



TEST REPORT

39-17652/2/T

Product: Outdoor Air/Water Heat pump

Type designation: Tivano split 12kW

Customer: LARS Andrzej Szymański
ul. Świerkowa 14
64-320 Niepruszewo
POLAND
Company ID No.: 008271431

Manufacturer: LARS Andrzej Szymański
ul. Świerkowa 14
64-320 Niepruszewo
POLAND

Report issue date: 2025-01-13

Distribution list: 1x copy to the SZÚ, s.p.
1x copy to the Customer

I. Description of product tested

The Heat pump **Tivano split 12kW** supplied by the company **LARS Andrzej Szymański** is structurally adapted to operate in air/water system. Device is divided to the outdoor unit **TIVANO-12KW**, placed outside on a pedestal and an indoor unit **HYDRONIC-12KW**. Outdoor and indoor units are connected by copper piping and electrical wires. Refrigerant R32 is used with charge 3.1kg. Power supply is a one-phase. Heat pump is able to work in heating and cooling mode. Heat pump is working with variable flow rate.

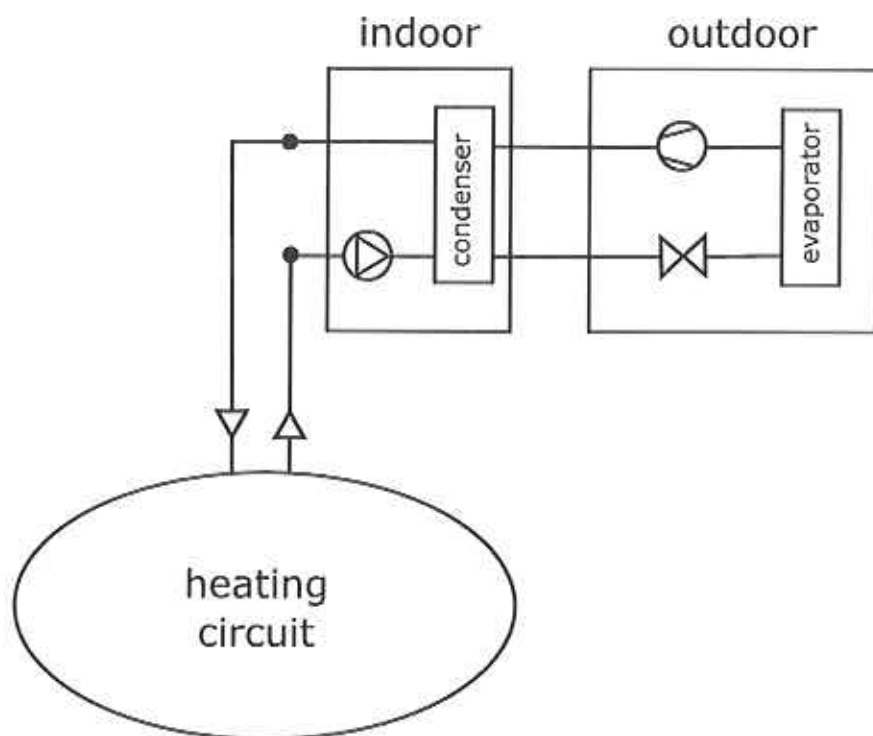
Main components of the outdoor unit **TIVANO-12KW:**

- Serial number SFF0WDNBMFK064000411
- Cuboid shape with dimensions 930 × 390 × 800 mm (W × D × H)
- Frame and casing made of varnished steel sheets
- Evaporator 3 rows:
 - I-shaped evaporator, 1 row, dimensions 580 × 20 × 770 mm (W × D × H), spacing 1.6 mm
 - L-shaped evaporator, 2 rows, dimensions 970 × 20 × 770 mm (W × D × H), spacing 1.6 mm
- Plate condenser GCHV Fin-tube-type
- Compressor GMCC EKTF310D43UMT
- Refrigerant R32 (3.1kg)
- Oil separator Heran
- Expansion valve Sanhua TS620C21
- 4-way reversing valve Dunan DSF-9AG
- Suction accumulator Dongguan Qingxin'an Refrigerator Fittings Co., Ltd
- Refrigerant accumulator
- Axial fan Ø550 mm Langdi
- Fan motor Lifeng
- Temperature sensor
- Refrigerant pipes

Main components of the indoor unit **HYDRONIC-12KW:**

- Serial number SFFRSDN8MFM086000481
- Cuboid shape with dimensions 490 × 340 × 910 mm (W × D × H)
- Frame and casing made of varnished steel
- Electric backup heater
- Circulation pump SHIMGE
- 3-way valve
- Expansion tank
- Display
- Control unit Lytran
- Regulation
- Temperature sensor
- Software GCHV
- Flow switch

Scheme:



Photodocumentation:



Heat pump Tivano split 12kW – outdoor unit
– Front view –



Heat pump Tivano split 12kW – outdoor unit
– Back view –



Heat pump Tivano split 12kW – outdoor unit
– Compressor label –



Heat pump Tivano split 12kW – outdoor unit
– Label –



Heat pump Tivano split 12kW – outdoor unit
– Without cover –



Heat pump Tivano split 12kW – indoor unit
– Label –



Heat pump Tivano split 12kW – indoor unit
– With cover –



Heat pump Tivano split 12kW – indoor unit
– Without cover –

II. Sample tested

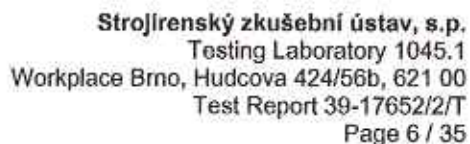
SZÚ reg. no.	Product name	Date of submission
1212.24.39716.001	Tivano split 12 kW	2024-03-20
1212.24.39717.001		2024-03-20

The visual inspection, tests and verification were carried out by Ing. Alexandr Jordanov at the test station of SZÚ, s.p.

The tests were performed using measuring and testing equipment with valid calibration.

III. Measuring and test equipment:

No.	Description	Inventory number
1.	Electrical energy meter	022370/1
2.	Digital watt meter	MaR01/EM01
3.	Flow meter Krohne Optiflux	022370/5
4.	Barometer	022370/7
5.	Differential pressure gauge	MaR01_TI
6.	Temperature-humidity meter HC2-IC305	022370/10
7.	Temperature-humidity meter HC2-IC305	022370/12
8.	Thermometers	022370/13



No.	Test objective	Requirement	Method of test	Documentation	Test evaluation/ verification *
1.	Rating conditions	-	ČSN EN 14511-2:2023 ČSN EN 14511-3:2023	Page No. 8	x
2.	Seasonal performance tests and SCOP calculation – Low temperature application	-	ČSN EN 14511-3:2023 ČSN EN 14825:2023	Page No. 9-15	x
3.	Seasonal performance tests and SCOP calculation – Medium temperature application	-	ČSN EN 14511-3:2023 ČSN EN 14825:2023	Page No. 16-22	x

*) Evaluation / statement of conformity:
+ Requirement fulfilled 0Not applicable
- Requirement not fulfilled x.....Not evaluated

Measured quantity	Unit	Uncertainty measurement	of	Evaluation
Liquid				
- temperature difference (dT)	[K]	$\pm 0.15 \text{ K}$		fulfilled
- temperature inlet/outlet	[°C]	$\pm 0.15 \text{ K}$		fulfilled
- volume flow	[m ³ /s]	$\pm 1 \%$		fulfilled
- static pressure difference	[kPa]	$\pm 1 \text{ kPa } (\Delta p \leq 20 \text{ kPa})$ or $\pm 5 \%$ ($\Delta p > 20 \text{ kPa}$)		fulfilled
Air				
- dry bulb temperature	[°C]	$\pm 0.2 \text{ K}$		fulfilled
- wet bulb temperature	[°C]	$\pm 0.4 \text{ K}$		fulfilled
- volume flow	[m ³ /s]	$\pm 5 \%$		not applied
- static pressure difference	[Pa]	$\pm 5 \text{ Pa } (\Delta p \leq 100 \text{ Pa})$ or $\pm 5 \%$ ($\Delta p > 100 \text{ Pa}$)		not applied
Refrigerant				
- pressure at compressor outlet	[kPa]	$\pm 1 \%$		not applied
- temperature	[°C]	$\pm 0.5 \text{ K}$		not applied
Concentration (in volume)				
- heat transfer medium	[%]	± 2		not related
Electrical quantities				
- electric power	[W]	$\pm 1 \%$		fulfilled
- voltage	[V]	$\pm 0.5 \%$		fulfilled
- current	[A]	$\pm 0.5 \%$		fulfilled
- electric energy	[kWh]	$\pm 1 \%$		not applied
Compressor rotational speed	[min ⁻¹]	$\pm 0.5 \%$		not applied
The heating or cooling capacities measured on the liquid side shall be determined within a maximum uncertainty of 5 % independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids.				fulfilled

Note:

The stated extended measurement uncertainties are calculated as a factor of the measurement uncertainty and the extension coefficient $k=2$, corresponding to the coverage certainty of 95% as regards standard classification.

If a statement of conformity is provided, the decision rule pursuant to ILAC-G8:09/2019, Art. 4.2.1 - binary statement for the simple acceptance rule shall apply.

Comment to abbreviated marking: e.g. A7/W35

A (air) 7 (input air, dry-bulb temperature in °C) / W (water), 35 (output heating water temperature in °C)

Test objective:	Rating conditions
Exact name of the test procedure:	1.37* - Tests of leakage, pressure resistance, thermal and technical parameters, combustion efficiency, safety functions
Test method:	ČSN EN 14511-2:2023, ČSN EN 14511-3:2023
Sample tested:	Heat pump Tivano split 12kW
Measuring equipment used:	see Chapter III

Specification of the assessment condition		A7/W35	A7/W55
Date of testing		2024-12-04	2024-12-04
Transient test procedure	YES / NO	NO	NO
Average defrost time of 1 cycle	[min]	–	–
Average time of 1 cycle	[min]	–	–
Calculation time	[min]	70.0	70.0
Output heating water – temperature calculation	[°C]	35.00	55.08
Input heating water – temperature calculation	[°C]	30.01	47.02
Output heating water temperature	[°C]	35.00	55.08
Input heating water temperature	[°C]	30.01	47.02
Air temperature – dry bulb temperature	[°C]	6.85	6.81
Air temperature – wet bulb temperature	[°C]	5.95	5.99
Relative humidity	[%]	88.02	89.03
Barometric pressure	[kPa]	99.477	99.271
Ambient temperature	[°C]	20.13	20.70
Secondary circuit pressure difference	[kPa]	42.811	78.797
Efficiency of the secondary liquid pump	[-]	0.318	0.318
Volume flow rate of heating water	[m ³ ·h ⁻¹]	2.0404	1.1041
Density of heating water	[kg·m ⁻³]	994.0	985.8
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.175	4.179
Voltage	[V]	230.98	230.55
Total current	[A]	13.04	19.11
Overall power input	[kW]	2.974	4.361
Capacity correction of sec. liquid pump	[W]	52.000	51.878
Power input correction of sec. liquid pump	[W]	76.26	76.04
Heating capacity – heating water	[kW]	11.729	10.218
Corrected heating capacity – heating water	[kW]	11.677	10.167
Uncertainty of corrected heating capacity	[kW]	± 0.200	± 0.109
Effective electric power input	[kW]	2.897	4.285
COP	[-]	4.030	2.373
Uncertainty of COP	[-]	± 0.069	± 0.026
Control settings	[Hz]	68	68
Circulation pump settings – heating water	[-]	3	3

Test objective:	Seasonal performance tests and SCOP calculation – Low temperature application
Exact name of the test procedure:	1.37* - Tests of leakage, pressure resistance, thermal and technical parameters, combustion efficiency, safety functions
Test method:	ČSN EN 14511-3:2023, ČSN EN 14825:2023
Sample tested:	Heat pump Tivano split 12kW
Measuring equipment used:	see Chapter III

Design			Air / water – split			
Conditions specification according to ČSN EN 14825:2023	Temperature application			Low (reference water temperature 35 °C)		
	Reference heating season			Average		
	Outlet water temperature - indoor heat exchanger			Variable		
	Compressor speed control			Variable		
	Air flow rate – primary circuit			Variable		
	Water flow rate – secondary circuit			Variable		
Seasonal space heating efficiency	Heating	Average	η_s		155.5	%
		Warmer	η_s		–	%
		Colder	η_s		–	%
Seasonal efficiency according to ČSN 14825:2023	Heating	Average	SCOP		3.96	–
		Warmer	SCOP		–	–
		Colder	SCOP		–	–
Function	Cooling			Yes		
	Heating	Yes	Reference heating season	Average	Yes	
				Warmer	–	
				Colder	–	
Full heating load	Cooling		$P_{designc}$	– kW		
	Heating	Average	$P_{designh}$	10.23 kW		
		Warmer	$P_{designh}$	– kW		
		Colder	$P_{designh}$	– kW		
Bivalent temperatures	Heating	Average	$T_{bivalent}$	-7 °C		
		Warmer	$T_{bivalent}$	– °C		
		Colder	$T_{bivalent}$	– °C		
Operation limit temperatures	Heating	Average	TOL	-10 °C		
		Warmer	TOL	– °C		
		Colder	TOL	– °C		
Seasonal power consumption according to ČSN EN 14825:2023	Cooling		Q_{cc}	– kWh		
	Heating	Average	Q_{he}	5333 kWh		
		Warmer	Q_{he}	– kWh		
		Colder	Q_{he}	– kWh		
Modes other than „active mode”		Off mode		P_{off}	7.3	W
		Thermostat off mode		P_{to}	31.4	W
		Standby mode		P_{sb}	7.3	W
		Crankcase heater mode		P_{ck}	0.2	W

Calculation of SCOP according to ČSN EN 14825:2023:

Number of hours used for calculation of reference SCOP (Annex B – Table B. 2, B. 3)

- For reversible heat pumps and reference heating season „A” = average

H _{HE}	2066	[h]
H _{TO}	178	[h]
H _{SB}	0	[h]
H _{CK}	178	[h]
H _{OFF}	0	[h]

Measured data:

P _{TO}	0.0314	[kW]
P _{SB}	0.0073	[kW]
P _{CK}	0.0002	[kW]
P _{OFF}	0.0073	[kW]
P _{designh}	10.23	[kW]
SCOP _{ON}	3.97	[-]

Coefficient and correction:

F(1)	3	[%]
F(2)	0	[%]
CC	2.5	[-]

Calculation of SCOP:

