

EHPA Testing Regulation

Testing of Air/Water Heat Pumps

**Terms, Test Conditions and Test Method based on
EN 14511-1 to 14511-4**

**Additional requirements for granting the international
quality label for heat pumps**



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1 Introduction

The test conditions and testing method for the EHPA Quality Label are based on the European standard EN 14511, Parts 1 to 4, version 2007. It applies for space heating, additionally requirements according EHPA Quality Label can be found in the text (they are also summarized in Annex A). Anything not defined in this test regulation should be handled in line with EN 14511.

A heat pump can be awarded the International Heat Pump Quality Label once it is successfully tested in accordance with this regulation. The process is described in the “EHPA regulations for granting the international quality label for electrically driven heat pumps”.

This regulation has been adopted by the EHPA Quality Label Committee. Any changes to them must be approved by the Committee.

2 Scope of testing regulation

The scope of this testing regulation is to specify the testing conditions and the test method for testing electrically driven air/water heat pumps. In order to qualify for the EHPA Quality Label, the heat pump submitted for testing must be from series production.

2.1 Scope of testing

The scope of the test comprises:

- a) A performance test for different standardized points as specified in EN 14511 Parts 2 & 3 and other points as defined in Chapter 5,
- b) The testing of the operating range as defined by the manufacturer (see chapter 3.5 and 6.3),
- c) A safety test (see chapter 6),
- d) Sound measurement in accordance with EN 12102 (see chapter 7),
- e) Testing the electrical characteristic values (see chapter 8).

2.2 Testing methods

2.2.1 Performance testing

Perform the test under constant ambient conditions, i.e., during the test, the set conditions (e.g. software and control devices) on both source and user sides must remain constant. This test determines the heat output and the electrical power consumed, from which the performance figure for the heat pump is calculated.

2.2.2 Testing the operating range

The operating range (max. 6 key points, see chapter 3.5 and figure 1 in Chapter 6) is declared by the manufacturer and describes the operating range for the heat pump which is covered by the full manufacturer's warranty. Testing is performed to evaluate whether the heat pump can operate at the limits of the operating range for an extended period of time.

2.2.3 Uncertainties of measurement for indicated values

Measurement variables	Unit	Uncertainty of measurement (\pm) of the cited values
Air		
- Dry-bulb temperature	°C	0,2 K
- Wet-bulb temperature	°C	0,3 K
- Relative humidity ¹	% RH	2,5 % RH
- Volume flow	m ³ /s	5 %
- Static pressure difference	Pa	5 Pa ($\Delta p \leq 100$ Pa) 5 % ($\Delta p > 100$ Pa)
Water/brine		
- Temperature inlet/outlet	°C	0,1 K
- Volume flow	m ³ /s	1 %
- Heat transfer medium (brine) concentration	%	2 %
- Static pressure difference	Pa	5 Pa ($\Delta p \leq 100$ Pa) 5 % ($\Delta p > 100$ Pa)
Electrical power	W	1 %
Voltage	V	0,5 %
Current	A	0,5 %
Electrical energy	kWh	1 %
The heat output determined by the water side must be determined such that there is a maximum 5% measurement uncertainty, regardless of the individual measurement inaccuracies.		

Table 1: Uncertainty of measurement (\pm) of the cited values in accordance with EN 14511-3 Section 4.3

¹ According to EN 14511, the wet bulb temperature is given to determine air humidity. The measurements can also be made on the basis of measurement of relative humidity. The measurement uncertainty specified by EN 14511 must not be exceeded.

2.2.4 Safety test

The safety of equipment is tested by simulating operational malfunctions during normal heat pump operation.

3 Terms and definitions

The following terms supplement the terms and definitions defined in EN 14511-1.

3.1 Heat source system

A heat source system is extracting the heat from the heat source (e.g. air, water, soil).

3.2 Heat sink system

A heat sink system is distributing the heat from the warm side (heat sink, condenser) of the heat pump to the heat distribution system (space heating, domestic hot water, swimming pools, etc.).

3.3 Heating capacity, P_H

Heat delivered by the heat pump to the heat transfer medium.

3.4 Effective power input, P_E

The average electrical power input of the unit within the defined interval of time obtained for operating the heat source system including all control, regulation and safety equipment.

3.5 Operating range

The working range for the heat pump as specified by the manufacturer, limited by a maximum of six points (see figure 1, in Chapter 6), and covered by full manufacturer warranty.

3.6 Safety range

The safety range are the conditions outside the operating range at which the safety devices prevent the heat pump from being damaged.

3.7 Acoustic power level

The acoustic power level is expressed in decibels, dB(A), as defined in EN 12012.

3.8 Defrosting

3.8.1 Defrosting system

Part of the heat pump system to remove ice or frost from the evaporator.

3.8.2 Defrost mode

Operating condition of the heat pump in heating mode when the outdoor heat exchanger is defrosting.

3.8.3 Defrost period

Time during which the unit is in defrost mode.

3.8.4 Operating cycle with defrost time

Cycle consisting of a heating period and a defrost period, from one defrost termination to the next defrost termination.

