	[a] / 41

[a] With the flow rate determined at the nominal conditions in Table 13 of EN 14511-2:2018 at conditions 40/45 for fixed flow units, and with a water temperature difference of 5K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit, the minimum flow rate is used together with the outlet water temperature.
[b] The variable outlet temperature is calculated by interpolation from Tsedign to the temperature closest to TOL.
[c] The variable outlet temperature is calculated by interpolation from the temperatures immediately above and below Tbivalent.
[d] If the output temperature is below the unit minimum, the unit minimum is used.
[e] If TOL < Tdesignh then TOL is replaced by Tdesignh.

Test conditions for heating mode

- Air-to-water units(brine) Medium temperature application

	Partial Load				Outdoor heat exchanger		Indoor heat exchanger			
	%				Dry Bulb (Wet Bulb) temperatures		Fixed output	Variable Output[d]		
					°C		°C	°C		
	Formula	Average	Warmer	Colder	Outdoor air	Exhaust air		Average	Warmer	Colder
A	(-7 - 16) / (Tdesignh - 16)	88,46	n.a.	60,53	-7(-8)	20(12)	[a] / 55	[a] / 52	n.a.	[a] / 44
B	(+2 - 16) / (Tdesignh - 16)	53,85	100	36,84	2(1)	20(12)	[a] / 55	[a] / 42	[a] / 55	[a] / 37
C	(+7 - 16) / (Tdesignh - 16)	34,62	64,29	23,68	7(6)	20(12)	[a] / 55	[a] / 36	[a] / 46	[a] / 32
D	(+12 - 16) / (Tdesignh - 16)	15,38	28,57	10,53	12(11)	20(12)	[a] / 55	[a] / 30	[a] / 34	[a] / 28
E	(TOL[e] - 16) / (Tdesignh - 16)				TOL[e]	20(12)	[a] / 55	[a] / [b]	[a] / [b]	[a] / [b]
F	(T_{biv} - 16) / (Tdesignh - 16)				T_{biv}	20(12)	[a] / 55	[a] / [c]	[a] / [c]	[a] / [c]
G	(-15 - 16) / (Tdesignh - 16)	n.a.	n.a.	81,58	-15	20(12)	[a] / 55	n.a.	n.a.	[a] / 49

[a] With the flow rate determined at the nominal conditions in Table 14 of EN 14511-2:2018 at conditions 47/55 for fixed flow units, and with a water temperature difference of 8K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the outlet water temperature.
[b] The variable outlet temperature is calculated by interpolation from Tsedign to the temperature closest to TOL.
[c] The variable outlet temperature is calculated by interpolation from the temperatures immediately above and below Tbivalent.
[d] If the output temperature is below the unit minimum, the unit minimum is used.
[e] If TOL < Tdesignh then TOL is replaced by Tdesignh.

Test conditions for heating mode

- Air-to-water units(brine) High temperature application

	Partial Load				Outdoor heat exchanger		Temperatures heat exchanger			
	%				Dry Bulb (Wet Bulb) temperatures		Fixed output	Variable Output[d]		
					°C		°C	°C		
	Formula	Average	Warmer	Colder	Outdoor air	Exhaust air		Average	Warmer	Colder
A	(-7 - 16) / (Tdesignh - 16)	88,46	n.a.	60,53	-7(-8)	20(12)	[a] / 65	[a] / 61	n.a.	[a] / 50
B	(+2 - 16) / (Tdesignh - 16)	53,85	100	36,84	2(1)	20(12)	[a] / 65	[a] / 49	[a] / 65	[a] / 41
C	(+7 - 16) / (Tdesignh - 16)	34,62	64,29	23,68	7(6)	20(12)	[a] / 65	[a] / 41	[a] / 53	[a] / 36
D	(+12 - 16) / (Tdesignh - 16)	15,38	28,57	10,53	12(11)	20(12)	[a] / 65	[a] / 32	[a] / 39	[a] / 30
E	(TOL[e] - 16) / (Tdesignh - 16)				TOL[e]	20(12)	[a] / 65	[a] / [b]	[a] / [b]	[a] / [b]
F	(T_{biv} - 16) / (Tdesignh - 16)				T_{biv}	20(12)	[a] / 65	[a] / [c]	[a] / [c]	[a] / [c]
G	(-15 - 16) / (Tdesignh - 16)	n.a.	n.a.	81,58	-15	20(12)	[a] / 65	n.a.	n.a.	[a] / 57

[a] At the flow rate determined at the nominal conditions in Table 15 of EN 14511-2:2018 at conditions 55/65 for fixed flow units, and at a water temperature difference of 10K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the outlet water temperature.
[b] The variable outlet temperature is calculated by interpolation from Tsedign to the temperature closest to TOL.
[c] The variable outlet temperature is calculated by interpolation from the temperatures immediately above and below Tbivalent.
[d] If the output temperature is below the unit minimum, the unit minimum is used.
[e] If TOL < Tdesignh then TOL is replaced by Tdesignh.