7.3 Calculation of the reference annual heating demand (Q_H)

$$Q_H = P_{designh} \cdot H_{HE} \quad [kWh]$$

$$Q_H = 10.23 \cdot 2066 = 21127 \quad [kWh]$$

7.4 Calculation of the annual electricity consumption (Q_{HE})

$$Q_{HE} = Q_H / SCOP_{ON} + H_{TO} \cdot P_{TO} + H_{SB} \cdot P_{SB} + H_{CK} \cdot P_{CK} + H_{OFF} \cdot P_{OFF} \quad [kWh]$$

$$Q_{HE} = 21127 / 3.97 + 178 \cdot 0.0314 + 0 \cdot 0.0073 + 178 \cdot 0.0002 + 0 \cdot 0.0073 = 5333 \quad [kWh]$$

7.2 General formula for calculation of reference SCOP

$$SCOP = Q_H / Q_{HE} \quad [-]$$

$$SCOP = 21127 / 5333 = 3.96 \quad [-]$$

7.1 Calculation of the seasonal space heating efficiency η_s

$$\Sigma F(i) = F(1) + F(2) \quad [-]$$

$$\Sigma F = 0.03 + 0 = 0.03 \quad [-]$$

$$\eta_s = 1 / CC \cdot SCOP - \Sigma F(i) \quad [-]$$

$$\eta_s (A) = (1 / 2.5) \cdot 3.96 - 0.03 = \underline{\underline{1.555}} \quad [-]$$

Temperature level		Low (reference water temperature 35 °C)		
Reference heating season		„A“ = average ($T_{designh} = -10\text{ °C}$)		
Assessment condition		A, T _{biv} (F)	B	C
Specification of the assessment condition		A-7/W34	A2/W30	A7/W27
Date of testing		2024-12-03	2024-12-12	2024-12-12
Transient test procedure	YES / NO	YES	YES	NO
Average defrost time of 1 cycle	[min]	4.3	3.7	–
Average time of 1 cycle	[min]	145.4	123.8	–
Calculation time	[min]	145.4	123.8	70.0
Output heating water – temperature calculation	[°C]	33.69	29.60	27.04
Input heating water – temperature calculation	[°C]	28.95	24.95	22.27
Output heating water temperature	[°C]	34.09	30.03	27.04
Input heating water temperature	[°C]	29.10	25.03	22.27
Air temperature – dry bulb temperature	[°C]	-7.17	1.90	6.87
Air temperature – wet bulb temperature	[°C]	-8.12	0.96	5.94
Relative humidity	[%]	76.05	84.66	87.57
Barometric pressure	[kPa]	98.755	99.822	99.775
Ambient temperature	[°C]	20.62	19.72	19.61
Secondary circuit pressure difference	[kPa]	57.280	78.607	83.207
Efficiency of the secondary liquid pump	[-]	0.326	0.316	0.271
Volume flow rate of heating water	[m ³ ·h ⁻¹]	1.6640	1.0822	0.6495
Density of heating water	[kg·m ⁻³]	994.4	995.6	996.4
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.175	4.176	4.177
Voltage	[V]	230.66	230.70	230.85
Total current	[A]	16.13	7.16	3.73
Overall power input	[kW]	3.678	1.576	0.701
Capacity correction of sec. liquid pump	[W]	54.687	51.180	40.427
Power input correction of sec. liquid pump	[W]	81.14	74.78	55.44
Heating capacity – heating water	[kW]	9.101	5.699	3.574
Corrected heating capacity – heating water	[kW]	9.046	5.648	3.534
Uncertainty of corrected heating capacity	[kW]	± 0.164	± 0.107	± 0.064
Effective electric power input	[kW]	3.597	1.502	0.646
COP	[-]	2.515	3.762	5.473
Uncertainty of COP	[-]	± 0.046	± 0.072	± 0.107
Control settings	[Hz]	82	39	22
Circulation pump settings – heating water	[-]	3	3	3

Temperature level		Low (reference water temperature 35 °C)	
Reference heating season		„A“ = average ($T_{designh} = -10\text{ °C}$)	
Assessment condition		D	TOL (E)
Specification of the assessment condition		A12/W26.06	A-10/W35
Date of testing		2024-12-13	2024-12-17
Transient test procedure	YES / NO	NO	YES
Average defrost time of 1 cycle	[min]	–	4.4
Average time of 1 cycle	[min]	–	135.9
Calculation time	[min]	70.0	135.9
Output heating water – temperature calculation	[°C]	26.10	34.71
Input heating water – temperature calculation	[°C]	22.47	29.94
Output heating water temperature	[°C]	26.10	35.02
Input heating water temperature	[°C]	22.47	30.01
Air temperature – dry bulb temperature	[°C]	11.91	-10.26
Air temperature – wet bulb temperature	[°C]	10.87	-11.16
Relative humidity	[%]	88.48	72.10
Barometric pressure	[kPa]	99.905	99.461
Ambient temperature	[°C]	19.91	19.80
Secondary circuit pressure difference	[kPa]	83.093	61.924
Efficiency of the secondary liquid pump	[–]	0.270	0.331
Volume flow rate of heating water	[m ³ ·h ⁻¹]	0.6479	1.6247
Density of heating water	[kg·m ⁻³]	996.6	994.0
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.177	4.175
Voltage	[V]	230.92	230.73
Total current	[A]	2.78	17.56
Overall power input	[kW]	0.474	3.999
Capacity correction of sec. liquid pump	[W]	40.344	56.382
Power input correction of sec. liquid pump	[W]	55.30	84.21
Heating capacity – heating water	[kW]	2.711	9.008
Corrected heating capacity – heating water	[kW]	2.671	8.951
Uncertainty of corrected heating capacity	[kW]	± 0.064	± 0.160
Effective electric power input	[kW]	0.418	3.915
COP	[–]	6.384	2.287
Uncertainty of COP	[–]	± 0.167	± 0.041
Control settings	[Hz]	17	90
Circulation pump settings – heating water	[–]	3	3

Data for SCOP calculation

- Low temperature application (reference water temperature 35 °C)
- Reference heating season „A” – average

	Outdoor heat exchanger	Indoor heat exchanger	Part load ratio	Part load	DC Declared capacity	COPd at declared capacity	Cdh degradation coefficient	CR	COPbin (Tj)	Eff. power input of compressor off state
	Outdoor air inlet	Outlet water temperature								
	[°C]	[°C]	[%]	[kW]	[kW]	[-]	[-]	[-]	[-]	[kW]
A	-7	34.00	88.46	9.05	9.046	2.515	0.900	1.00	2.515	–
B	2	30.00	53.85	5.51	5.648	3.762	0.900	1.00	3.762	–
C	7	27.00	34.62	3.54	3.534	5.473	0.900	1.00	5.473	–
D	12	26.06	15.38	1.57	2.671	6.384	0.925	0.59	6.066	0.0314
TOL (E)	-10	35.00	100.00	10.23	8.951	2.287	0.900	1.00	2.287	–
Tbiv (F)	-7	34.00	88.46	9.05	9.046	2.515	0.900	1.00	2.515	–

Adaption of water temperature – according to ČSN EN 14825:2023, Annex E

- Low temperature application (reference water temperature 35 °C)
- Reference season „A” – average
- Condition D
- Variable water flow rate – secondary circuit

General formulas and derivation:

$$\begin{aligned}
 t_{\text{outlet, average}} &= t_{\text{inlet, capacity test}} + (t_{\text{outlet, capacity test}} - t_{\text{inlet, capacity test}}) \cdot CR & [^{\circ}\text{C}] \\
 t_{\text{outlet, average}} &= t_{\text{inlet, capacity test}} + (\Delta t) \cdot CR & [^{\circ}\text{C}] \\
 t_{\text{outlet, average}} &= t_{\text{outlet, capacity test}} - \Delta t + \Delta t \cdot CR & [^{\circ}\text{C}] \\
 t_{\text{outlet, capacity test}} &= t_{\text{outlet, average}} + \Delta t - \Delta t \cdot CR & [^{\circ}\text{C}]
 \end{aligned}$$

For variable flow:

$$\Delta t = 5$$

$$CR \cdot \Delta t = \text{Part load} / \text{Declared capacity} \cdot 5$$

$$t_{\text{outlet, capacity test, variable flow}} = t_{\text{outlet, average}} + 5 - \text{Part load} / \text{Declared capacity} \cdot 5$$

Measured data:

$t_{\text{outlet, average}}$	24.00	[°C]
Declared capacity	2.671	[kW]
Declared capacity standard rating condition A7/W35	–	[kW]
Part load	1.57	[kW]

Calculation of water temperature

$$t_{\text{outlet, capacity test, variable flow}} = 24 + 5 - 1.57 / 2.671 \cdot 5 = \underline{\underline{26.06}} \quad [^{\circ}\text{C}]$$

Calculation SCOP, SCOP_{on}, SCOP_{net}

- Low temperature application (reference water temperature 35 °C)

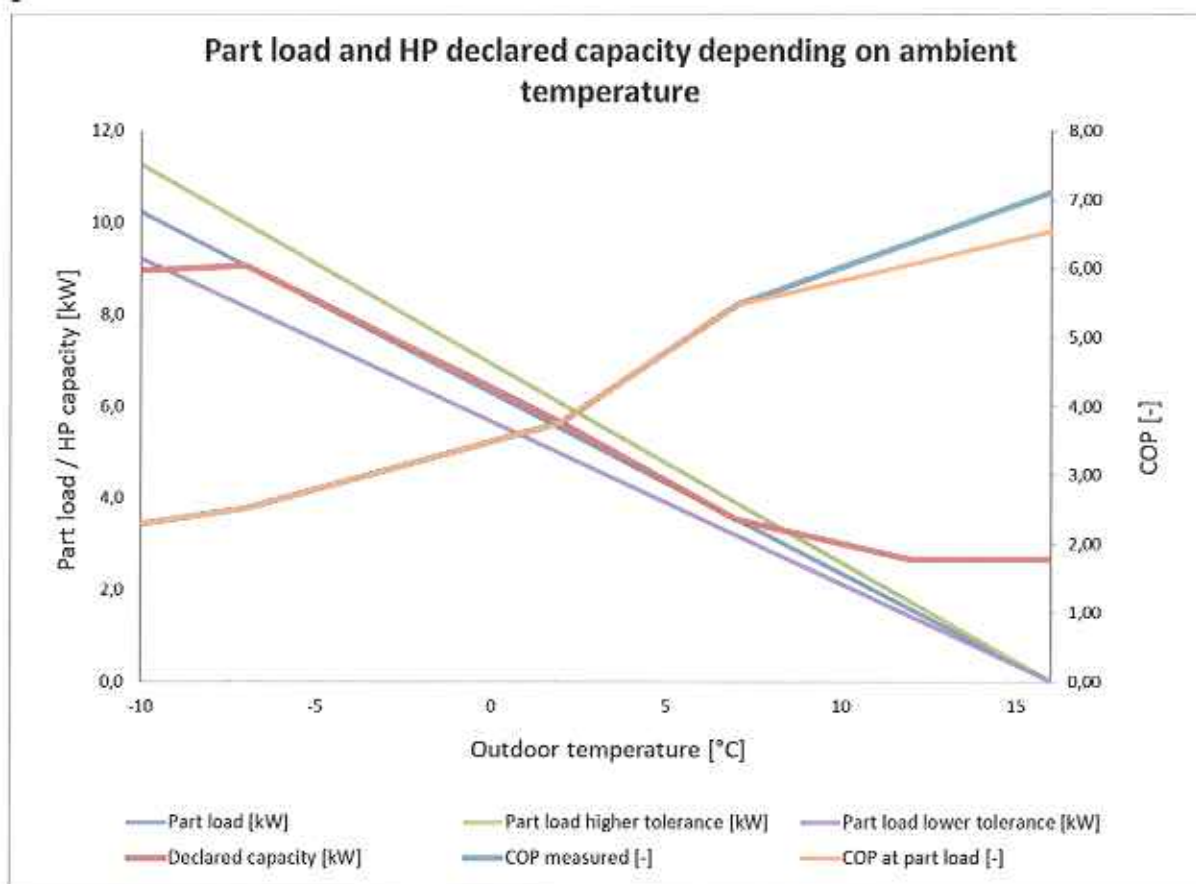
- Reference heating season „A“ – average

	Bin	Outdoor temp. (dry bulb)	Hours	Part load ratio	Heat load	Capacity of HP	Heat load covered by heat pump	Resistive heat elbu (Tj)	Annual resistive heat	COPbin (Tj)	Annual heating demand	Annual power input including electric back up heating	Net annual heating capacity	Net annual power input without electric back up heating
	J	Tj	h		Ph(Tj)			elbu(Tj)	h _j x elbu(Tj)	COP _b In (Tj)	h _j x P _h (Tj)		h _j x (P _h (Tj) + elbu(Tj))	
	[-]	[°C]	[h]	[%]	[kW]	[kW]	[kW]	[kW]	[kWh]	[-]	[kWh]	[kWh]	[kWh]	[kWh]
TOL(E)	21	-10	1	100.00	10.23	8.95	8.95	1.27	1.27	2.29	10	5	9	4
	22	-9	25	96.15	9.83	8.98	8.98	0.85	21.25	2.36	246	116	225	95
	23	-8	23	92.31	9.44	9.01	9.01	0.42	9.77	2.44	217	95	207	85
A, Tblv(F)	24	-7	24	88.46	9.05	9.05	9.05	0.00	0.00	2.52	217	86	217	86
	25	-6	27	84.62	8.65	8.67	8.65	0.00	0.00	2.85	234	88	234	88
	26	-5	68	80.77	8.26	8.29	8.26	0.00	0.00	2.79	562	201	562	201
	27	-4	91	76.92	7.87	7.91	7.87	0.00	0.00	2.93	716	244	716	244
	28	-3	89	73.08	7.47	7.54	7.47	0.00	0.00	3.07	665	217	665	217
	29	-2	165	69.23	7.08	7.16	7.08	0.00	0.00	3.21	1168	364	1168	364
	30	-1	173	65.38	6.69	6.78	6.69	0.00	0.00	3.35	1157	346	1157	346
	31	0	240	61.54	6.29	6.40	6.29	0.00	0.00	3.48	1510	433	1510	433
	32	1	280	57.69	5.90	6.03	5.90	0.00	0.00	3.62	1652	456	1652	456
B	33	2	320	53.85	5.51	5.65	5.51	0.00	0.00	3.76	1762	468	1762	468
	34	3	357	50.00	5.11	5.23	5.11	0.00	0.00	4.10	1825	445	1825	445
	35	4	358	46.15	4.72	4.80	4.72	0.00	0.00	4.45	1680	378	1680	378
	36	5	303	42.31	4.33	4.38	4.33	0.00	0.00	4.79	1311	274	1311	274
	37	6	330	38.46	3.93	3.96	3.93	0.00	0.00	5.13	1298	253	1298	253
C	38	7	326	34.62	3.54	3.53	3.53	0.00	0.00	5.47	1154	211	1154	211
	39	8	348	30.77	3.15	3.36	3.15	0.00	0.00	5.59	1095	196	1095	196
	40	9	335	26.92	2.75	3.19	2.75	0.00	0.00	5.71	922	162	922	162
	41	10	315	23.08	2.36	3.02	2.36	0.00	0.00	5.83	743	128	743	128
	42	11	215	19.23	1.97	2.84	1.97	0.00	0.00	5.95	423	71	423	71
D	43	12	169	15.38	1.57	2.67	1.57	0.00	0.00	6.07	266	44	266	44
	44	13	151	11.54	1.18	2.50	1.18	0.00	0.00	6.18	178	29	178	29
	45	14	105	7.69	0.79	2.33	0.79	0.00	0.00	6.30	83	13	83	13
	46	15	74	3.85	0.39	2.15	0.39	0.00	0.00	6.42	29	5	29	5
	Σ		4910							Σ	21123	5327	21091	5294