3.8.5 Relative defrost time

The relative defrost time is the ratio of the defrost time over the time for an operating cycle with defrost time.

4 Test conditions

4.1 Ambient conditions and electrical data

Model:	Measurement variable:	Limit values:
Air/water heat pump with duct connection on the air inlet and outlet side	Ambient temperature	15 to 30 °C
	Electrical voltage (230V/400V; 50 Hz)	± 4 %
Air/water heat pump without duct connection on the air inlet side	Ambient temperature	For test conditions see Tab. 3 below.
	Electrical voltage (230V/400V; 50 Hz)	± 4%

Table 2: Ambient conditions and electrical data¹ (see footnote below)

4.2 Test conditions for performance testing

Test conditions / testing points air/water heat pumps:							
Test cond.	Standard	Type ¹	Source			Sink	
			inlet temperatures		φ (%)	outlet temperatures	
			T.db (°C)	T.wb(°C)			T.out (°C)
A7/W35	EN 14511-2	N	7	6	89	35	30
A2/W35²	EN 14511-2	QL	2	1	84	35	a
A-7/W35	EN 14511-2	B	-7	-8	75	35	a
A-15/W35	EN 14511-2	B	-15	--	--	35	a
A7/W45	EHPA	B	7	6	89	45	a
A7/W55	EHPA	B	7	6	89	55	a
A-7/W55	EHPA	B	-7	-8	75	55	a
A20/W55	EHPA	B	20	14	50	55	a

1 Type name: N -> standard rated point, B -> operating rated point, QL -> point to determine COP for Quality Label
2 Relevant test condition for the EHPA Quality label

a The test is conducted with the volume flows indicated at A7/W35

Table 3: Conditions for performance testing of air/water heat pumps

4.3 Air-side volume flow

In ducted units the volume flow and the pressure difference shall be related to standard air with a dry evaporator. Standard air is dry air at 20 °C and at standard barometric pressure of 101,325 kPa, having a mass density of 1,204 kg/ m³.

Below are pressure requirement for comfort air conditioners, minimal External Static Pressures (ESP) defined. For the inlet-side and outlet-side are:

Rated power up to 8 kW:	25 Pa
Rated power from 8 to 12 kW:	37 Pa
Rated power from 12 to 20 kW:	50 Pa
Rated power from 20 to 30 kW:	62 Pa
Rated power from 30 to 45 kW:	75 Pa

The measured ESP must be greater than the min. values in above table. Otherwise the air flow rate is lowered in order to achieve an ESP equal to 80 %.

If the evaporator fan can be run at more than one speed, the speed selected must meet above pressure conditions and result in value as close as possible to the manufacturer's rated volume flow.

¹ Table 1, the testing conditions for the voltage are fixed according to common procedure in all EHPA test labs. This is not part of the standard.

4.4 Setting up and connecting the test object

The heat pump must be set up and connected for the test as recommended by the manufacturer in the installation and operating manual.

The length of each refrigerant pipe (for a split system) must be between 5 and 7,5 m and the height difference should not exceed 1 m, the pipes should be thermal insulated according the manufacturer's instructions. At least half of the connecting lines shall be exposed to the outside conditions.

Heat pump start-up shall be performed by a manufacturer's representative otherwise the test laboratory shall charge the unit according to the specification of the manufacturer, which shall include:

- the quantity of refrigerant,
- the suction pressure and the superheating temperature
- and the expansion device or other component setting for achieving a correct operation of the heat pump.

Compact units automatically filled with refrigerant at the manufacturer's site can be delivered as produced. The manufacturer has to confirm that a control system documenting the filling is used.

If such a system does not exist the heat pump must be delivered filled with nitrogen and shall be charged with refrigerant defined by the manufacturer at the test laboratory.

The refrigerant type and charge must be in line with the technical data (marking plate) presented by the manufacturer.

4.5 Requirements for the test facility

Different requirements apply during heating operation and the defrosting phases with regard to meeting the specified desired values.

4.5.1 Test conditions during heating operation – steady state

Measured quantity:	Permissible dev. (\pm) of the arithmetic mean values from set value	Permissible dev. (\pm) of individual measured values from set values
Air:		
Temperature, dry-bulb	0,3 K	1 K
Temperature, wet-bulb	0,3 K	1 K
Relative humidity ¹	3 % RH	7 % RH
Water/brine:		
Inlet temperature	0,2 K	0,5 K
Outlet temperature	0,3 K	0,6 K
Volume flow	2%	5%
Electrical voltage	4%	4%

Table 4 a: Permissible deviations (\pm) from set values during heating operation

¹ According to EN 14511, the wet bulb temperature is given to determine air humidity. The measurements can also be made on the basis of measurement of relative humidity. The measurement uncertainty specified by EN 14511 must not be exceeded.

4.5.2 Defrost cycle test conditions – transient

The test conditions apply during a defrost cycle and during the first 10 min after the termination of a defrost cycle when the heat pump is operating in the heating mode, see table 5 (EN 14511-3) for more applied conditions when using the transient ("T") test procedure, see also Chapter 5.4.

