



**Air-Conditioning, Heating, and Refrigeration  
Institute (AHRI) Low-GWP Alternative Refrigerants  
Evaluation Program (Low-GWP AREP)**

## **TEST REPORT #61**

### **System Drop-in Tests of DR-3, L-20 (R-444B), and R-290 in Air-to- Water Heat Pump-Heating Mode**

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**This report has been made available to the public  
as part of the author company's participation in the  
AHRI's Low-GWP AREP.**



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## 1- Introduction.

This report describes the test of three alternative low GWP refrigerants in a standard air to water heat pump with refrigerant R-407C as the base line refrigerant. The purpose of the tests is to gain knowledge of capacity and efficiency of low GWP refrigerants applied in applications.

The tested refrigerants are listed below:

Refrigerant	Composition (wt. %)	GWP	Glide at 0°C
R-407C (base line)	52% R-134a, 25% R-125, 23% R-32	1526	6,7K
DR3	78,5% R-1234yf, 21,5% R-32	146	7,8K
R-444B/L20	48,5% R-1234ze, 41,5% R-32, 10% R-152A	295	8,8K
R-290	100% R-290	3	0,0K

The tests were performed in a period of time from October 2015 to November 2015 in Danfoss Application Development Center, Nordborg, Denmark.

## 2- Details of test Setup

### a. Description of System

The air to water heat pump unit selected for the drop in test is a residential unit manufactured by Danfoss Heat Pumps. The rated capacity stated by the manufacturer is 15,21 kW at A7/W35 according to EN14511.

It is equipped with Copeland scroll compressor (ZH38K4E-TDF-524) and charged with 5,7kg R-407C and 32 cSt POE oil. The expansion device is a Danfoss electronic expansion valve (ETS6) with a Danfoss EIM316 superheat controller. The unit is equipped with a 4-way valve for reversing the refrigerant flow during defrosting of the evaporator coil.

The system is mainly used for heating of residential homes. The heating functionality is the only function that is evaluated in this report.

### b. Description of Modification to System

For test purposes, pressure transmitters and temperature sensors were installed in the positions shown in fig 1. The EIM316 superheat controller was changed to a prototype controller. The reason for the change was to adapt the pressure temperature conversion to the alternative refrigerants. The prototype controller contained the same control algorithm as the factory mounted controller.

The pressure temperature conversions for the alternative refrigerants were calculated from Refprop 9.1 update HMX.BNC file of 08.12.2014.

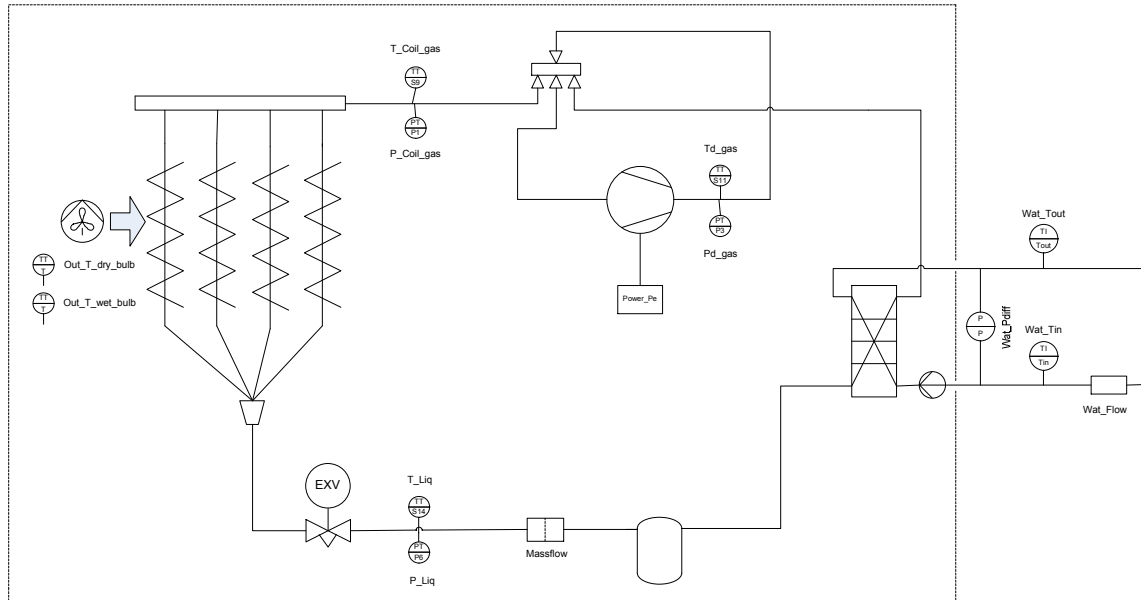


Fig. 1  
 Danfoss DHP-AQ 16  
 Updated 20151124 JJJ

### c. Description of Tests Conducted

The heat pump was installed in a psychrometric test chamber and connected on the water side to a load system that was placed outside the test chamber.