SCOPon	3.97	SCOPnet	3.98
		SCOP	3.96

Part load performance diagram

- Low temperature application (reference water temperature 35 °C)
- Reference heating season „A” – average



Test objective:	Seasonal performance tests and SCOP calculation – Medium temperature application
Exact name of the test procedure:	1.37* - Tests of leakage, pressure resistance, thermal and technical parameters, combustion efficiency, safety functions
Test method:	ČSN EN 14511-3:2023, ČSN EN 14825:2023
Sample tested:	Heat pump Tivano split 12kW
Measuring equipment used:	see Chapter III

Design			Air / water – split				
Conditions specification according to ČSN 14825:2023	to EN	Temperature application			Medium (reference water temperature 55 °C)		
		Reference heating season			Average		
		Outlet water temperature - indoor heat exchanger			Variable		
		Compressor speed control			Variable		
		Air flow rate – primary circuit			Variable		
		Water flow rate – secondary circuit			Variable		
Seasonal space heating efficiency	Heating	Average	η_s		114.3	%	
		Warmer	η_s		–	%	
		Colder	η_s		–	%	
Seasonal efficiency according to ČSN 14825:2023	Heating	Average	SCOP		2.93	–	
		Warmer	SCOP		–	–	
		Colder	SCOP		–	–	
Function	Cooling				Yes		
	Heating	Yes	Reference heating season	Average	Yes		
				Warmer	–		
				Colder	–		
Full heating load	Cooling		$P_{designc}$		–	kW	
	Heating	Average	$P_{designh}$		9.66	kW	
		Warmer	$P_{designh}$		–	kW	
		Colder	$P_{designh}$		–	kW	
Bivalent temperatures	Heating	Average	$T_{bivalent}$		-7	°C	
		Warmer	$T_{bivalent}$		–	°C	
		Colder	$T_{bivalent}$		–	°C	
Operation limit temperatures	Heating	Average	TOL		-10	°C	
		Warmer	TOL		–	°C	
		Colder	TOL		–	°C	
Seasonal power consumption according to ČSN EN 14825:2023	to	Cooling		Q_{CE}		–	kWh
		Heating	Average	Q_{HE}		6807	kWh
			Warmer	Q_{HE}		–	kWh
			Colder	Q_{HE}		–	kWh
Modes other than „active mode“		Off mode			P_{OFF}	7.3	W
		Thermostat off mode			P_{TO}	31.4	W
		Standby mode			P_{SB}	7.3	W
		Crankcase heater mode			P_{CK}	0.2	W

Calculation of SCOP according to ČSN EN 14825:2023:

Number of hours used for calculation of reference SCOP (Annex B – Table B. 2, B. 3)

- For reversible heat pumps and reference heating season „A” = average

H _{HE}	2066	[h]
H _{TO}	178	[h]
H _{SB}	0	[h]
H _{CK}	178	[h]
H _{OFF}	0	[h]

Measured data:

P _{TO}	0.0314	[kW]
P _{SB}	0.0073	[kW]
P _{CK}	0.0002	[kW]
P _{OFF}	0.0073	[kW]
P _{designh}	9.66	[kW]
SCOP _{ON}	2.94	[-]

Coefficient and correction:

F(1)	3	[%]
F(2)	0	[%]
CC	2.5	[-]

Calculation of SCOP:

7.3 Calculation of the reference annual heating demand (Q_H)

$$Q_H = P_{designh} \cdot H_{HE} \quad [kWh]$$

$$Q_H = 9.66 \cdot 2066 = 19964 \quad [kWh]$$

7.4 Calculation of the annual electricity consumption (Q_{HE})

$$Q_{HE} = Q_H / SCOP_{ON} + H_{TO} \cdot P_{TO} + H_{SB} \cdot P_{SB} + H_{CK} \cdot P_{CK} + H_{OFF} \cdot P_{OFF} \quad [kWh]$$

$$Q_{HE} = 19964 / 2.94 + 178 \cdot 0.0314 + 0 \cdot 0.0073 + 178 \cdot 0.0002 + 0 \cdot 0.0073 = 6807 \quad [kWh]$$

7.2 General formula for calculation of reference SCOP

$$SCOP = Q_H / Q_{HE} \quad [-]$$

$$SCOP = 19964 / 6807 = 2.93 \quad [-]$$

7.1 Calculation of the seasonal space heating efficiency η_s

$$\Sigma F(i) = F(1) + F(2) \quad [-]$$

$$\Sigma F = 0.03 + 0 = 0.03 \quad [-]$$

$$\eta_s = 1 / CC \cdot SCOP - \Sigma F(i) \quad [-]$$

$$\eta_s (A) = (1 / 2.5) \cdot 2.93 - 0.03 = \underline{1.143} \quad [-]$$

Temperature level		Medium (reference water temperature 55 °C)		
Reference heating season		„A“ = average ($T_{designh} = -10\text{ °C}$)		
Assessment condition		A, Tblv (F)	B	C
Specification of the assessment condition		A-7/W52	A2/W42	A7/W36
Date of testing		2024-12-05	2024-12-11	2024-12-11
Transient test procedure	YES / NO	NO	YES	NO
Average defrost time of 1 cycle	[min]	–	3.9	–
Average time of 1 cycle	[min]	–	123.9	–
Calculation time	[min]	70.0	123.9	70.0
Output heating water – temperature calculation	[°C]	51.98	41.35	36.00
Input heating water – temperature calculation	[°C]	43.98	33.93	31.39
Output heating water temperature	[°C]	51.98	41.94	36.00
Input heating water temperature	[°C]	43.98	33.97	31.39
Air temperature – dry bulb temperature	[°C]	-7.22	1.86	6.89
Air temperature – wet bulb temperature	[°C]	-8.16	0.88	5.90
Relative humidity	[%]	76.11	83.87	86.77
Barometric pressure	[kPa]	99.195	99.523	99.527
Ambient temperature	[°C]	19.90	19.50	19.91
Secondary circuit pressure difference	[kPa]	80.699	83.033	83.100
Efficiency of the secondary liquid pump	[-]	0.304	0.272	0.271
Volume flow rate of heating water	[m ³ ·h ⁻¹]	0.9353	0.6603	0.6509
Density of heating water	[kg·m ⁻³]	987.2	991.7	993.6
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.178	4.176	4.175
Voltage	[V]	230.27	230.63	230.84
Total current	[A]	25.05	8.99	4.51
Overall power input	[kW]	4.627	2.011	0.920
Capacity correction of sec. liquid pump	[W]	47.930	40.705	40.440
Power input correction of sec. liquid pump	[W]	68.90	55.93	55.47
Heating capacity – heating water	[kW]	8.596	5.639	3.455
Corrected heating capacity – heating water	[kW]	8.548	5.598	3.415
Uncertainty of corrected heating capacity	[kW]	± 0.093	± 0.066	± 0.064
Effective electric power input	[kW]	4.558	1.955	0.864
COP	[-]	1.875	2.863	3.951
Uncertainty of COP	[-]	± 0.020	± 0.034	± 0.077
Control settings	[Hz]	80	42	22
Circulation pump settings – heating water	[-]	3	3	3

Temperature level		Medium (reference water temperature 55 °C)	
Reference heating season		„A“ = average ($T_{designh} = -10\text{ °C}$)	
Assessment condition		D	TOL (E)
Specification of the assessment condition		A12/W33.57	A-10/W55
Date of testing		2024-12-13	2024-12-17
Transient test procedure	YES / NO	NO	NO
Average defrost time of 1 cycle	[min]	–	–
Average time of 1 cycle	[min]	–	–
Calculation time	[min]	70.0	70.0
Output heating water – temperature calculation	[°C]	33.53	54.92
Input heating water – temperature calculation	[°C]	29.87	46.92
Output heating water temperature	[°C]	33.53	54.92
Input heating water temperature	[°C]	29.87	46.92
Air temperature – dry bulb temperature	[°C]	11.79	-10.11
Air temperature – wet bulb temperature	[°C]	10.76	-10.99
Relative humidity	[%]	88.52	73.00
Barometric pressure	[kPa]	100.020	99.560
Ambient temperature	[°C]	20.72	19.05
Secondary circuit pressure difference	[kPa]	83.108	82.003
Efficiency of the secondary liquid pump	[-]	0.270	0.287
Volume flow rate of heating water	[m ³ ·h ⁻¹]	0.6469	0.7751
Density of heating water	[kg·m ⁻³]	994.5	985.9
Specific heat capacity of heating water	[kJ·kg ⁻¹ ·K ⁻¹]	4.175	4.179
Voltage	[V]	230.80	230.43
Total current	[A]	3.78	24.37
Overall power input	[kW]	0.703	4.459
Capacity correction of sec. liquid pump	[W]	40.324	43.801
Power input correction of sec. liquid pump	[W]	55.26	61.46
Heating capacity – heating water	[kW]	2.728	7.124
Corrected heating capacity – heating water	[kW]	2.687	7.080
Uncertainty of corrected heating capacity	[kW]	± 0.064	± 0.077
Effective electric power input	[kW]	0.648	4.398
COP	[-]	4.150	1.610
Uncertainty of COP	[-]	± 0.102	± 0.018
Control settings	[Hz]	19	76
Circulation pump settings – heating water	[-]	3	3

Data for SCOP calculation

- Medium temperature application (reference water temperature 55 °C)
- Reference heating season „A“ – average

	Outdoor heat exchanger	Indoor heat exchanger	Part load ratio	Part load	DC Declared capacity	COP _d at declared capacity	C _{dh} degradation coefficient	CR	COP _{bin} (T _j)	Eff. power input of compressor off state
	Outdoor air inlet	Outlet water temperature								
	[°C]	[°C]	[%]	[kW]	[kW]	[-]	[-]	[-]	[-]	[kW]
A	-7	52.00	88.46	8.55	8.548	1.875	0.900	1.00	1.875	–
B	2	42.00	53.85	5.20	5.598	2.863	0.900	1.00	2.863	–
C	7	36.00	34.62	3.34	3.415	3.951	0.900	1.00	3.951	–
D	12	33.57	15.38	1.49	2.687	4.150	0.952	0.55	3.994	0.0314
TOL (E)	-10	55.00	100.00	9.66	7.080	1.610	0.900	1.00	1.610	–
T_{biv} (F)	-7	52.00	88.46	8.55	8.548	1.875	0.900	1.00	1.875	–

Adaption of water temperature – according to ČSN EN 14825:2023, Annex E

- Medium temperature application (reference water temperature 55 °C)
- Reference season „A“ – average
- Condition D
- Variable water flow rate – secondary circuit

General formulas and derivation:

$$\begin{aligned}
 t_{\text{outlet, average}} &= t_{\text{inlet, capacity test}} + (t_{\text{outlet, capacity test}} - t_{\text{inlet, capacity test}}) \cdot CR & [^{\circ}\text{C}] \\
 t_{\text{outlet, average}} &= t_{\text{inlet, capacity test}} + (\Delta t) \cdot CR & [^{\circ}\text{C}] \\
 t_{\text{outlet, average}} &= t_{\text{outlet, capacity test}} - \Delta t + \Delta t \cdot CR & [^{\circ}\text{C}] \\
 t_{\text{outlet, capacity test}} &= t_{\text{outlet, average}} + \Delta t - \Delta t \cdot CR & [^{\circ}\text{C}]
 \end{aligned}$$

For variable flow:

$$\Delta t = 8$$

$$CR \cdot \Delta t = \text{Part load} / \text{Declared capacity} \cdot 8$$

$$t_{\text{outlet, capacity test, variable flow}} = t_{\text{outlet, average}} + 8 - \text{Part load} / \text{Declared capacity} \cdot 8$$

Measured data:

$t_{\text{outlet, average}}$	30.00	[°C]
Declared capacity	2.687	[kW]
Declared capacity standard rating condition A7/W55	–	[kW]
Part load	1.49	[kW]

Calculation of water temperature

$$t_{\text{outlet, capacity test, variable flow}} = 30 + 8 - 1.49 / 2.687 \cdot 8 = \underline{\underline{33.57}} \quad [^{\circ}\text{C}]$$

