EHPA-DACH Testing Regulation

Testing of Water/Water and Brine/Water Heat Pumps

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

Supplemental requirements for obtaining the international quality label for heat pumps

Version 1.2
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Contents

1 Introduction

The test conditions and testing method described in this regulation are based on the European standard EN 14511, Parts 1 through 4, Version 2004 and the additional standards and guidelines referenced therein. Anything not defined in this regulation should be proceeded regarding EN 14511.

By testing a heat pump according to these regulation and by fulfilling the corresponding requirement in the quality seal regulation, the EHPA-DACH Quality Label Commission can grant the International Heat Pump Quality Seal.

This regulation has been adopted by the EHPA-DACH Quality Label Commission, changes of this regulation must also be approved by the Commission.

2 Purpose

The purpose of this testing regulation is to specify the scope of the test, the testing conditions and the test method for testing electrically driven water/water and brine/water heat pumps.

3 Scope of application

This test program applies to the testing of electrically driven water/water and brine/water heat pumps under the testing conditions specified in chapter 5. In order to attain the international quality label, the test specimen must be a heat pump manufactured in series production.

3.1 Scope of the test

The scope of the test comprises:
a) A performance test for different standardized points according to EN 14511 Parts 2 & 3 and other points according to this regulation (see chapter 6)
b) The testing of the usage limits as defined by the manufacturer (see chapter 7)
c) A safety test (see chapter 8)
d) A sound measurement according to EN 12102 (see chapter 9)
e) The testing of the electrical characteristic values (see chapter 10)

3.2 Testing method

3.2.1 Performance testing

The performance testing is performed under constant ambient conditions, i.e., during the test, the set conditions remain constant from the source and user sides. This is used to determine the heat output and the electrical power consumed, from which the performance figure for the heat pump is calculated.

3.2.2 Testing the warranted usage limits

The test of the warranted usage limt[1] is performed on the vertices (max. 6 vertices, see Figure 1) of the usage range specified by the manufacturer. This is the range within which the heating system planner may use the device and within which the full manufacturer's warranty applies. In essence, this involves testing whether the test object can be operated at the planned usage limit over a longer period of time.

[1] The usage limt is specified by the manufacturer.