Measurement quantity:	Permissible dev. (\pm) of the arithmetic mean values from set value	Permissible dev. (\pm) of individual measured values from set values value
Air:		
Temperature, air entering indoor-side:		
dry-bulb	1,5 K	2,5 K
wet-bulb	-	-
Temperature, air entering outdoor-side:		
dry-bulb	1,5 K	5,0 K
wet-bulb	1,0 K	-
Relative humidity ¹	9 % RH	-
Water/brine:		
Inlet temperature	-	-
Outlet temperature	-	± 2 K
Volume flow	2%	5%
Electrical voltage	4%	4%

Table 4 b: Permissible deviations (\pm) from the desired values during the defrost cycle and recovery period

¹The measurements can also be made on the basis of measurement of relative humidity. The measurement uncertainty specified by EN 14511 must not be exceeded.

5 Performance testing

5.1 General

Ensure throughout the test that there is no water drips or drains from any part of the equipment except from the drainage openings intended for the purpose.

5.2 Performance measurement procedure

Start the measurement with a preconditioning period, during which the actual values over at least ten minutes must lie within the tolerance limits defined in Table 4a (Region A in Graphs 1-3).

Follow this by a defrost cycle with a 10-minute recovery phase with the defrosting being triggered automatically or manually by the test item control gear. During this period, deviations from the desired values as shown in Table 4b are permissible (Region B in Graphs 1-3).

Once the recovery phase has ended, the actual values must again be within the tolerance limits given in Table 4a. The equilibrium phase that follows lasts 60 minutes (Region C in Graphs 1-3). Follow this by the data collection period, which last 35 minutes or three hours, depending on the test conditions.

If defrosting occurs during the equilibrium phase and/or the measurement period, the tolerance limits for the desired values during the defrost phases and the subsequent 10-minute recovery period according to Table 4b apply, defrost cycle test conditions – transient.

Record the measured values every 10 seconds throughout the entire measurement period.

5.2.1 Measurement of steady state or transient test conditions

Basically performance measurements must be regarded as, and treated as, transient test conditions if it is possible for the heat pump to defrost during the test. If the temperature difference (leaving and

entering temperatures of the heat transfer medium) decreases by more than 2.5% during the first 35 minutes of the data collection period the data collection has to be extended up to a minimum of 3 hours.

Experience indicates that this applies to all of the tests shown in table 3 to be performed with an air temperature less than or equal to +2 °C. All these test conditions must be carried out under transient conditions as described in 5.4.

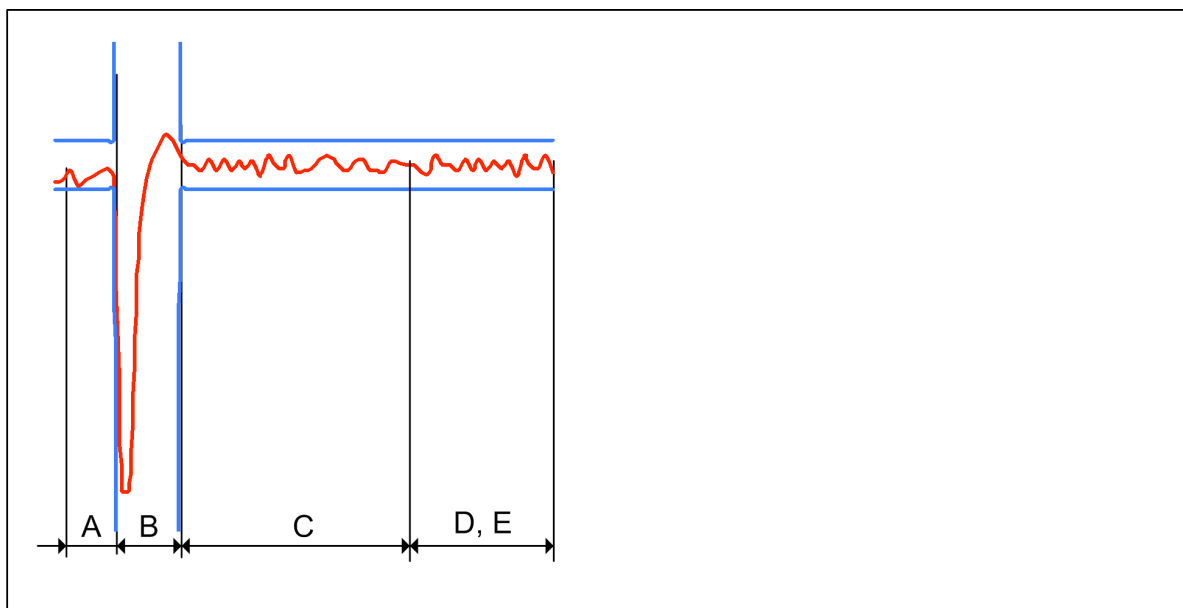
Measure the standard A7/W35 rating point under transient test conditions. If during this measurement no defrosting of the evaporator occurs, the measurements of A7/W55 could be performed under steady state conditions in accordance with chapter 5.3. If not, the measurements must be carried out in accordance with chapter 5.4.