Calculation SCOP, SCOP_{on}, SCOP_{net}

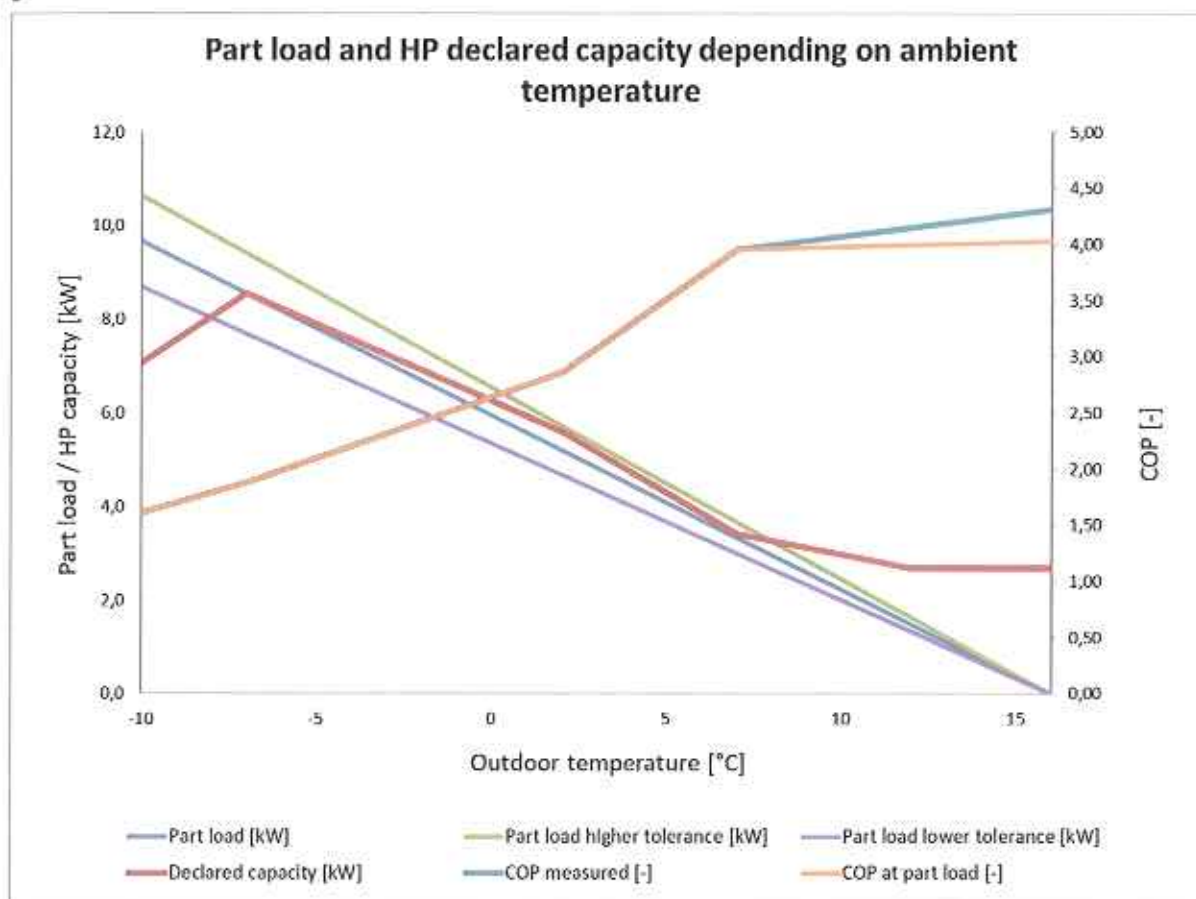
- Medium temperature application (reference water temperature 55 °C)
- Reference heating season „A“ – average

	Bin	Outdoor temp. (dry bulb)	Hours	Part load ratio	Heat load	Capacity of HP	Heat load covered by heat pump	Resistive heat elbu (Tj)	Annual resistive heat	COP _{bin} (Tj)	Annual heating demand	Annual power input including electric back up heating	Net annual heating capacity	Net annual power input without electric back up heating
	J	Tj	h		Ph(Tj)			elbu(Tj)	h _j x elbu(Tj)	COP _b In (Tj)	h _j x P h(Tj)		h _j x (P h(Tj) - elbu(Tj))	
	[-]	[°C]	[h]	[%]	[kW]	[kW]	[kW]	[kW]	[kWh]	[-]	[kWh]	[kWh]	[kWh]	[kWh]
TOL(E)	21	-10	1	100.00	9.66	7.08	7.08	2.58	2.58	1.61	10	7	7	4
	22	-9	25	96.15	9.29	7.57	7.57	1.72	43.05	1.70	232	154	189	111
	23	-8	23	92.31	8.92	8.06	8.06	0.86	19.80	1.79	205	124	185	104
A, Tblv(F)	24	-7	24	88.46	8.55	8.55	8.55	0.00	0.00	1.88	205	109	205	109
	25	-6	27	84.62	8.18	8.22	8.18	0.00	0.00	1.98	221	111	221	111
	26	-5	68	80.77	7.80	7.89	7.80	0.00	0.00	2.09	531	253	531	253
	27	-4	91	76.92	7.43	7.56	7.43	0.00	0.00	2.20	676	307	676	307
	28	-3	89	73.08	7.06	7.24	7.06	0.00	0.00	2.31	628	272	628	272
	29	-2	165	69.23	6.69	6.91	6.69	0.00	0.00	2.42	1104	455	1104	455
	30	-1	173	65.38	6.32	6.58	6.32	0.00	0.00	2.53	1093	431	1093	431
	31	0	240	61.54	5.95	6.25	5.95	0.00	0.00	2.64	1427	540	1427	540
	32	1	280	57.69	5.57	5.93	5.57	0.00	0.00	2.75	1561	567	1561	567
B	33	2	320	53.85	5.20	5.60	5.20	0.00	0.00	2.86	1665	582	1665	582
	34	3	357	50.00	4.83	5.16	4.83	0.00	0.00	3.08	1725	560	1725	560
	35	4	356	46.15	4.46	4.72	4.46	0.00	0.00	3.30	1588	481	1588	481
	36	5	303	42.31	4.09	4.29	4.09	0.00	0.00	3.52	1239	352	1239	352
	37	6	330	38.46	3.72	3.85	3.72	0.00	0.00	3.73	1226	329	1226	329
C	38	7	326	34.62	3.34	3.42	3.34	0.00	0.00	3.95	1090	276	1090	276
	39	8	348	30.77	2.97	3.27	2.97	0.00	0.00	3.96	1035	261	1035	261
	40	9	335	26.92	2.60	3.12	2.60	0.00	0.00	3.97	872	220	872	220
	41	10	315	23.08	2.23	2.98	2.23	0.00	0.00	3.98	702	177	702	177
	42	11	215	19.23	1.86	2.83	1.86	0.00	0.00	3.99	400	100	400	100
D	43	12	169	15.38	1.49	2.69	1.49	0.00	0.00	3.99	251	63	251	63
	44	13	151	11.54	1.11	2.54	1.11	0.00	0.00	4.00	168	42	168	42
	45	14	105	7.69	0.74	2.40	0.74	0.00	0.00	4.01	78	19	78	19
	46	15	74	3.85	0.37	2.25	0.37	0.00	0.00	4.02	28	7	28	7
		Σ	4910							Σ	19960	6800	19895	6734

SCOP _{on}	2.94	SCOP _{net}	2.95
		SCOP	2.93

Part load performance diagram

- Medium temperature application (reference water temperature 55 °C)
- Reference heating season „A“ – average



Tested by: Ing. Alexandr Jordanov

Date: 2025-01-13

Signed: 

Reviewed and approved by: Ing. Dominik Šedivý, Ph.D.

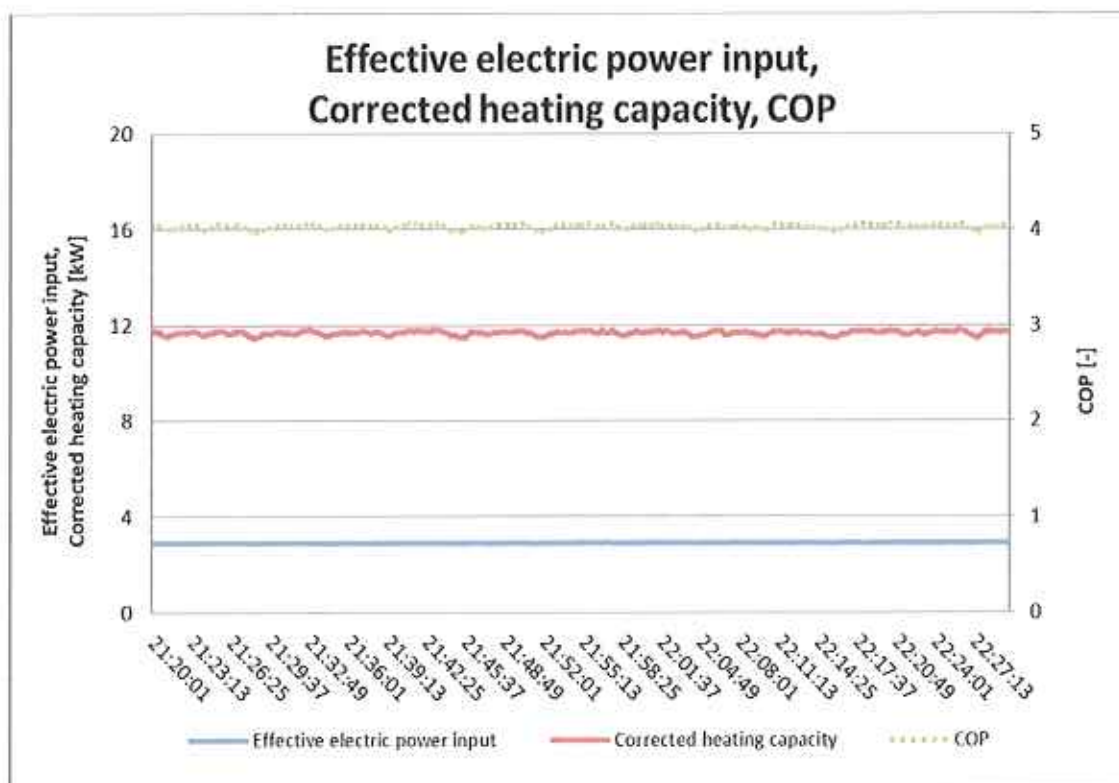
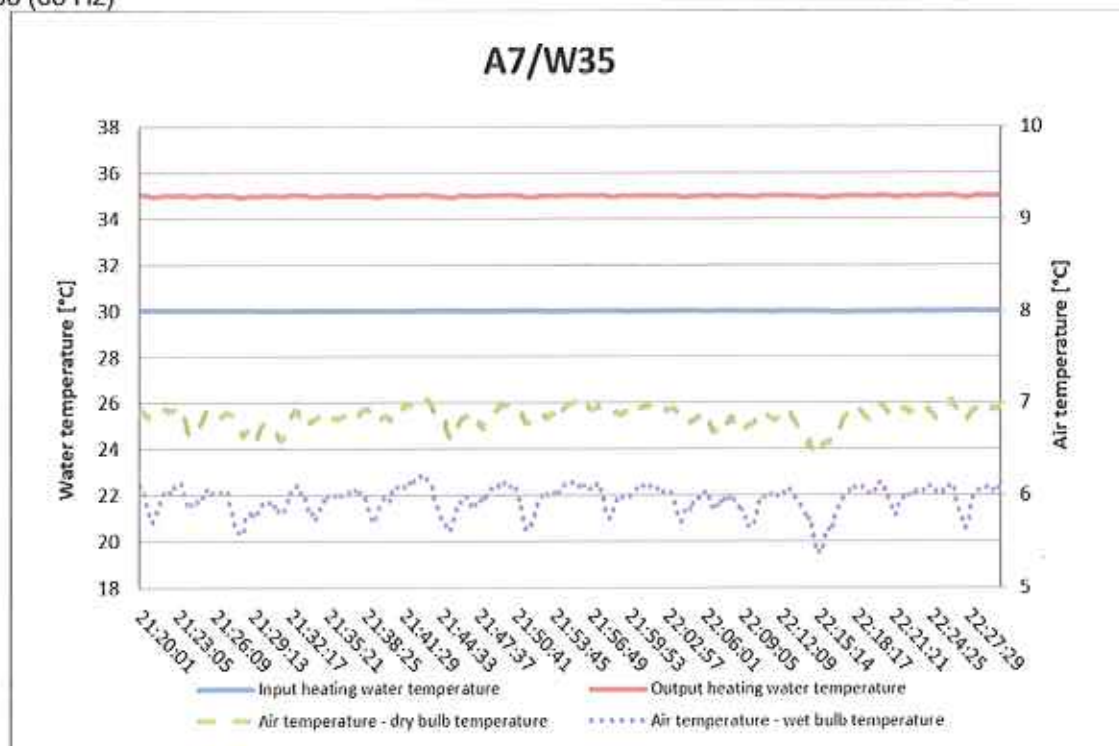
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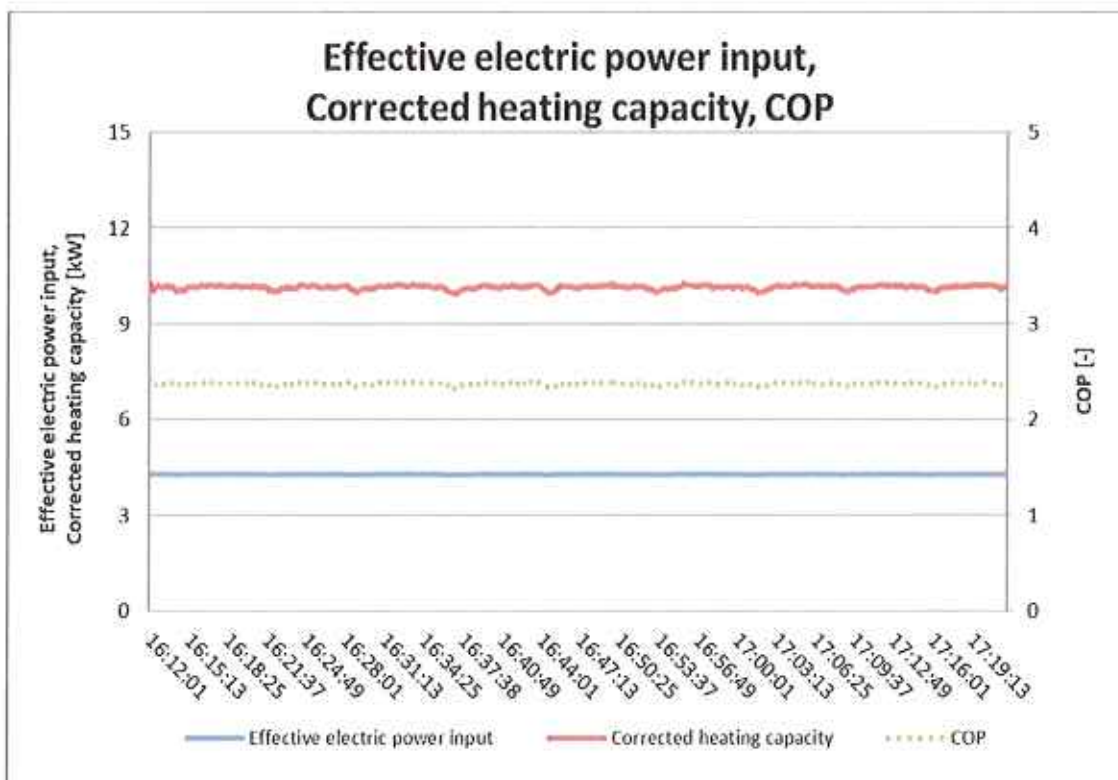
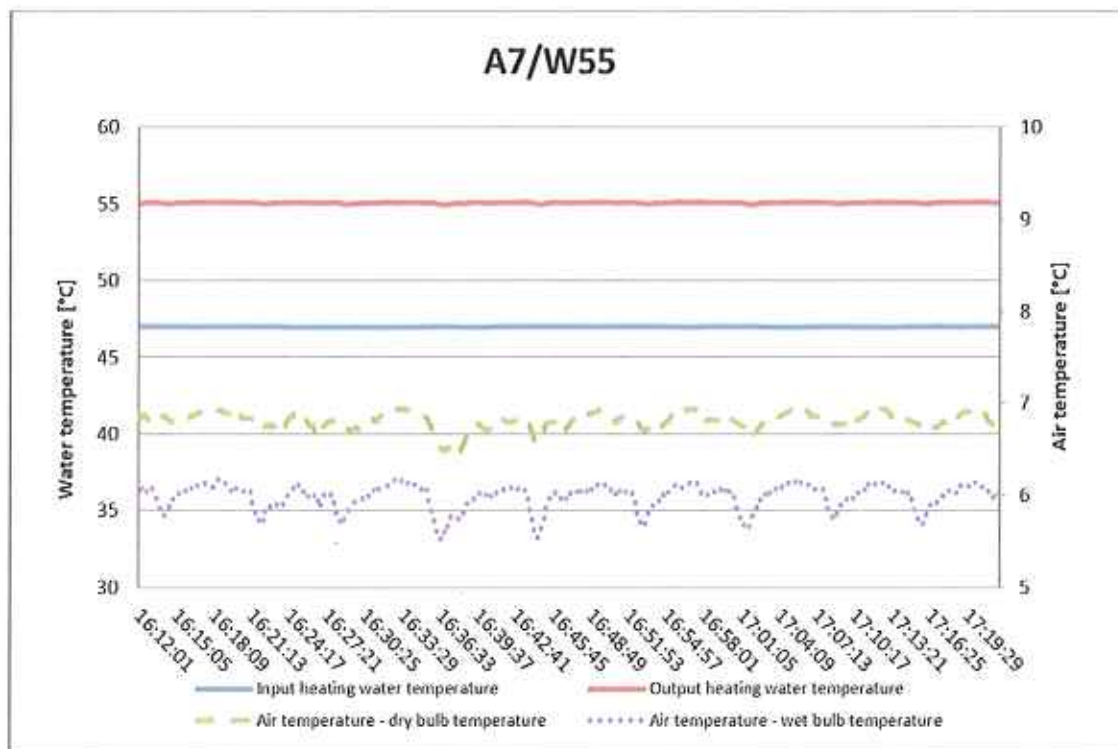
V. Graphs