Test conditions for heating mode

- Water(brine)-to-water units Low temperature application

	Part load				Outdoor heat exchanger			Indoor heat exchanger			
	%				Temperatures of Input / Output °C		Temperature bathroom °C	Fixed output °C	Variable output[d] °C		
	Formula	Average	Warmer	Colder	Water	Brine	DX		Average	Warmer	Colder
A	(-7 - 16) / ($T_{designh}$ - 16)	88,46	n.a.	60,53	10 / [b]	0 / [b]	4	[a] / 35	[a] / 34	n.a.	[a] / 30
B	(+2 - 16) / ($T_{designh}$ - 16)	53,85	100	36,84	10 / [b]	0 / [b]	4	[a] / 35	[a] / 30	[a] / 35	[a] / 27
C	(+7 - 16) / ($T_{designh}$ - 16)	34,62	64,29	23,68	10 / [b]	0 / [b]	4	[a] / 35	[a] / 27	[a] / 31	[a] / 25
D	(+12 - 16) / ($T_{designh}$ - 16)	15,38	28,57	10,53	10 / [b]	0 / [b]	4	[a] / 35	[a] / 24	[a] / 26	[a] / 24
E	($T_{designh}$ - 16) / ($T_{designh}$ - 16)		100		10 / [b]	0 / [b]	4	[a] / 35	[a] / 35	[a] / 35	[a] / 35
F	(T_{biv} - 16) / ($T_{designh}$ - 16)				10 / [b]	0 / [b]	4	[a] / 35	[a] / [c]	[a] / [c]	[a] / [c]

[a] With the flow rate determined at the standardised conditions given in Table 7 of EN 14511-2:2018 or Table 3 of EN 15879-1:2011 at conditions 30/35 for fixed flow units, and with a water temperature difference of 5K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the water outlet temperature.

[b] With the flow rate determined at the standardised conditions given in Table 7 of EN 14511-2:2018 for fixed flow units, and with a water temperature difference of 3K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the inlet water temperature.

[c] The variable output temperature is calculated by interpolation from the temperatures immediately above and below Tbivalent.

[d] If the output temperature is below the unit minimum, the unit minimum is used.

Test conditions for heating mode

- Water(brine)-to-water units Intermediate temperature application

	Part load				Outdoor heat exchanger			Indoor heat exchanger			
	%				Temperatures of Input / Output °C		Temperature bathroom °C	Fixed output °C	Variable output[d] °C		
	Formula	Medium	Tempering	Cold	Water	Brine	DX		Medium	Tempering	Cold
A	(-7 - 16) / ($T_{designh}$ - 16)	88,46	n.a.	60,53	10 / [b]	0 / [b]	4	[a] / 45	[a] / 43	n.a.	[a] / 38
B	(+2 - 16) / ($T_{designh}$ - 16)	53,85	100	36,84	10 / [b]	0 / [b]	4	[a] / 45	[a] / 37	[a] / 45	[a] / 33
C	(+7 - 16) / ($T_{designh}$ - 16)	34,62	64,29	23,68	10 / [b]	0 / [b]	4	[a] / 45	[a] / 33	[a] / 39	[a] / 30
D	(+12 - 16) / ($T_{designh}$ - 16)	15,38	28,57	10,53	10 / [b]	0 / [b]	4	[a] / 45	[a] / 28	[a] / 31	[a] / 26
E	($T_{designh}$ - 16) / ($T_{designh}$ - 16)	100			10 / [b]	0 / [b]	4	[a] / 45	[a] / 45	[a] / 45	[a] / 45
F	(T_{biv} - 16) / ($T_{designh}$ - 16)				10 / [b]	0 / [b]	4	[a] / 45	[a] / [c]	[a] / [c]	[a] / [c]

[a] With the flow rate determined at the standardised conditions given in Table 8 of EN 14511-2:2018 or Table 3 of EN 15879-1:2011 at conditions 40/45 for fixed flow units, and with a water temperature difference of 5K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the water outlet temperature.
[b] With the flow rate determined at the standardised conditions given in Table 8 of EN 14511-2:2018 for fixed flow units, and with a water temperature difference of 3K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the inlet water temperature.
[c] The variable output temperature is calculated by interpolation from the temperatures immediately above and below Tbivalent.
[d] If the output temperature is below the unit minimum, the unit minimum is used.