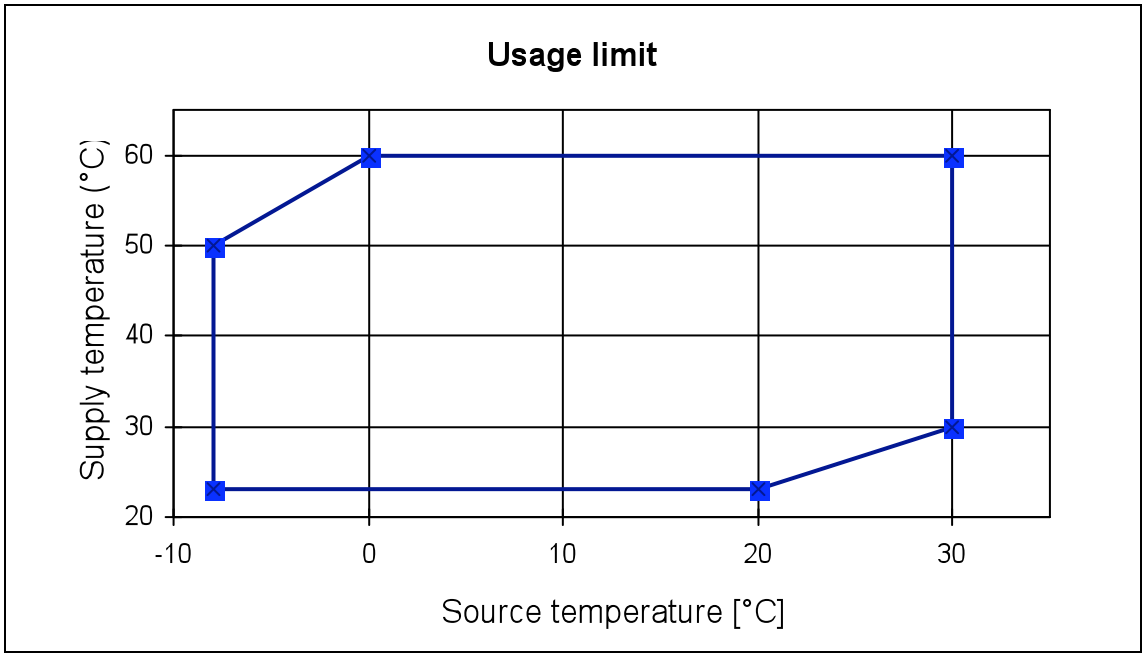

Figure 1: Example of the usage limit defined by the manufacturer

3.2.3 Allowable measurement inaccuracy of the measuring equipment

Measurement variables	Unit	Measuring inaccuracy (+/-) of the cited values
Water/brine		
- Temperature	°C	0.1 K
- Volume flow	m^3/s	1%
- Static pressure difference	Pa	5%
- Heat transfer medium concentration	%	2%
Electrical power	W	1%
Voltage	V	0.5%
Current	A	0.5%
Electrical work	kWh	1%
The heat output determined by the water side must be determined such that there is a maximum 5% measurement inaccuracy, regardless of the individual measurement inaccuracies.		

Table 1: Measurement inaccuracy (+/-) of the cited values according to EN 14511-3 Section 4.3

3.2.4 Safety Test

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

4 Terms and definitions

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

4.1 Heat source system (HSS)

A heat source system is defined as an equipment for extracting heat from a heat source and transporting the heat transfer medium between the heat source and the cooler side of the heat pump, including all of the additional equipment. Heat sources are materials from which heat can be extracted.

4.2 Heat usage system (HUS)

A heat usage system (area heating, wash water, pool, etc.) consists of the equipment to transport the heat from the warm side of the heat pump to the heat consumers, including all of the additional equipment.

4.3 Thermal heat

Usable heat that is output by the heat pump on the warm side to the heat transfer medium during heating operation within a specific timeframe.

4.4 Heat capacity

The heat output is the usable *heat flow* from the heat pump to the heat transfer medium on the warm side. It is the quotient from the thermal heat produced in a period of time.

4.5 Power demand of the heat source system

It's the electrical power demand of the heat source system during continuous operation for operating the heat source system, including all of the control, regulation and safety equipment. Only the fraction needed for transporting the heat source medium within the heat pump is included according the standard EN 14511.

4.6 Power demand of the heat usage system

It's the electrical power demand of the heat usage system during continuous operation for operating the heat source system, including all of the control, regulation and safety equipment. Only the fraction needed for transporting the medium within the heat pump is included according the standard EN 14511.

4.7 Warranted usage range

A working range for the heat pump specified by the manufacturer, limited by a maximum six vertices within which the heat pump is deemed usable, to have functioned error-free, to have met the warranted characteristics and for which the manufacturer's warranty applies.

4.8 Safety range

Range outside the warranted usage range in which the heat pump does not need to function any longer. The safety features must be able to engage, however, before the heat pump is damaged.

4.9 Acoustic power level

Ten times the logarithm for the base 10 of the ratio of the existing sound level for the reference acoustic power, given in decibels. The reference acoustic power is 1 pW (=10^{-12}W).

5 Test conditions

5.1 Ambient conditions and electrical connection data

The ambient conditions and the electrical connection data for the performance and functional inspection are listed in Table 2.

Model:	Measurement variable:	Limit values:
Water-water resp. brine-water heat pumps	Ambient temperature	15 to 30 °C
	Electrical voltage	+/- 4% rated voltage[1]
[1] Manufacturer's information		

Table 2: Ambient conditions and electrical connection data

5.2 Test conditions for the performance testing

Test conditions / testing points water/water heat pumps:

Test condit.	Standard	Type[1]	HSS		HUS	
			T.in (°C)	T.out (°C)	Tout (°C)	Tin (°C)
W10/W35[2]	**EN 14511-2**	**QL**	**10**	**7**	**35**	**30**
W10/W35-25	DACH-EHPA	N	10	7	35	25
W10/W45	EN 14511-2	N	10	a	45	a
W15/W45	EN 14511-2	B	15	a	45	a
W10/W55	EN 14511-2	B	10	a	55	a
W15/W55	DACH-EHPA	B	15	a	55	a

[1] Type name: N -> standard rated point, B -> operating rated point, QL -> Quality Label

[2] For the EHPA-DACH Quality Label relevant test condition

a The test is conducted with the volume flows indicated for W10/W35

Table 3a: Rated points for power testing of water/water heat pumps

Test conditions / testing points brine/water heat pumps:

Test condit.	Standard	Type[1]	HSS		HUS	
			T.in (°C)	T.out (°C)	T.out (°C)	Tin. (°C)
B0/W35[2]	**EN 14511-2**	**QL**	**0**	**-3**	**35**	**30**
B0/W35-25	DACH-EHPA	N	0	-3	35	25
B5/W35	EN 14511-2	B	5	a	35	a
B0/W45	EN 14511-2	N	0	a	45	a
B5/W45	EN 14511-2	B	5	a	45	a
B-5/W45	EN 14511-2	B	-5	a	45	a
B0/W55	EN 14511-2	B	0	a	55	a
B5/W55	DACH-EHPA	B	5	a	55	a

[1] Type name: N -> standard rated point, B -> operating rated point, QL -> Quality Label

[2] For the EHPA-DACH Quality Label relevant test condition

a The test is conducted with the volume flows indicated for B0/W35

Table 3b: Rated points for power testing of brine/water heat pumps

5.3 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.

For this the heat pump is installed on the test facility of the test center. Then the refrigeration cycle is evacuated and filled up with the specified type and quantity of refrigerant. Heat pump start-up shall be performed by a manufacturer's representative.

In any case, the heat pump unit has to be delivered filled with nitrogen and shall be charged with refrigerant supplied by the test laboratory.

5.4 Requirements for the test facility

During the measurement the following deviations from the set values have to be achieved:

Measurement variable:	Max. permissible deviation (+/-) of arithmetic mean from target value	Max. permissible dev. individual measured values from target value
Water/brine:		
Entry temperature	0.2 K	0.5 K
Exit temperature	0.3 K	0.6 K
Volume flow	2%	5%
Electrical voltage	4%	4%

Table 4: Permissible deviations (+/-) from the desired values.

6 Performance testing

6.1 General

If other liquid heat transfer media besides water are used, the specific thermal capacity and density of the heat transfer medium must be determined and taken into account during the evaluation.

When testing brine/water heat pumps, a brine of 30% by vol. ethylene glycol is used, wherein the freezing point is set at -15 °C.

During the entire test it must be ensured that there is no dripping or draining of water apart from the provided drainage openings.

6.2 Performance measurement procedure

6.2.1 Steady-state condition

The outputs are measured in steady-state condition. This must be retained prior to beginning the measurements and is considered met and retained if all the measurement variables were held constant for at least 60 minutes without having to change the set values. The following measurement period lasts a minimum of 35 minutes.

Periodic fluctuations in the measured variables are permitted according to the technical regulations, if the mean values of the allowable deviations as per table 4 are not exceeded.

All of the necessary measured values registered at intervals of max. 30 seconds are registered for the output measurement during the whole test period.

6.3 Performance test with variable-output heat pumps

6.3.1 General

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

The measurements with partial load are taken with the source and drain volume flows determined from the full-load measurements found during continuous operation without shutting off the test specimens.

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

6.3.2 Heat pumps with gradual output variation

For the present, all output points listed in Table 3 are measured with the maximum heat output, i.e., measurements are taken at maximum output. For test point W10/W35 or B0/W35, an additional test is performed at the output level nearest to 50% of the rated heat output. The output data for the same output setting is also determined for both test points W10/W45 and W10/W55 as well as B0/W45 and B0/W55.

Other test points from Table 3 can be measured with the same output setting if desired by the applicant.

The output levels must be able to be adjusted manually during testing. This setting must not be able to be self-adjusting during the test.

6.3.3 Heat pumps with continuous output variation

All output points listed in Table 3 are measured with the maximum heat output. For test point W10/W35 or B0/W35, an additional test is performed at 50% of the rated heat output. The heat pump is set so that its output is 50% of the heat output measured at this test point with full load. The output data for the same output setting is also determined for both test points W10/W45 and W10/W55 as well as B0/W45 and B0/W55.

Other test points from Table 3 can also be measured if desired by the applicant. The settings dependent on output are retained from the 50% output measurement for W10/W35 and B0/W35, respectively.

The output level must be able to be set manually during testing. This setting must not be able to be self-adjusting during the test.