Measurement under test conditions A20/W55 can always be carried out under steady state conditions (chapter 5.3).

5.3 Steady state conditions without defrosting the evaporator

Measurement conditions can be regarded as steady state if:

- no defrosting processes occur during the equilibrium or data collection period (see graph 1) and/or
- the temperature difference is less than 2,5 % as explained in Chapter 5.2.1.



- A Preconditioning period: 10 minutes
- B Defrost with recovery time: defrost time + 10 minutes
- C Equilibrium period: 60 minutes
- D Data collection period: 35 minutes
- E Period for capacity calculation

Graph 1: Testing and evaluation under steady state operating conditions without defrosting

Use the data from the entire data collection period to determine the capacity calculation (Regions E and D in graph 1).

5.4 Transient test conditions with defrosting of the evaporator

Transient test conditions are present if one or more defrosting cycles occur during the equilibrium or data collection period. The defrosting processes of the evaporator are triggered only by the defrost control of the test object.

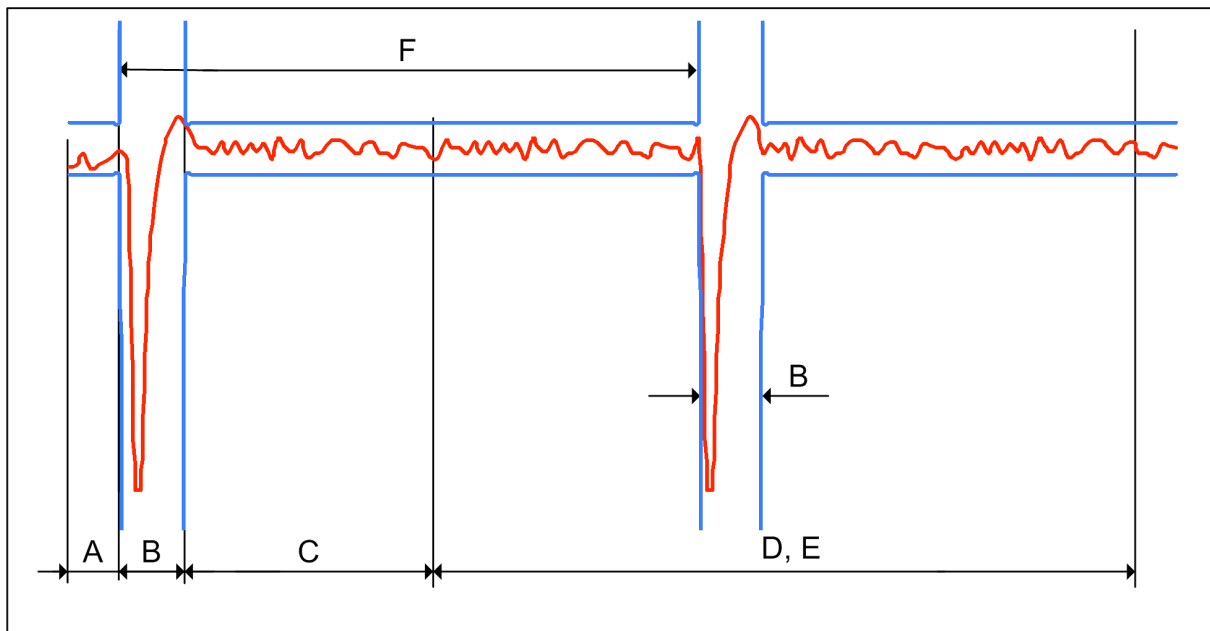
To determine the outputs, record all significant measured values every ten seconds and calculate an integral average.

5.4.1 Performance determination with one defrost in the data collection period

If a defrosting process occurs during the data collection period, the measured values recorded during the entire data collection period are applied to determine the capacity calculation (see graph 2 Section E).

The length of the operating cycle with one defrost period is shown in graph 2, Region F “Operating cycle with defrost”. It is the time between the defrost cycle before the equilibrium period and the defrost cycle during the data collection period.

Determine the performance data in accordance with the performance specification for multiple-defrostings in the measuring period as outlined in chapter 5.4.2.