Test conditions for heating mode

- Water(brine)-to-water units Medium temperature application

	Part load				Outdoor heat exchanger			Indoor heat exchanger			
	%				Inlet / Outlet temperatures °C		Bath temperature °C	Fixed output °C	Variable output[d] °C		
	Formula	Average	Warmer	Colder	Water	Brine	DX		Average	Warmer	Colder
A	(-7 - 16) / (Tdesignh - 16)	88,46	n.a.	60,53	10 / [b]	0 / [b]	4	[a] / 55	[a] / 52	n.a.	[a] / 44
B	(+2 - 16) / (Tdesignh - 16)	53,85	100	36,84	10 / [b]	0 / [b]	4	[a] / 55	[a] / 42	[a] / 55	[a] / 37
C	(+7 - 16) / (Tdesignh - 16)	34,62	64,29	23,68	10 / [b]	0 / [b]	4	[a] / 55	[a] / 36	[a] / 46	[a] / 32
D	(+12 - 16) / (Tdesignh - 16)	15,38	28,57	10,53	10 / [b]	0 / [b]	4	[a] / 55	[a] / 30	[a] / 34	[a] / 28
E	(Tdesignh - 16) / (Tdesignh - 16)		100		10 / [b]	0 / [b]	4	[a] / 55	[a] / 55	[a] / 55	[a] / 55
F	(Tbiv - 16) / (Tdesignh - 16)				10 / [b]	0 / [b]	4	[a] / 55	[a] / [c]	[a] / [c]	[a] / [c]

[a] With the flow rate determined at the standardised conditions given in Table 9 of EN 14511-2:2018 or Table 3 of EN 15879-1:2011 at conditions 47/55 for fixed flow units, and with a water temperature difference of 8K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the water outlet temperature.
[b] With the flow rate determined at the standardised conditions given in Table 9 of EN 14511-2:2018 for fixed flow units, and with a water temperature difference of 3K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the inlet water temperature.
[c] The variable output temperature is calculated by interpolation from the temperatures immediately above and below Tbivalent.
[d] If the output temperature is below the unit minimum, the unit minimum is used.

Test conditions for heating mode

- Water(brine)-to-water units High temperature application

	Part load				Outdoor heat exchanger			Indoor heat exchanger			
	%				Inlet / Outlet temperatures		Bath temperature	Fixed output	Variable output[d]		
					°C		°C	°C	°C		
	Formula	Average	Warmer	Colder	Water	Brine	DX		Average	Warmer	Colder
A	$(-7 - 16) / (T_{designh} - 16)$	88,46	n.a.	60,53	10 / [b]	0 / [b]	4	[a] / 65	[a] / 61	n.a.	[a] / 50
B	$(+2 - 16) / (T_{designh} - 16)$	53,85	100	36,84	10 / [b]	0 / [b]	4	[a] / 65	[a] / 49	[a] / 65	[a] / 41
C	$(+7 - 16) / (T_{designh} - 16)$	34,62	64,29	23,68	10 / [b]	0 / [b]	4	[a] / 65	[a] / 41	[a] / 53	[a] / 36
D	$(+12 - 16) / (T_{designh} - 16)$	15,38	28,57	10,53	10 / [b]	0 / [b]	4	[a] / 65	[a] / 32	[a] / 39	[a] / 30
E	$(T_{designh} - 16) / (T_{designh} - 16)$	100			10 / [b]	0 / [b]	4	[a] / 65	[a] / 65	[a] / 65	[a] / 65
F	$(T_{biv} - 16) / (T_{designh} - 16)$				10 / [b]	0 / [b]	4	[a] / 65	[a] / [c]	[a] / [c]	[a] / [c]

[a] At the flow rate determined at the standardised conditions given in Table 10 of EN 14511-2:2018 or Table 3 of EN 15879-1:2011 at conditions 55/65 for fixed flow units, and at a water temperature difference of 10K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the water outlet temperature.

[b] With the flow rate determined at the standardised conditions given in Table 10 of EN 14511-2:2018 for fixed flow units, and with a water temperature difference of 3K for variable flow units. If for any test condition the resulting flow rate is less than the minimum flow rate of the unit then that minimum flow rate is used together with the inlet water temperature.

[c] The variable output temperature is calculated by interpolation from the temperatures immediately above and below Tbivalent.

[d] If the output temperature is below the unit minimum, the unit minimum is used.