1. Rating conditions

A7W35 (68 Hz)

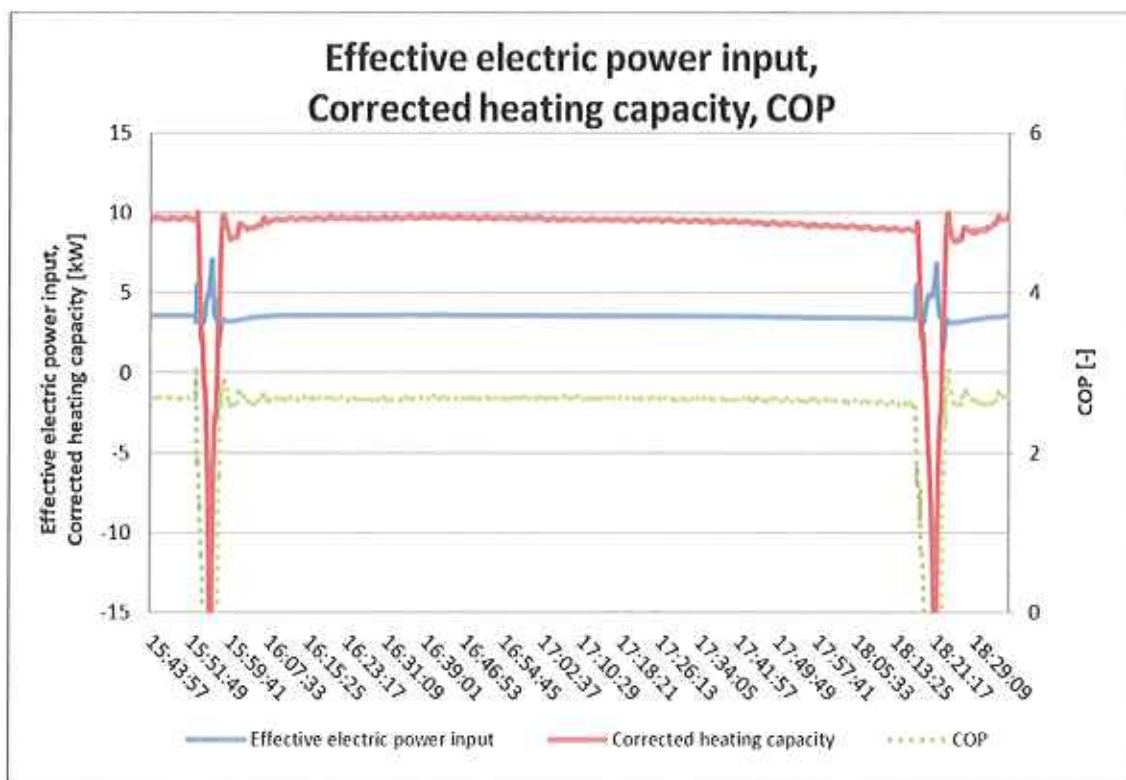
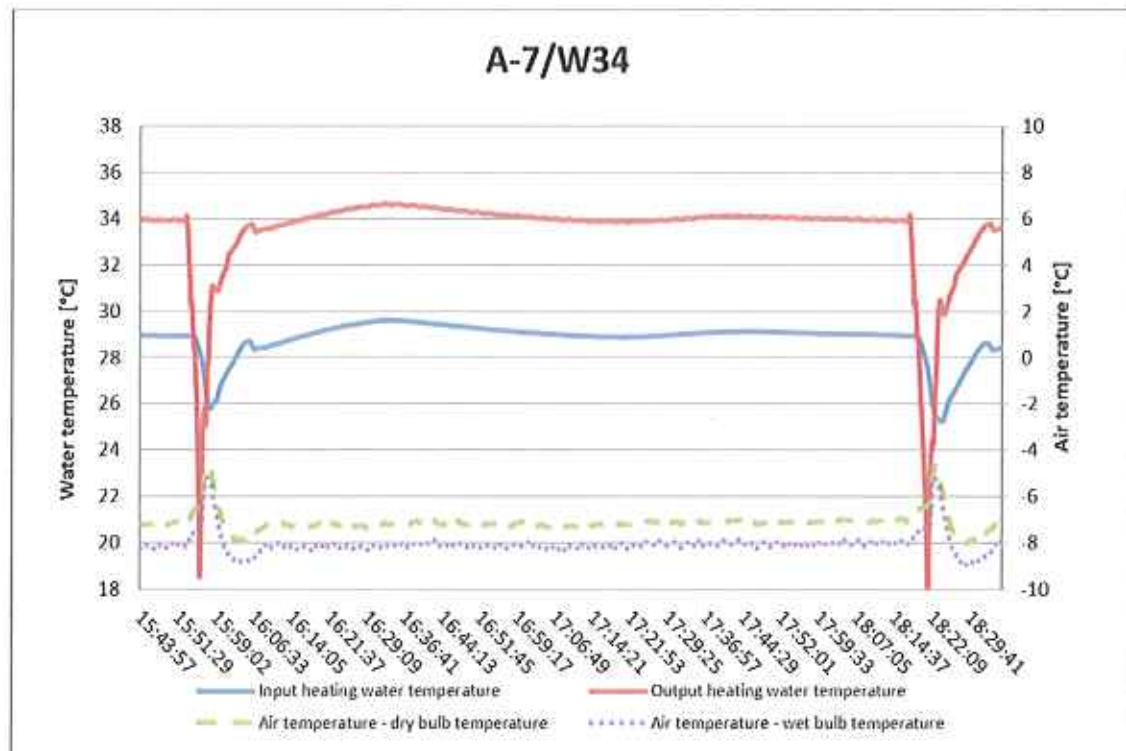


A7W55 (68 Hz)

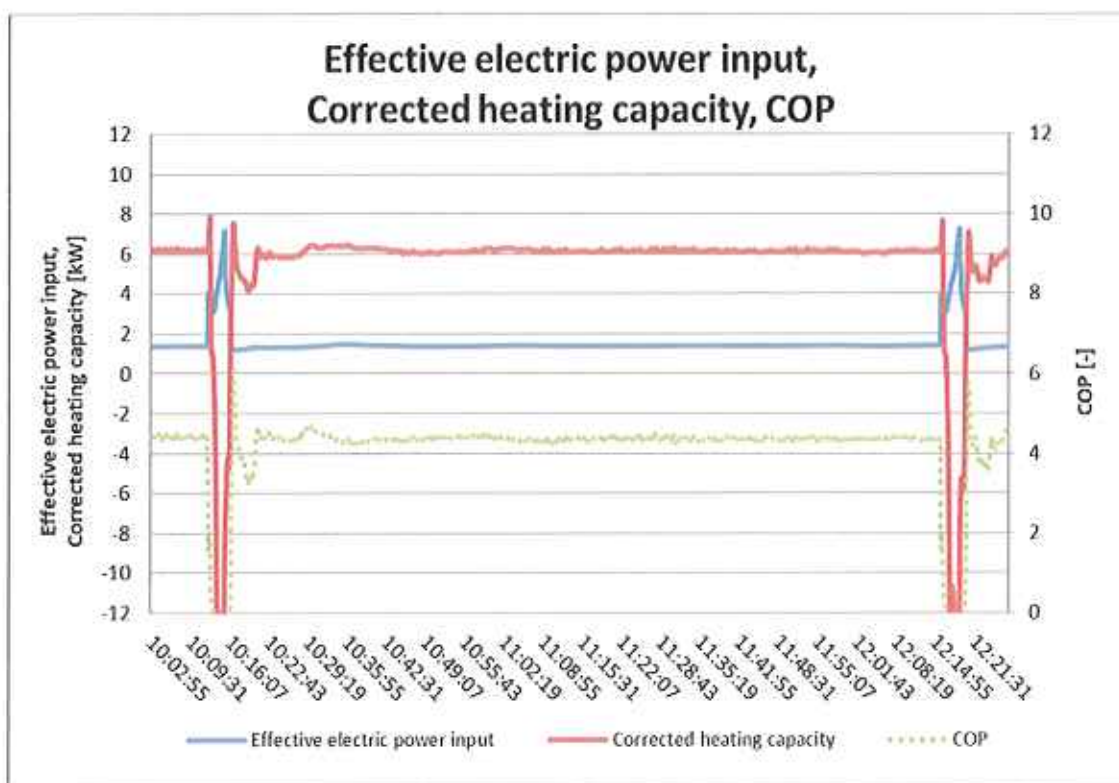
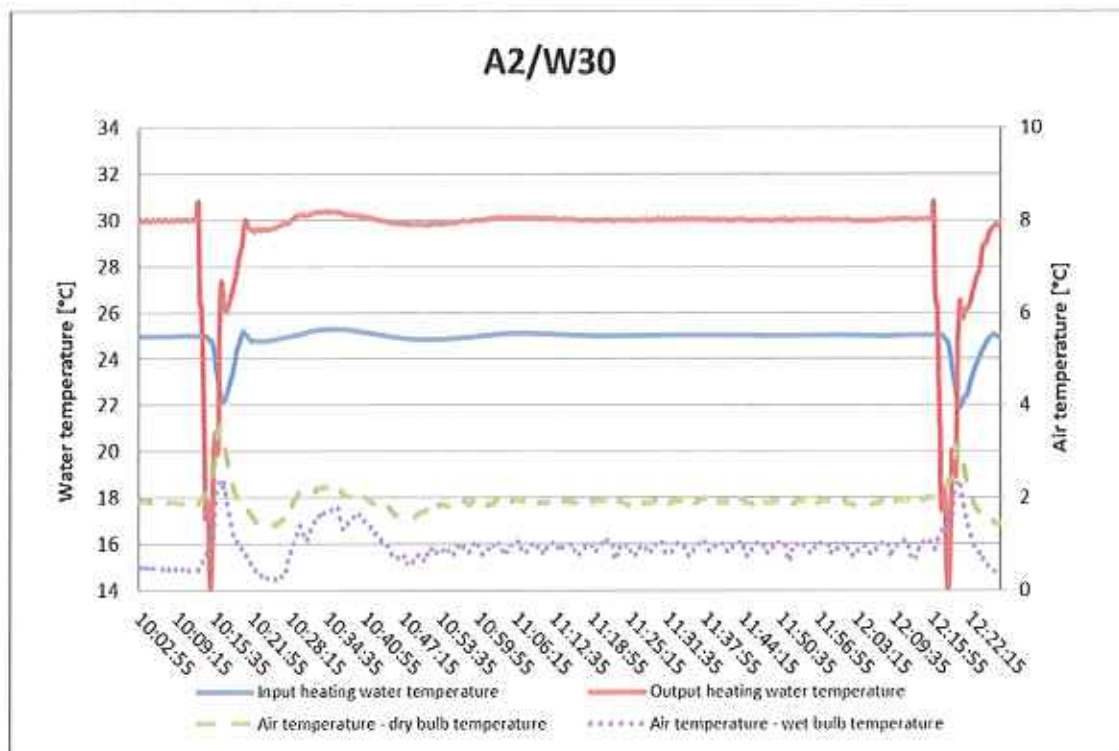