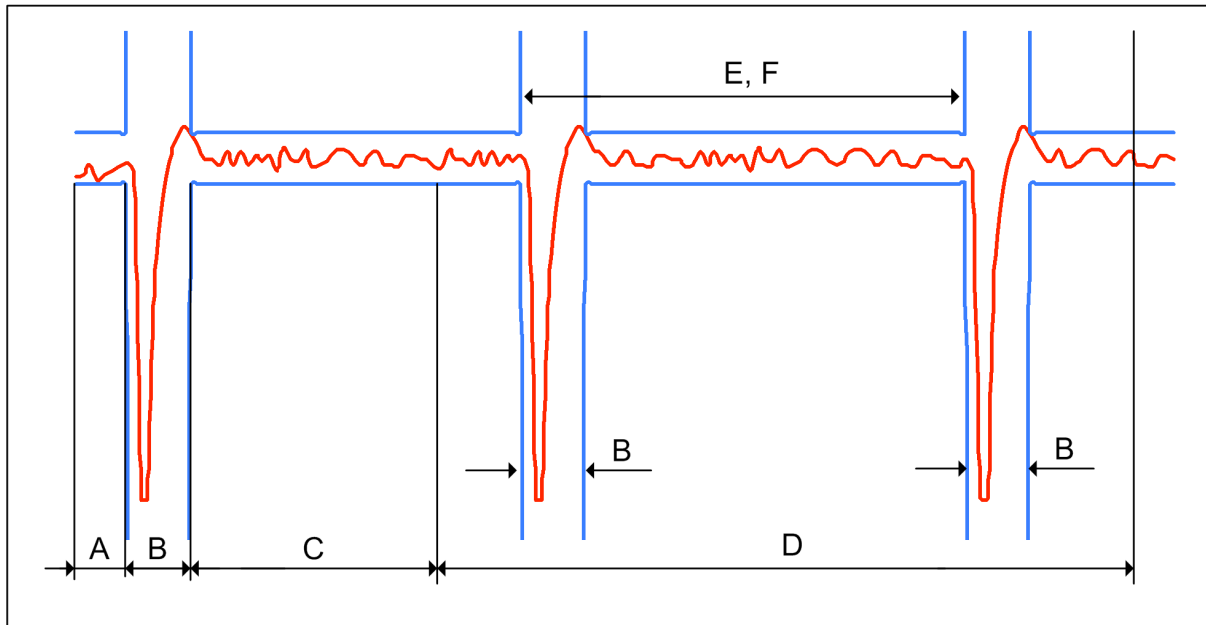
- A Preconditioning period: 10 minutes
- B Defrost with recovery time: defrost time + 10 minutes
- C Equilibrium period: 60 minutes
- D Data collection period: 3 hours
- E Period for capacity calculation
- F Operating cycle with defrost period

Graph 2: Transient operating conditions with one defrosting process in the measuring period

5.4.2 Performance determination for multiple defrosting in the data collection period

If two or more defrost periods occurs during the data collection period, the measured values found in the period between the beginning of the first defrosting cycle and the beginning of the last defrosting cycle in the data collection period can be used for the capacity calculation (see Graph 3, Region E).

The length of an operating cycle is consisting of complete cycles and includes at least a period from termination to termination of defrost or from start to start of defrost (graph 3, Region F “operating cycle with defrost”).



- A Preconditioning period: 10 minutes
- B Defrost with recovery time: defrost time + 10 minutes
- C Equilibrium period: 60 minutes
- D Data collection period: 3 hours
- E Period for capacity calculation
- F Work cycle with defrost time

Graph 3: Transient operating conditions with multiple defrosting cycles in the data collection period

5.5 Output measurement with variable-output heat pumps

5.5.1 General

Standard heat pumps, which are run in on/off mode, always deliver full output during operation. Variable-output heat pumps, which can be run depending on need, can deliver reduced output during operation.

Make partial-load measurements with liquid flow rates as set at full load measurements during continuous operation.

The usage limit test, safety test and sound measurement are always performed with maximum heat output.

5.5.2 Heat pumps with variable capacity

All test points listed in Table 3 at 100 % heat output must be measured. For test point A7/W35 an additional test is performed at the output level nearest to 50 % of the measured heat output. 50 % is based on the capacity measured at A7 and return temperature W30. The liquid flow rate is set at A7/W35 full load and is maintained constant.

Other test points from Table 3 can be measured with the same output setting, if requested by the applicant. It must be possible to adjust the output levels during testing. The setting must remain constant during the test.

It must be possible manually to adjust the output levels during testing. The setting must not vary itself during the test. See Annex and further documentation on how to test Capacity controlled units.

5.6 Analysis

Calculations are in accordance with standard EN 14511 for information, equations used are listed in Annex B.

6 Safety test

The safety test checks if the safety devices respond correctly to operational malfunctions and protect the heat pump from damage. Perform this test in addition to the tests specified in EN 14511-4.

6.1 General

- a) Perform this test at A7/W35 under the conditions given in Chapter 4.2, Table 3. When starting the test, the limit values as shown in Table 4a must be met.
- b) To check the safety devices of the heat pump, simulate a series of operating states and malfunctions (see 6.2.a and 6.3.b, below). Before and after each simulated state or malfunction, the test object must reach the steady-state condition of normal operation for the indicated test condition.
- c) For the safety tests, disable devices on the heat pump that do not serve as overload protection or safety devices. Any time delays that may be found must also be considered in the test periods in the test sequence. (This is done in coordination with the respective manufacturer.)

6.2 Malfunctions to be simulated

Maintain the simulated malfunctions for transfer medium flows for at least two hours². The test object must not suffer any damage throughout the entire sequence of tests and must be fully functional after testing.

The heat pump must not switch on and off more than four times during the last 60 minutes of the test. If a safety device locks the heat pump out of operation (locking malfunction), the heat pump is considered to have passed the test and the test is ended.