6.4 Analysis

6.4.1 Calculation of heat output

The heat output of the test object is calculated as follows:

$$\dot{Q}_{WP.mittel} = \frac{Q_{WP}}{t_{Prüfdauer}} \quad [W] \quad (1)$$

where:

$$Q_{WP} = \sum_{i=1}^{n-1} \frac{\dot{Q}_{WP.i} + \dot{Q}_{WP.i+1}}{2} \cdot \Delta t \quad [J] \quad (2)$$

Where:

$$\dot{Q}_{WP} = \dot{V}_W \cdot \rho_W(T_R) \cdot cp \cdot (T_V - T_R) \quad [W] \quad (3)$$

Definitions:

$\dot{Q}_{WP.mittel}$	Average heat output in [W]
Q_{WP}	Heat energy given off during the test in [J]
$\dot{Q}_{WP.i}$	Heat output for the i^{th} measurement in [W]
$\dot{Q}_{WP}$	Present heat output in [W]
$t_{Prüfdauer}$	Test duration in [s]
n	Number of measuring intervals
Δt	Duration of a measuring interval in [s]
$\dot{V}_W$	Volume flow from the heat transfer medium on the warm side in [m³/s]
$\rho_W(T_R)$	Density of the heat transfer medium at return temperature in [kg/m³]
cp	Specific heat capacity of the heat transfer medium J/(kg K)
T_V, T_R	Temperature of the heat transfer medium in (outflow and return, respectively) in [K]

The indices V and R correspond to flow and return, respectively.

6.4.2 Calculation of power consumption

The power consumption of the heat pump can be calculated from the power consumption of the compressor and all electrical mechanisms of the heat pump that function during heat mode.

The power consumption figures for the delivery apparatus of the heat pump are considered only to such an extent that they are required to overcome the internal static pressure differentials in the heat exchangers of the heat pump.

The power consumption of the heat pump is calculated as follows:

$$P_{WP.mittel} = \frac{E_{el}}{t_{Prüfdauer}} \quad [W] \quad (4)$$

where:

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

where:

$$P_{WP} = P_V + P_{UP.Quelle} + P_{UP.Nutzer} + P_E \qquad [W] \qquad (6)$$

And where:

$$P_{UP.Quelle/Nutzer} = \frac{\dot{V}_{W.Quelle/Nutzer} \cdot \Delta p_{Quelle/Nutzer}}{\eta_{UP}} \qquad [W] \qquad (7)$$

Definitions:

$P_{WP.mittel}$	Average electrical power consumption in [W]
P_{WP}	Electrical power consumption of the entire heat pump in [W]
$P_{WP.i}$	Electrical power consumption for the i^{th} measurement in [W]
P_V	Electrical power consumption of the compressor in [W]
P_{UP}	Proportional electrical power consumption of the circulating pump on the source and user side in [W]
P_E	Electrical power consumption of all additional mechanisms in [W]
E_{el}	Electrical energy consumed during the test in [J]
$t_{Prüfdauer}$	Test duration in [s]
n	Number of measuring intervals
Δt	Duration of a measuring interval in [s]
$\dot{V}_W$	Volume flow from the heat transfer medium on the cold or warm side in [m³/s]
Δp	Static pressure drop (source, respective user) via the heat pump in [Pa]
η_{UP}	Efficiency of the circulating pump = 0.3 per EN 14511-3 chapter. 4.1.6

6.4.3 Determining the Coefficient Of Performance (COP)

The COP (coefficient of performance) corresponds to the quotient of the heat output and effective electrical power consumption as measured or calculated in the output test. The average COP is determined by dividing the thermal heat gained during the test by the corresponding electrical work consumed.

The average COP is calculated as follows:

$$\varepsilon_{WP} = \frac{Q_{WP}}{E_{el}} \qquad [-] \qquad (8)$$

Definitions:

ε_{WP}	COP of the heat pump
Q_{WP}	Heat energy given off during the test in [J]
E_{el}	Electrical energy consumed during the test in [J]

7 Testing the usage limits

7.1 Purpose

The test at the vertices of the warranted usage range is intended to show whether the heat pump is fully functional and operable in the warranted usage range indicated by the manufacturer.

7.2 Test conditions

The definition of the vertices is explained in chapter 3.2.2. The values given by the manufacturer are set as target values for the source temperatures. The values given by the manufacturer are set as target values for the flow temperatures. The permissible deviations defined in Table 4 must be adhered to.

The source and drop side volume flows are set to the volume flows determined for the standard rated points W10/W35, respectively B0/W35. The ambient conditions according to Table 2 must also be met.

7.3 Test sequence

The test object must remain in operation under the specified operating conditions and at the rated volume flow for at least 60 minutes without any safety equipment being switched on. There must be no damage to the test specimen throughout the entire test.