2. Seasonal performance tests and SCOP calculation – Low temperature application

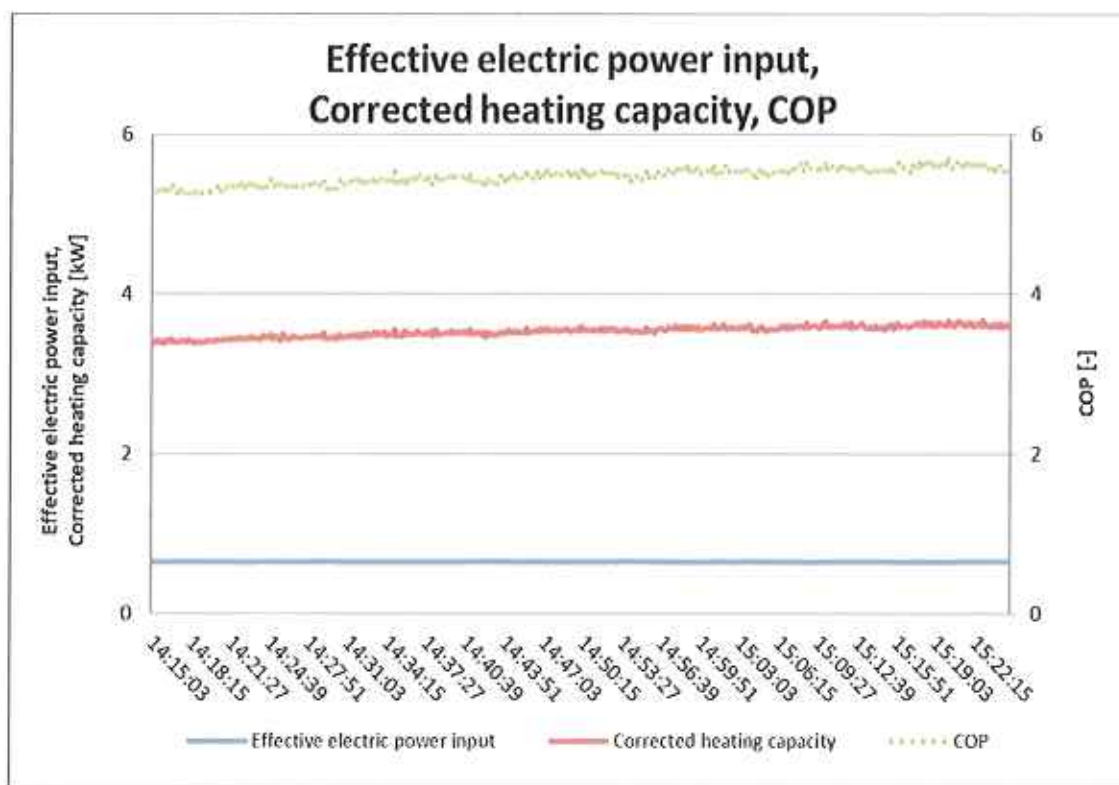
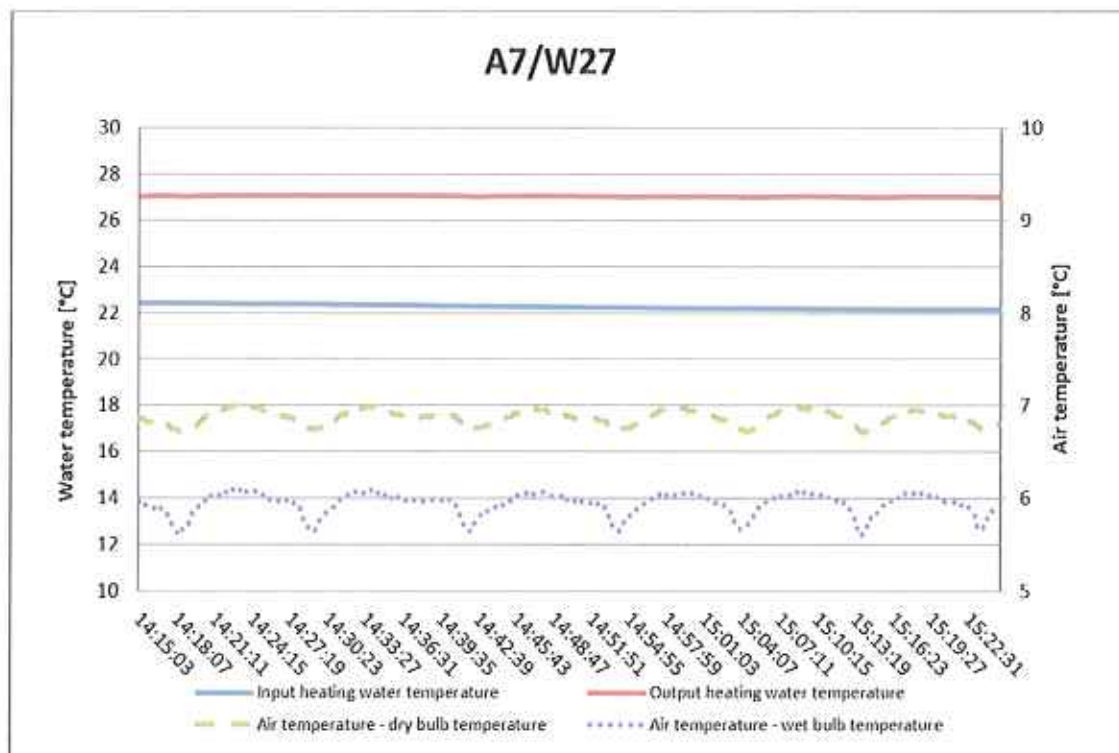
A-7W34 (82 Hz)



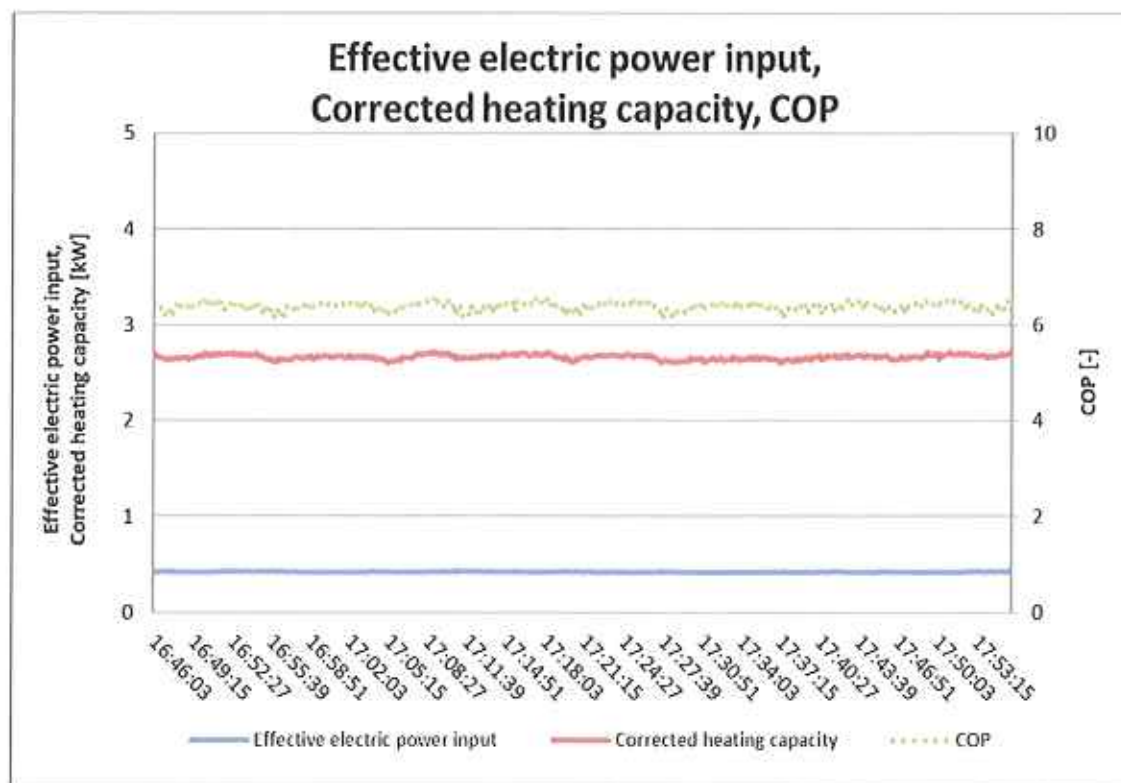
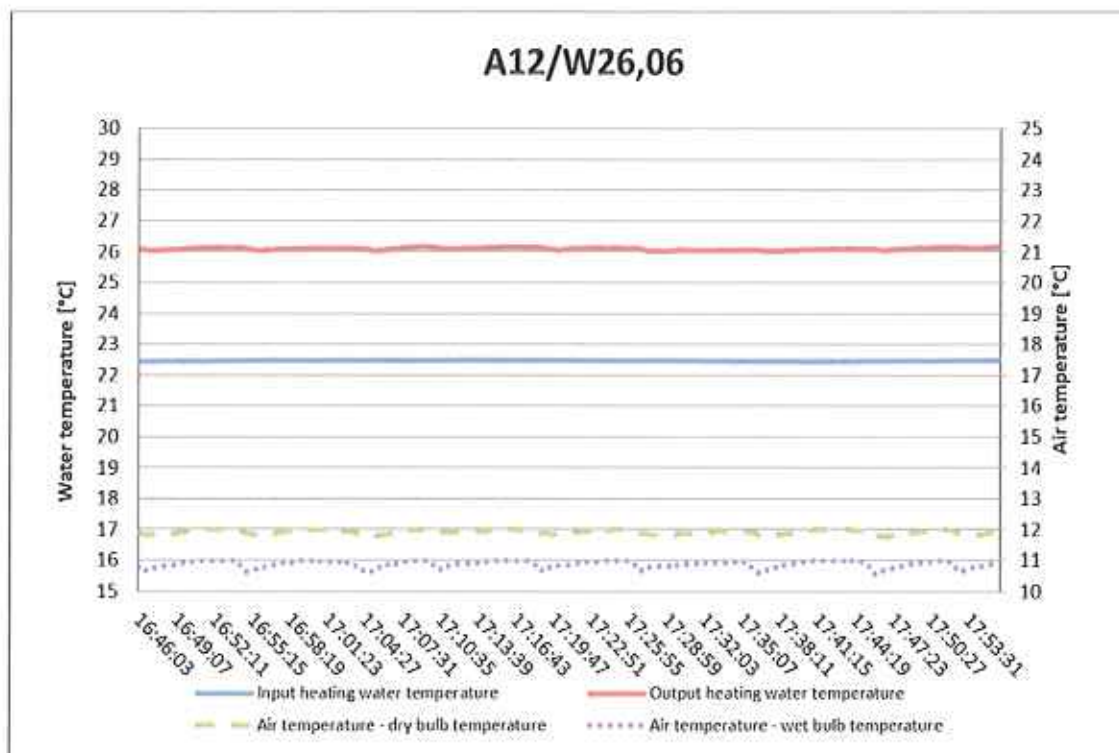
A2W30 (39 Hz)



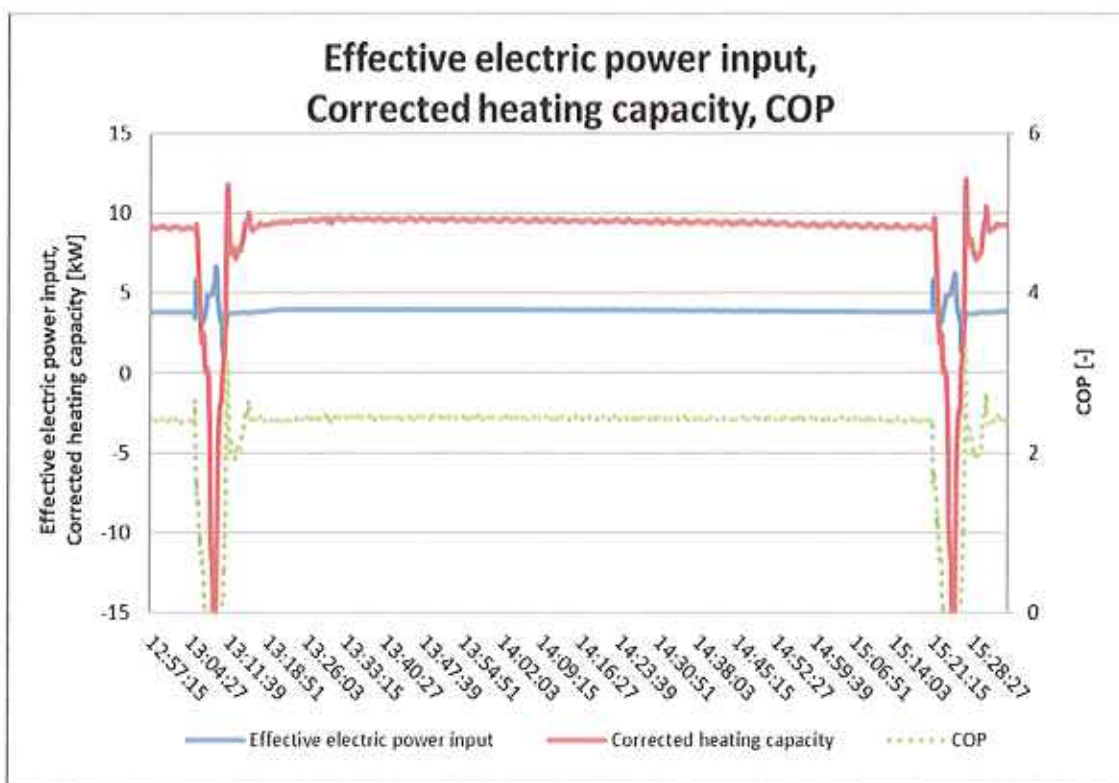
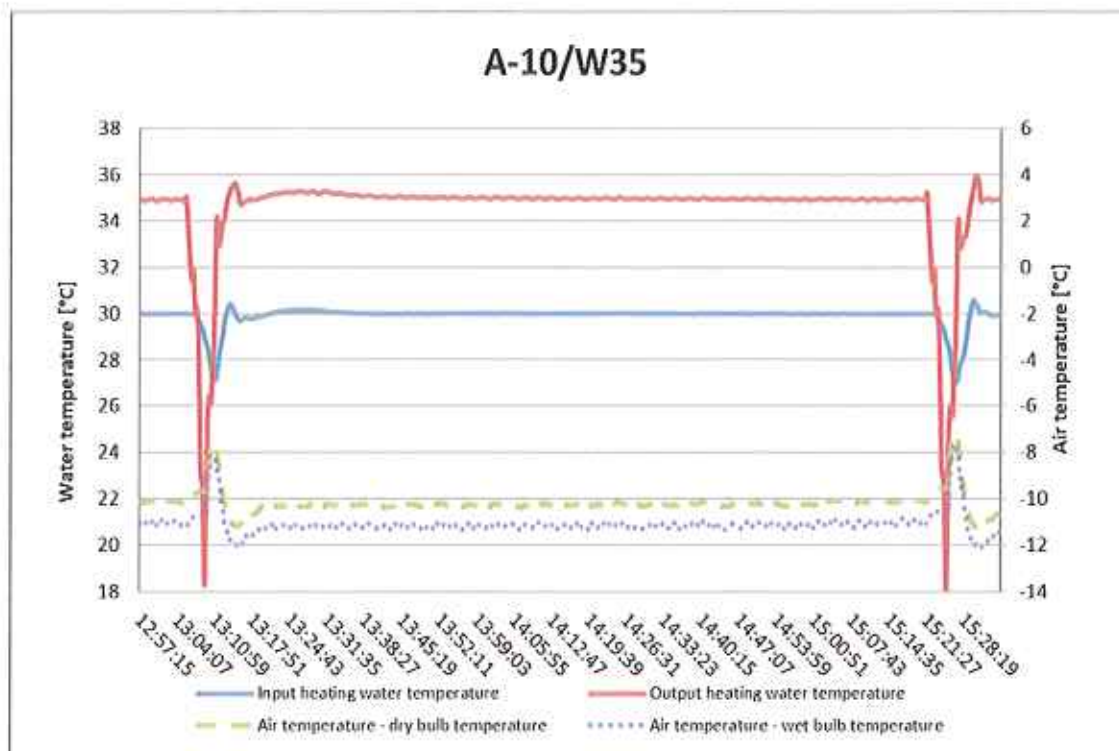
A7W27 (22 Hz)