- a) Blocking the heat transfer medium flow of the heat source system (switch the fan off on the source side).
- b) Blocking the heat transfer medium flow of the heat usage system (switch the circulating pump off on the user side).
- c) Complete power failure for at least five seconds. The heat pump must return to a stable operating state no later than 20 minutes after restarting the compressor.
- d) The test point A2 is included for at freeze up test, explained in standard EN 14511-4 Chapter 4.2.3. For units with defrosting system the heat transfer medium flow at the indoor heat exchanger, at the beginning of the defrosting phase is shut off, explained in standard EN 14511-4 Chapter 4.4.

The test is performed at the flow rate obtained during the test at the corresponding standard rating conditions.

6.3 Testing the usage limit

The test at the boundaries is intended to show whether the heat pump is fully functional and operable in the warranted usage range stated by the manufacturer. For the test of usage limit (operating range) see Chapter 6.4 in standard EN14511-4.

6.3.1 Test conditions

The definition of the operating boundaries is explained in Section 2.2.2 and Figure 1 below. Use the values given by the manufacturer as target values for the source temperatures. The calculations of humidity must be done as given in Annex A equation. Test have to be performed with same flow rates as used for the test point A7/W35.

During the test conditions in Chapter 4. (Table 4a to Table 4b) must not be exceeded.

² This requirement is set by EHPA. In order to maintain the readability of the text, it is made here and in the Annex A.

6.3.2 Test sequence

The heat pump must remain in operation during the entire test period without being shut off by a safety device. There must be no damage to the heat pump throughout the entire test. The test object must remain in operation under the specified operating conditions for at least 60 minutes without external interference.

If experience from the output measurement indicates that a defrost cycle can be expected at the corresponding usage limit and a defrost cycle does not automatically occur during the 1-hour test period, a defrost cycle must be triggered by manual control. The test is finished only when the actual values have been within the tolerance limits defined in Table 4a for at least 10 minutes after defrosting.

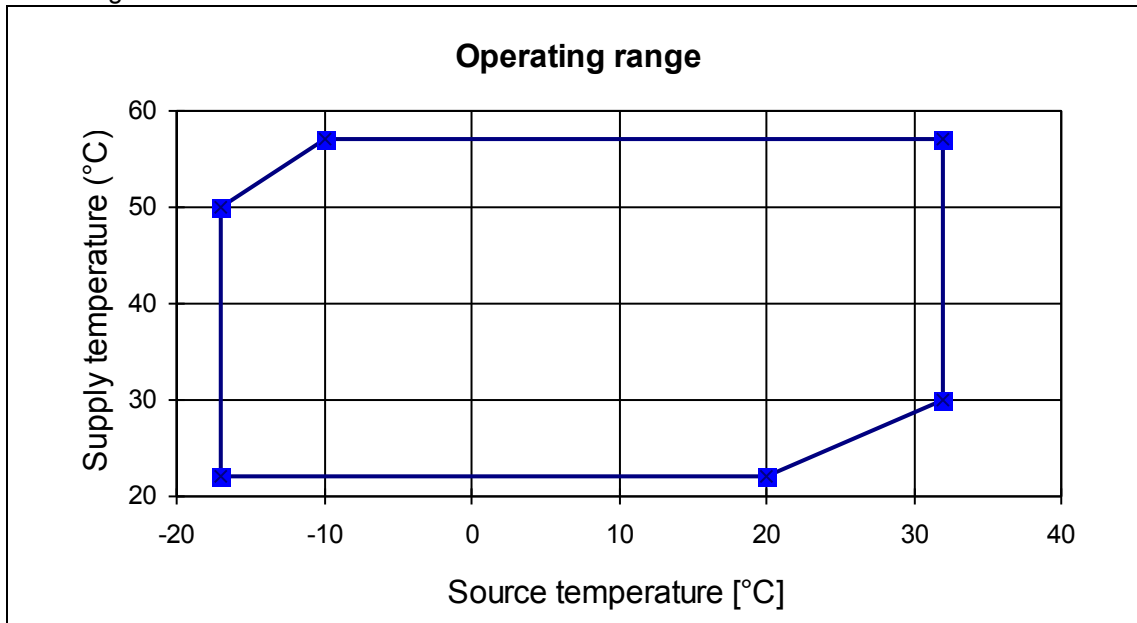


Figure 1: Example of the operating range defined by the manufacturer

7 Sound measurement

Test is performed according to EN 12102 and EN 14511-2 in standard rating condition A7/W35 according to table 3. For set up see standard EN 12102. Measure the sound level by one of the following methods:

- Live room method in accordance with EN ISO 3741 and EN ISO 3743
- Free field method in accordance with EN ISO 3744 and EN ISO 3745
- Intensity method in accordance with EN ISO 9614-2
- EN ISO 3746
- EN ISO 3747, provided that the test environment meet the requirements for engineering method (grade 2)

8 Test of electrical characteristic values

The electrical characteristic values for the start and operation of each phase are recorded using a voltage analyzer. Only the measured state is given in the test report. This test is performed at the standard test point A7/W35 according to table 3.