8 Safety test

8.1 Purpose

The safety test checks if the safety devices respond correctly in case of operational malfunctions and protect the heat pump from damage. This test is carried out in addition to the tests according to EN 14511-4.

8.2 General

a) This test is performed at W10/W35, respectively B0/W35, under the conditions given in Table 3. If this test point cannot be started with the test object, the test must be performed at a different test point according to Table 3.
When starting the test points, the tolerance values per Table 4 must be met.

b) To check the safety devices of the heat pump, a series of operating states and malfunctions are simulated. Before and after each simulated state or malfunction, the test object must reach the steady-state condition of normal operation under the indicated test condition for the procedure.

c) The simulated malfunctions a) and b) must be maintained for at least 2 hours. The test object must not suffer any damage throughout the entire sequence of tests and must be fully functional after testing.

The test specimen must not switch on and off more than 4 times during the last 60 minutes of the test. If a safety device puts the test specimen permanently out of operation (locking malfunction), it is considered to have passed the test and the test is ended.

d) For the safety tests, those control devices on the heat pump that do not serve as overload protection or safety devices must be disabled. 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.)

8.3 Malfunctions to be simulated

a) Blocking the heat transfer medium flow of the heat source system (the circulation pump is switched off on the source side).

b) Blocking the heat transfer medium flow of the heat usage system (the circulating pump is switched off on the user side).

c) Complete power failure of at least 5 seconds. The test object must return to a stable operating state no later than 20 minutes after starting the compressor.

9 Sound measurement

For the sound measurement the heat pump is operated at test point W10/W35 resp. B0/W35 according to table 3. For set up see standard EN 12102. The sound level is to be measured 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)

10 Test of electrical characteristic values

The electrical characteristic values for the start and operation of each phase are recorded using a digital voltage analyzer. It is up to the individual heat pump manufacturers whether to equip their machines with soft-start devices. Only the measured state is given in the test report.

This test is performed at the standard test points W10/W35 or B0/W35, respectively, according to Table 3.

In a combined test (water/water and brine/water heat test), the electrical characteristic values are only determined for the brine/water test.

11 Inspection of documentation provided by the manufacturer

11.1 Name plate

Each heat pump must have a name plate securely and permanently attached. It must be applied such that it is easily readable and accessible. It must include the following information:

- Manufacturer or supplier
- Type
- Serial or production number
- Coefficient of performance (COP) and heat output in kW with at least 3 significant figures for W10/W35 and / or B0/W35
- Type and filling weight of the refrigerant

12 Test Report

12.1 General

Three different supplementary test reports are worked out:

a) Test report stage 1:
This test report lists the essential information and the most important measured values for the respective machines. This test report serves mainly as the basis for general publications.

b) Test report stage 2:
This is a more detailed version of test report 1 and is used for the application of the EHPA-DACH Quality Label.

c) Test report stage 3:
This dossier contains all test documents. This test report is part of the test and is sent only to the manufacturer or potential testing customer.

The heat pump test centers only publish the test results if the customer has approved them for publication with an authorized signature.

12.2 Contents of the test reports

12.2.1 General information on the testing institute

- Date:
- Testing institute:
- Test site:
- Tester:
- Test number
- Test length

12.2.2 Machine-specific information

- Customer and manufacturer, if not identical to the customer
- Machine type, name, of the customer and manufacturer
- Serial number (if compressor serial no. not available) customer and possibly manufacturer
- Brief description of the design
- Refrigerant filling (type and quantity)
- Rated volume flow on user side with which the measurements were taken.
- Rated volume flow on source side with which the measurements were taken.
- Information on design, such as compressor type, heat exchanger type, expansion valve type, etc.
- Dimensions and weight of the heat pump

12.3 Test results

12.3.1 Output measurement

The stage 1 and stage 2 test reports contain a summary of the following points:
- Average heat output (chapter 6.4.1)
- Average electrical power consumption (chapter 6.4.2)
- COP (chapter 6.4.3)
- Hydraulic pressure drop in user system (stage 2 only)

12.3.2 Usage limits and safety Test

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

12.3.3 Electrical measurements

- Max. start current with or without soft start
- Output factor (average)

12.3.4 Sound measurement

For the sound measurement, the sound output level is given in dB(A) as well as the measurement precision (standard deviation in dB).