A12W26.06 (17 Hz)

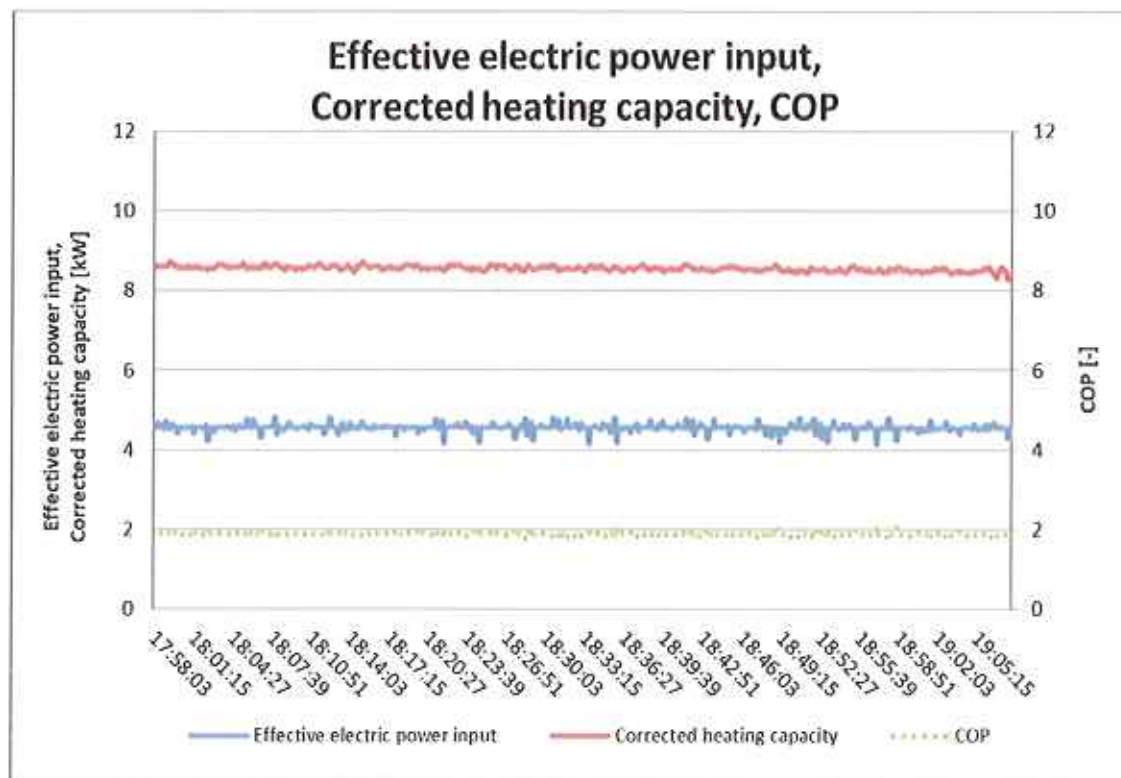
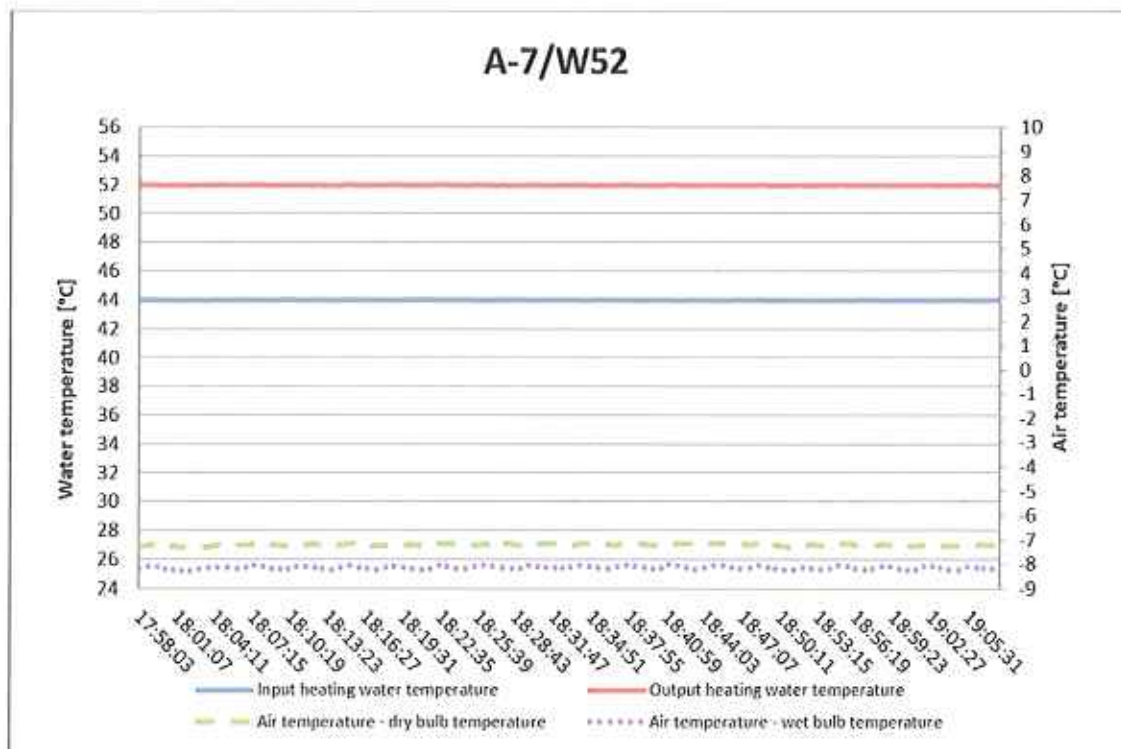


A-10W35 (90 Hz)

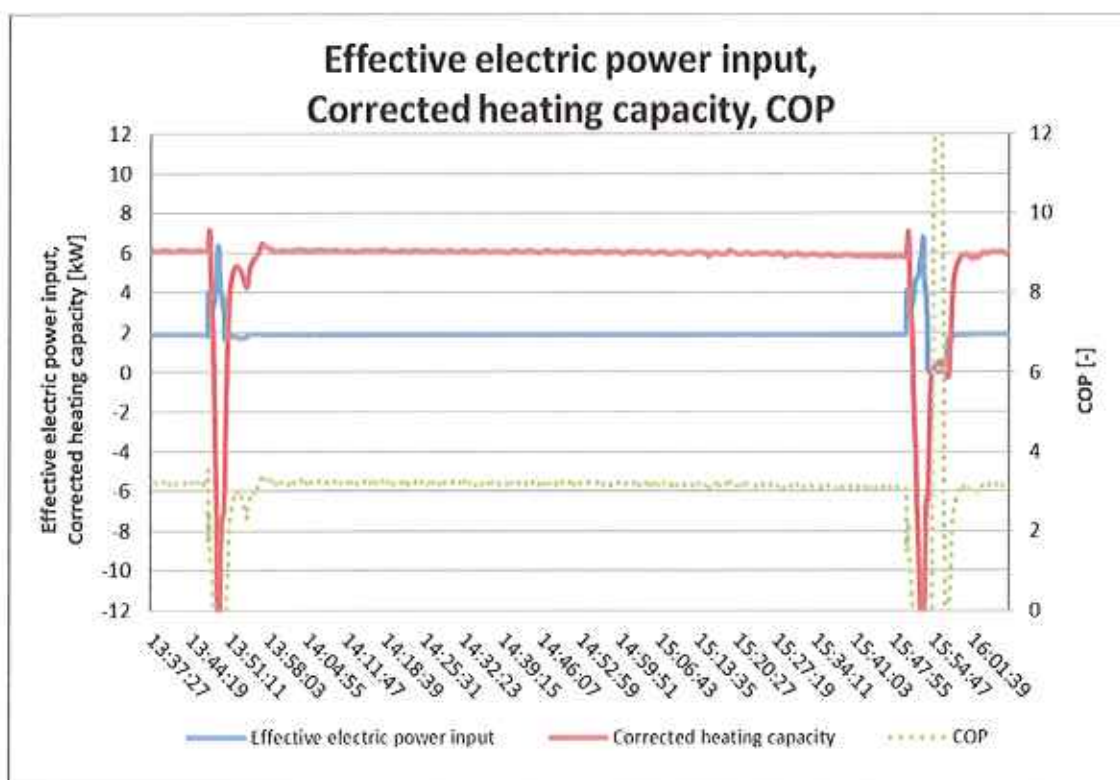
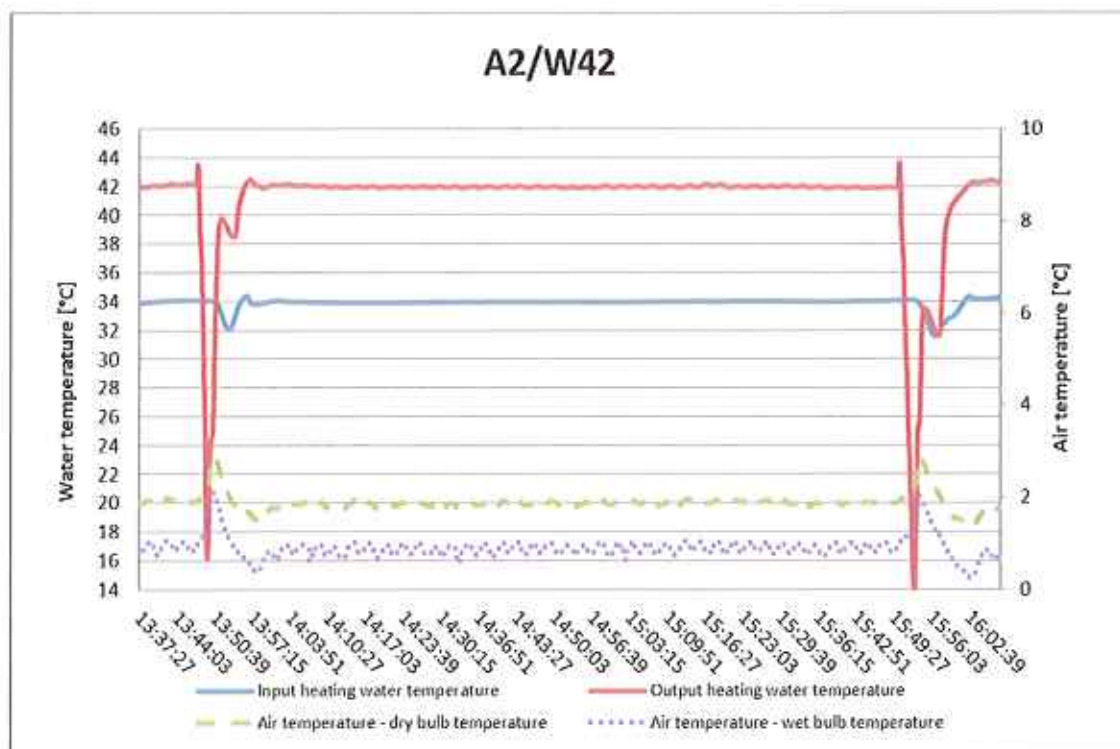