9 Documentation provided by the manufacturer

9.1 Marking

Each heat pump unit must have a name plate securely and permanently attached. It must be applied such that it is easily readable and accessible and include the following information. For additional information see also EN 60335-1, -2-40:

- Manufacturer or supplier
- Model designation and serial number
- COP and heat output in kW with at least three significant figures for A2/W35 and A7/W35
- Type and filling weight of the refrigerant

10 Test reports

The heat pump test centers publish the test results only if the customer has approved such publication with an authorized signature. The full report is given according to the requirements in EN 14511-3 (Test report level 1). It belongs to the consumer. A public summary report is published (Test report level 2). Both reports must make reference to used CEN standard, EHPA rules and regulations. It must clearly be stated that the test center is accredited for the used methods.

10.1 Test report Level 1 (disclosure status: private):

This dossier contains all test documents and fulfills the requirements in EN 14511. Production of this test report is part of the overall test procedure, and the report is sent only to the manufacturer or the customer who has ordered the tests.

10.1.1 General Information on the testing institute

- Date:
- Name of the testing institute:
- Test location:
- Test method:
- Test supervisor:
- Test number:
- Type of refrigerant:
- Mass of refrigerant:
- GWP value of the refrigerant (as required by the EU Ecolabel, 2007/742/EC)
- Properties of fluids:
- References to this European Standard:
- References to the EHPA regulation and ver. 1.4

10.1.2 Machine-specific information

- Name of the customer (usually the manufacturer)
- Machine type, designation
- Serial number (if not available, compressor serial number)
- Brief description of the design
- Rated volume flow on user side at which the measurements were taken.
- Fan speed, air volume flow and maximum permissible external static pressure drop
- Information on the components, such as compressor type, heat exchanger type, expansion valve type, etc.
- Year of production
- Photo of the machine
- Dimensions and weight of the heat pump

10.1.3 Operating range and safety test

- Extreme points tested and reached
- Safety test passed or failed

10.1.4 Electrical measurements

- Max. start current with or without soft starter
- Output factor (mean value).

10.1.5 Sound measurement

- As measured before.

10.2 Test report Level 2 (disclosure status: public)

This data serves mainly as the basis for EHPA Quality Label Database. It contains at least:

- Average heat output
- Average electrical power consumption
- COP for test points according test regulation
- Operating range and safety test
- Electrical measurements
- Sound measurements
- GWP value of the refrigerant (as required by the EU Ecolabel, 2007/742/EC)

Annex A – additional requirements according to EHPA

The test conditions and testing method for the EHPA Quality Label are based on the European standard EN 14511, Parts 1 to 4, version 2007. It applies for space heating, additionally requirements can be found in the text and are also summarized in this Annex. Anything not defined in this test regulation should be handled in line with EN 14511.

Chapter 4

Testing points are given in Chapter 4.2; Table 3.

The ambient conditions and the electrical data for performance testing and functional inspection are listed in the Table below.

Model:	Measurement variable:	Limit values:
Air/water heat pump with duct connection on the air inlet and outlet side	Ambient temperature	15 to 30 °C
	Electrical voltage (230V/400V; 50 Hz)	± 4%
Air/water heat pump without duct connection on the air inlet side	Ambient temperature	For test conditions see Tab. 3 below.
	Electrical voltage (230V/400V; 50 Hz)	± 4%

Table 3: Ambient conditions and electrical data. The testing conditions for the voltage are fixed according to common procedure in all EHPA test labs.

For the heat pump start-up the following information shall be included, see 4.3:

- the quantity of refrigerant,

For refrigerant charge the value on the marking plate can be used (for compact, factory filled units with a monitoring system in place). In all other cases, the heat pump unit has to be delivered filled with nitrogen and shall be charged with refrigerant supplied by the test laboratory (see chapter 4.4).

Chapter 5

Period of defrost 35 minutes vs. 3 hours. Recent test results show that a testing duration of 3 hours gives more accurate results (see chapter 5).

Flow rates must be indicated at A7/W35 flow for all test-points.

Chapter 6

All medium flow malfunctions are simulated for at least two hours, which is a longer time than prescribed in EN14511.

Regarding automatic restart after power-off simulation (see chapter 6.2), the test has not to be performed if the machine is not capable of restarting automatically after power supply failure.

Calculation of humidity

For chapter 6.3, the humidity relative to the source temperatures of the maximum 6 boundary condition lines must be determined as follows (rounded to 1%):

$T_{Q.Boundary}$ (°C)		Relative humidity [%]
	$\leq -7^{\circ}\text{C}$	Not defined
$> -7^{\circ}\text{C}$	$\leq 7^{\circ}\text{C}$	$\varphi_L = T_{Q.Boundary} + 82$
$> 7^{\circ}\text{C}$	$\leq 20^{\circ}\text{C}$	$\varphi_L = -3,0 * T_{Q.Boundary} + 110$
$> 20^{\circ}\text{C}$		50

Definitions:

φ_L Relative humidity in [%]

$T_{Q.Boundary}$ Source temperature (air temperature) of the respective boundary line in ° C.