The psychrometric chamber controls dry and wet bulb air temperatures in the test chamber and the load system controls water flow to a fixed temperature difference between inlet and outlet water. At the same time the outlet water temperature was controlled to a fixed value. In other tests the water flow was fixed and only the water outlet temperature was controlled.

All capacity and efficiency data published were measured and calculated in this work are water side data. The instrumentation (specified below) remained unchanged throughout the tests.

Instrumentation				
Refrigerant Side				
Measuring Point	Schematic Fig.1	Sensor ID	Accuracy	Range
Pressures				
Compressor Discharge	Pd_gas	263284	0.2bar	1-41 bar(A)
Expansion Device Inlet	P_liq	263290	0.2bar	1-41 bar(A)
Evaporator outlet	P_Coil_gas	263291	0.2bar	1-41 bar(A)
Temperatures				
Compressor Discharge	Td_gas	263322	0.1°C	-20 +80 °C
Expansion Device Inlet	T_liq	263341	0.1°C	-20 +80 °C
Evaporator outlet	T_Coil_gas	263342	0.1°C	-20 +80 °C
Air Side				
Measuring Point	Schematic Fig.1	Sensor ID	Accuracy	Range
Air Side				
Outdoor Air Entering dry bulb	Out_T_dry_bulb	264587	0.1°C	-20 +60 °C
Outdoor Air Entering wet bulb	Out_T_wet_bulb	264904	0.2°C	-20 +25 °C
Water Side				
Measuring Point	Schematic Fig.1	Sensor ID	Accuracy	Range
Water Side				
Water Entering heat pump	Wat_Tin	270993	0.1°C	0-60°C
Water Leaving heat pump	Wat_Tout	270994	0.1°C	0-60°C
Water static pressure drop in/out	Wat_Pdiff	270988	<0,05bar	0-1 Bar
Water Volumenflow	Wat_Flow	263855	<40l/h	0-4000 l/h
Electric Power				Range
		Sensor ID	Accuracy	
Total Power input to heat pump	Powe_Pe	265131	0,068kW	0-13,6 kW

Table: 1. Specifications of measurement devices.

The tests were performed according to the table below for the base line refrigerant R-407C and the alternative refrigerants DR3, R-444B and R-290. The conditions was specified (by the standard) by ambient temperature and outlet water temperature for the EN14511 test. (A12/W35 means ambient +12C water outlet +35C) For the EN14825 tests the conditions were specified by ambient temperature and weighted average of inlet and outlet temperature for the given part load condition. (A12/WA35 means ambient +12C average water inlet/outlet +35C). Ambient wet bulb temperature is controlled to 1K below ambient dry bulb temperature in all conditions as described in EN14825.

Equipment	Standard	Standard Test	Conditions test	Output
16kW residential air to water heat pump	EN14511:2013	Air to water heating mode (low temperatures, heating season average )	A12/W35 A7/W35 A2/W35 A-7/W35 A-15/W35	Capacities COP's
	EN14825:2013	SCOP in "heating season average", "fixed water outlet", "low temperature application" and bivalent point -7C.	A12/AW35 A7/ AW35 A2/ AW35 A-7/ AW35 A-15/ AW35	SCOP Design capacity

Table 2: Test conditions and outputs.

In order to delimit the test work the tests were only done for "low temperature application" and "heating season average".

The charging of R-407C was done in test condition A7/W35. It was charged gradually until the rated capacity was reached.

Charging of the alternative refrigerants was done in the same test condition and to the same sub cooling as R-407C.

The tests of SCOP were also limited to "low temperature application", "heating season average" and fixed water temperature. The SCOP calculation for the various refrigerants was also done at a fixed bivalent point – ambient temperature of -7C. (The bivalent point is defined as the ambient temperature at which the heat demand is equal to the heat pump capacity). Fixed bivalent point resulted in different capacities at the design point temperature for the different refrigerants which is the heating demand at the design point temperature (defined as -10C for "heating season average" in EN14825).

### 3- Results

#### a. Data forms.

Data forms for the tests are shown appendix A.

#### b. Results of EN14511 test of capacities and COP's.

The system was charged as shown in the table below.

Standard A7W35	R-407c	DR-3	R-444B	R-290
Charge amount, kg	5,2	5,0	4,6	2,6
Sub cooling, K	5,1	4,3	4,4	5,7

Table 3: Determined flow at standard test A7W35 with controlled 5K difference between inlet water and outlet water temperatures.