3. Seasonal performance tests and SCOP calculation – Medium temperature application

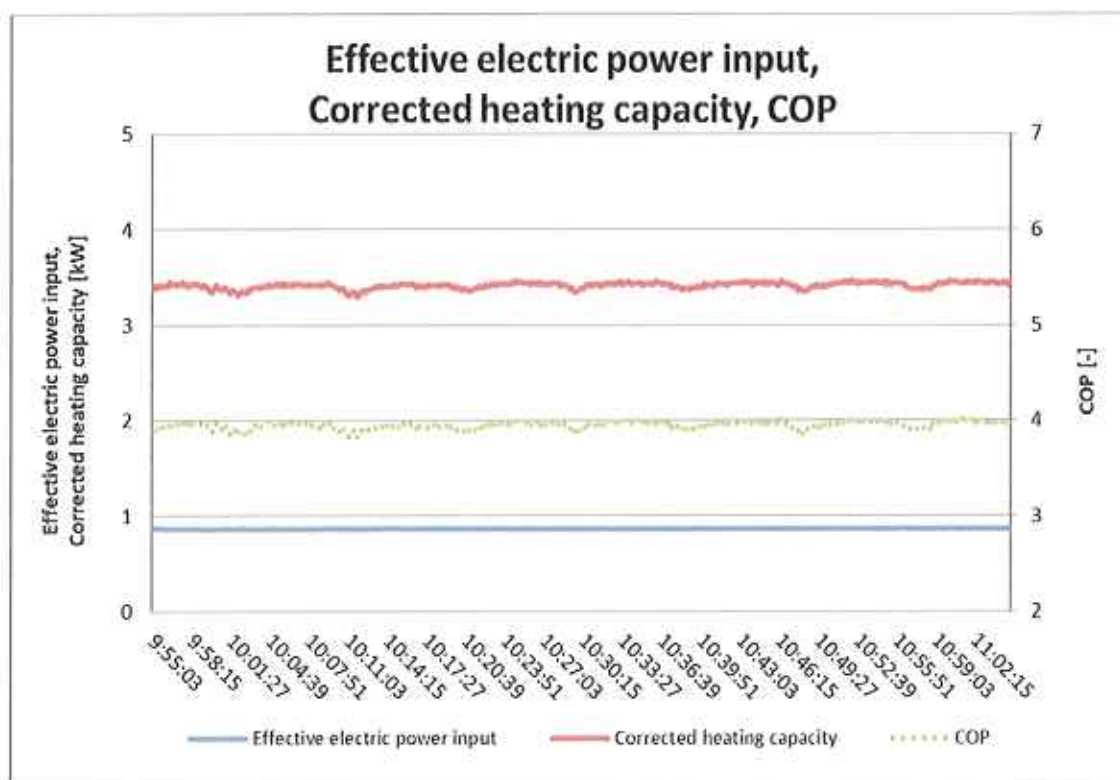
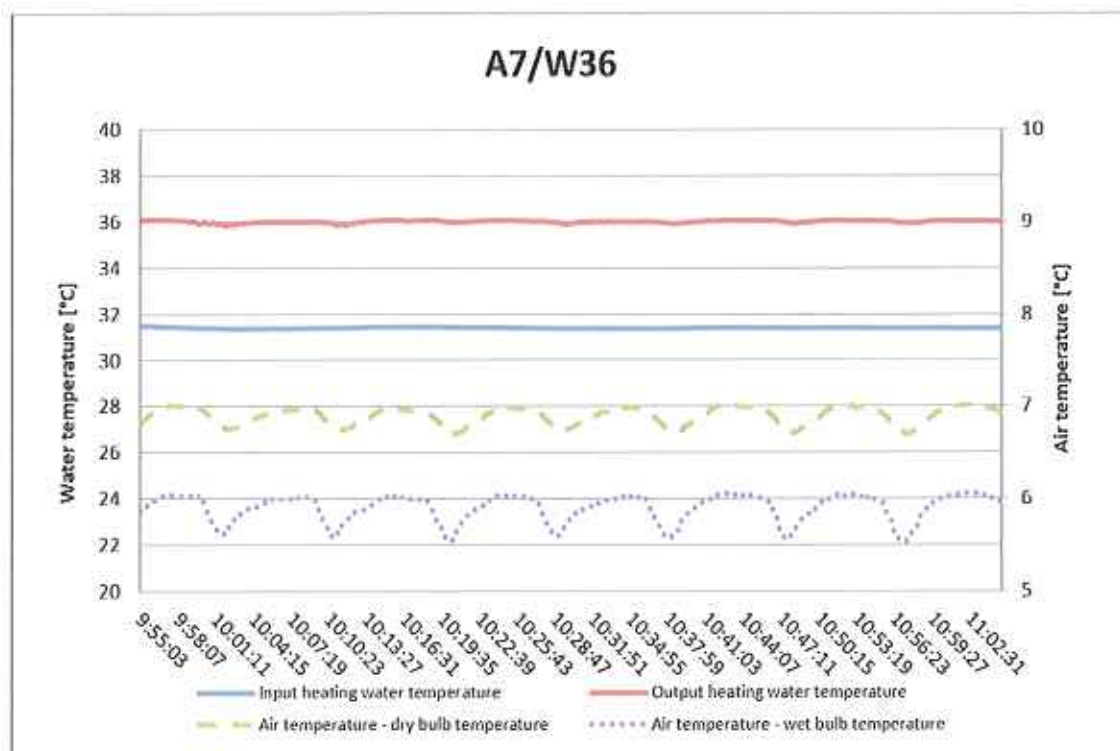
A-7W52 (82 Hz)



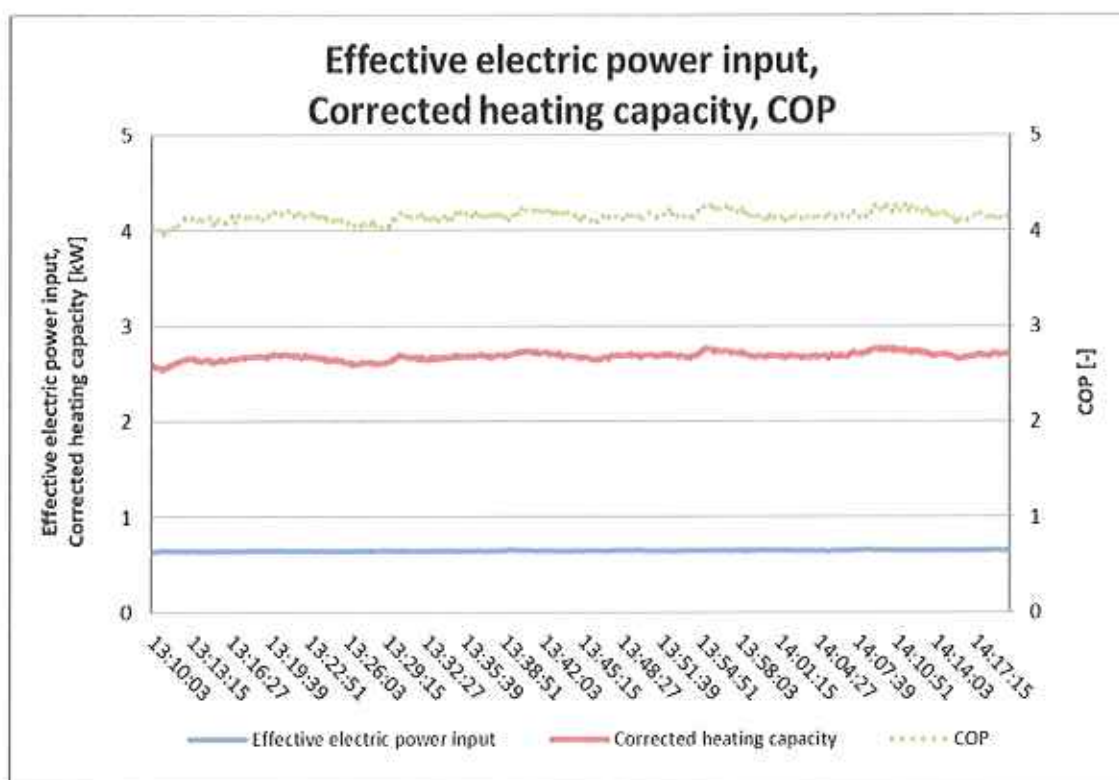
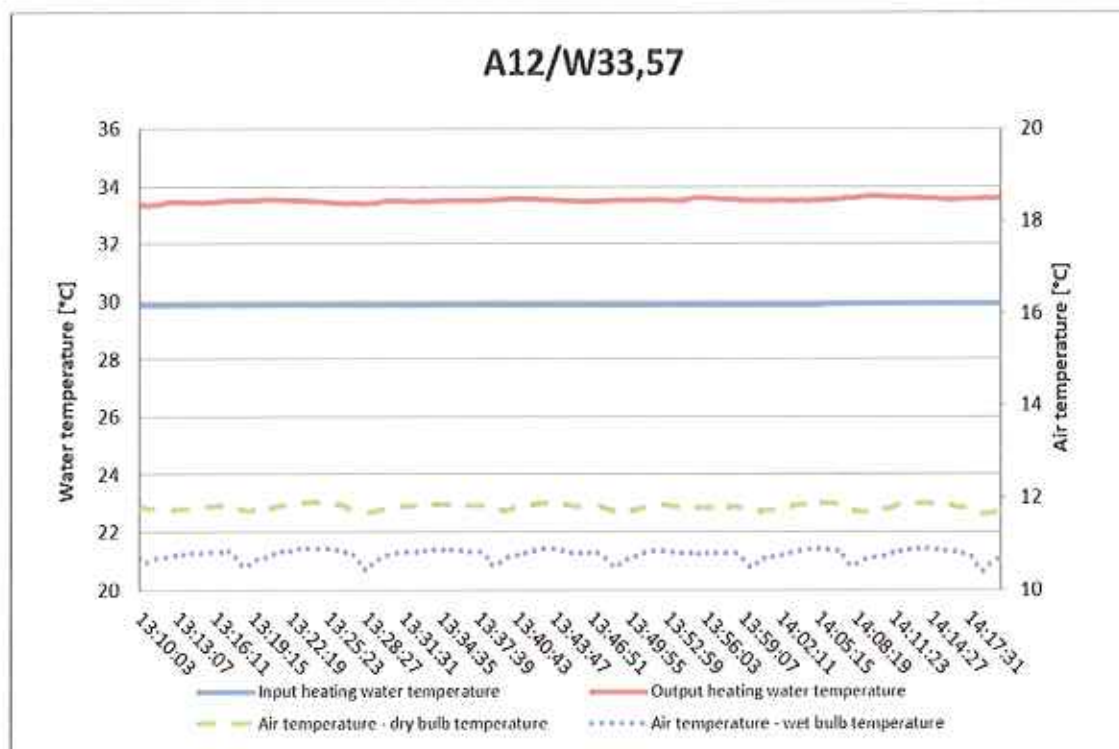
A2W42 (42 Hz)



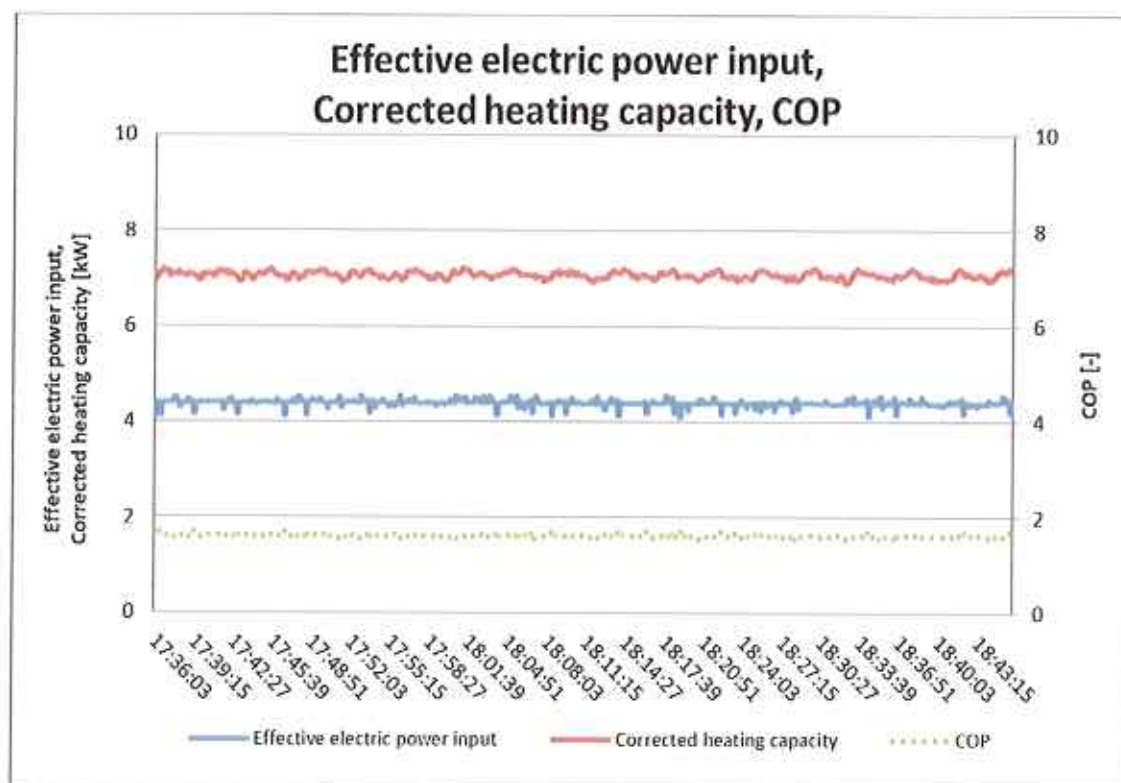
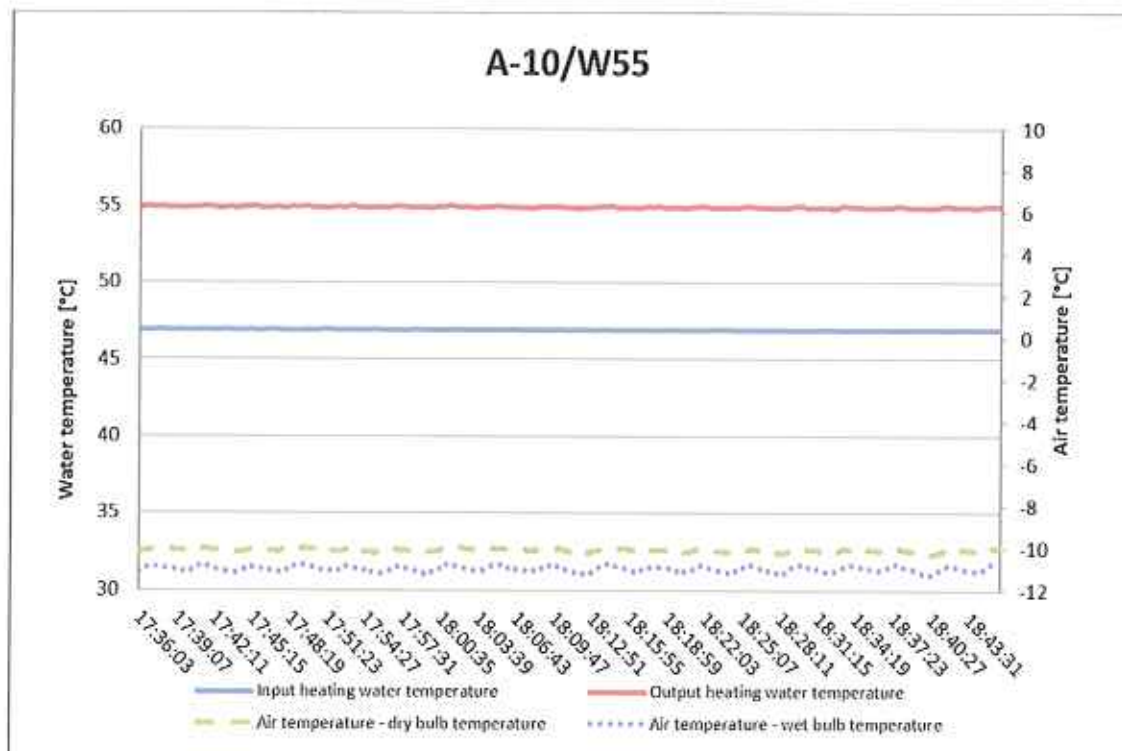
A7W36 (22 Hz)



A12W33.57 (19 Hz)



A-10W55 (76 Hz)



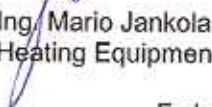
VI. A list of referenced documents

- Order of 2024-03-18 (Order reg. no. B-81819, received on 2024-03-18)
- Contract B-81819/39
- ČSN EN 14511-2:2023 - Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors - Part 2: Test conditions
- ČSN EN 14511-3:2023 - Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors - Part 3: Test methods
- ČSN EN 14825:2023 - 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
- Background of the task 39-17652
- Record measurement file 39-17652

Test Report compiled by: Ing. Alexandr Jordanov



Test Report approved by: Ing. Mario Jankola
Heating Equipment and Construction Products Manager



– End of Test Report –