Chapter 10

In the test report references to the EHPA regulation and version are required.

Annex B - Equations

Calculation of heat output/ heating capacity

Calculate the heat output of the test object as follows:

$$\dot{Q}_{\text{HPaverage}} = \frac{Q_{\text{HP}}}{t_{\text{duration}}} \quad [\text{W}] \quad (1)$$

where:

$$Q_{\text{HP}} = \sum_{i=1}^{n-1} \frac{\dot{Q}_{\text{HPaverage},i} + \dot{Q}_{\text{HPaverage},i+1}}{2} \quad [\text{W}] \quad (2)$$

where

$$Q_{\text{HP}} = q_w \cdot \rho_w(T_{\text{return}}) \cdot c_{p_w} \cdot (T_{\text{outlet}} - T_{\text{return}}) \quad [\text{W}] \quad (3)$$

Definitions:

$\dot{Q}_{\text{HPaverage}}$	Average heat output in [W]
Q_{HP}	Heat energy given off during the test in [J]
$\dot{Q}_{\text{HP},j}$	Heat output for the i^{th} measurement in [W]
\dot{Q}_{HP}	Present heat output in [W]
t_{duration}	Test duration in [s]
n	Number of measurement intervals
Δt	Duration of a measurement interval in [s]
q_w	Volume flow from the heat transfer medium on the warm side in [m ³ /s]
$\rho_w(T_{\text{return}})$	Density of the heat transfer medium at return temperature in [kg/m ³]
c_{p_w}	Specific heat capacity of the heat transfer medium in [J/(kg K)]
$T_{\text{outlet}}, T_{\text{return}}$	Temperature of the heat transfer medium (outlet and return, respectively) in [K]

Calculation of power consumption

Calculate the effective power consumption of the heat pump from the power consumption of the fan, the compressor and all electrical equipment of the heat pump that functions during the heating mode.

Include the power consumption figures for the delivery apparatus of the heat pump only to such an extent as is required to overcome the internal static pressure differentials.

Calculate the power consumption of the heat pump as follows:

$$P_{HP,average} = \frac{E_{el}}{t_{duration}} \quad [W] \quad (4)$$

where:

$$E_{el} = \sum_{i=1}^{n-1} \frac{P_{HP,i} + P_{HP,i+1}}{2} \cdot \Delta t \quad [J] \quad (5)$$

where:

$$P_{HP} = P_{em} + P_{ep} + P_E - P_{efan} \quad [W] \quad (6)$$

where:

$$\pm P_{ep} = \frac{q_w \cdot \Delta p}{\eta_p} \quad [W] \quad (7)$$

where:

$$\pm P_{efan} = \frac{q_c \cdot \Delta p_{fan}}{\eta_{fan}} \quad [W] \quad (8)$$

Definitions:

$P_{HP,average}$	Average electrical power consumption in [W]
P_{HP}	Electrical power consumption of the entire heat pump in [W]
$P_{HP,i}$	Electrical power consumption for the i^{th} measurement in [W]
P_{em}	Electrical power consumption of the compressor in [W]
P_{ep}	Proportional electrical power consumption of the circulating pump in [W] excluded or included depending on if the unit is an integral part or not
P_{efan}	Proportional electrical power consumption of the blower for the external pressure drop in [W] (only if $\Delta p_K > 25$ Pa), excluded or included depending on if the unit is an integral part or not
P_E	Electrical power consumption of all additional mechanisms in [W]
E_{el}	Electrical energy consumed during the test in [J]
$t_{duration}$	Test duration in [s]
n	Number of measuring intervals
Δt	Duration of a measuring interval in [s]
q_w	Volume flow from the heat transfer medium on the warm side in [m ³ /s]
q_c	Volume flow from the heat transfer medium on the cool side in [m ³ /s]
Δp	Static pressure drop in the heat exchanger via the heat pump in [Pa]
Δp_{fan}	Maximum external static pressure drop for heat pumps with duct/channel interface in [Pa]
η_p	Efficiency of the circulating pump = 0.3 (as given in EN 14511)
η_{fan}	Efficiency of the fan = 0.3 (as given in EN 14511)

Determining the Coefficient of Performance (COP)

The COP (coefficient of performance) corresponds to the ratio of the heat output to the electrical power consumption as measured or calculated in the output test.

COP values must be determined with an **accuracy of two decimal places**.

Calculate the average COP as follows:

$$COP_{HP} = \frac{Q_{HP}}{E_{el}} \quad [-] \quad (9)$$

Definitions:

COP_{HP}	Coefficient of performance for the heat pump
Q_{HP}	Heat energy given off during the test in [J]
E_{el}	Electrical energy used during the test in [J]

Calculation of relative defrost time

Calculate the relative defrost time as follows:

$$\tau_{rel} = \frac{\tau_D}{(\tau_H + \tau_D)} \cdot 100 \quad [\%] \quad (10)$$

Definitions:

τ_{rel}	Relative defrost time in %
τ_D	Interval D, defrosting + 10 minutes of reheating in [h]
τ_H	Interval H, heating period in [h]