The first test according to EN14511 determined the water flow at A7/W35 where temperature difference was controlled to 5K on the water side at ambient 7C. Outlet water temperature was controlled to +35C.

Standard A7W35	R-407C	DR3	R-444B	R-290
Flow, l/s	0,754	0,704	0,693	0,678

Table 4: Determined flow at standard test A7W35 with controlled 5K difference between inlet water and outlet water temperatures.

These water flows were fixed in the following tests where the capacities and COP's were measured with fixed outlet water temperature and various ambient temperatures.

Capacity	R-407C	DR3		R-444B		R-290	
	kW	kW	%	kW	%	kW	%
A12W35	17,96	17,04	-5,1	18,06	+0,6	15,78	-12,1
A7W35	15,94	13,52	-15,2	13,41	-15,9	14,29	-10,4
A2W35	12,06	11,59	-3,9	11,83	-1,9	11,26	-6,6
A-7W35	10,91	10,03	-8,0	10,37	-4,9	10,18	-6,6
A-15W35	7,72	7,46	-3,3	6,86	-11,1	6,58	-14,7

Table 5: Capacities measured with fixed outlet water temperature and fixed water flow with deviation from base line refrigerant.

COP	R-407C	DR3		R-444B		R-290	
			%		%		%
A12W35	4,89	4,87	-0,4	5,03	+2,9	5,24	+7,2
A7W35	4,43	4,04	-8,8	3,87	-12,6	4,80	+8,4
A2W35	3,48	3,50	+0,6	3,48	0,0	3,92	+12,6
A-7W35	3,25	3,13	-3,7	3,14	-3,4	3,48	+7,1
A-15W35	2,44	2,46	+0,8	2,21	-9,4	2,42	-0,8

Table 6: COP measured with fixed outlet water temperature and fixed water flow with deviation from base line refrigerant.

### c. Results of EN14825 test of SCOP's and design capacities.

The results from the EN14511 test were used for determining the test conditions for the SCOP test according to EN14825.

Outlet water temp.	R-407C, C	DR3, C	R-444B, C	R-290, C
A12WA35	40,1	40,7	41,1	39,9
A7WA35	38,7	38,6	38,5	38,6
A2WA35	36,7	37,0	37,1	36,7
A-7WA35	35,0	35,0	35,0	35,0
A-15WA35	32,8	32,8	32,3	32,5

Table 7: Outlet water temperatures for SCOP calculations

The tests were performed with the above calculated outlet water temperatures and fixed flows.

Capacity	R-407C	DR3		R-444B		R-290	
	kW	kW	%	kW	%	kW	%
A12WA35	17,48	16,38	-6,3	17,46	-0,1	15,18	-13,1
A7WA35	15,84	14,55	-8,1	13,59	-14,2	14,00	-11,6
A2WA35	12,07	11,42	-5,4	11,76	-2,6	11,18	-7,3
A-7WA35	10,91	10,03	-8,0	10,37	-4,9	10,18	-6,6
A-15WA35	7,66	7,14	-6,7	6,75	-11,8	6,66	-13,0

Table 8: Measured capacities for SCOP calculations with deviation from base line refrigerant.

COP	R-407C	DR3		R-444B		R-290	
			%		%		%
A12WA35	4,39	4,34	-1,1	4,44	+1,1	4,66	+6,2
A7WA35	4,15	4,07	-1,9	3,71	-10,6	4,43	+6,7
A2WA35	3,41	3,34	-2,1	3,34	-2,1	3,81	+11,7
A-7WA35	3,25	3,13	-3,7	3,14	-3,4	3,48	+7,1
A-15WA35	2,50	2,43	-2,8	2,26	-9,6	2,52	+0,8

Table 9: Measured COP's for SCOP calculations with deviation from base line refrigerant

	R-407C	DR3		R-444B		R-290	
			%		%		%
Capacity at design point temperature, kW	12,33	11,34	-8,0	11,72	-4,9	11,51	-6,7
SCOP	3,50	3,43	-2,0	3,32	-5,1	3,81	+8,9

Table 10: Capacity at design point temperature and SCOP with deviations from base line refrigerant calculated with fixed bivalent point of -7C and fixed outlet water temperature for heating season average and low temperature application according to EN14825.

#### d. Other - discussion of results.

Applied on this heat pump DR3 showed generally lower capacities than R-407C - especially in the test point A7W35 and A-7W35 (-8% to -15%). The SCOP showed a 2% decrease in efficiency. COP drops especially at A7W35.

Applied on this heat pump R-444B showed generally lower capacities than R-407C especially in the test point A7W35 and A-7W35 (-14% to 16%). The SCOP showed a 5% decrease in efficiency. COP drops especially at A7W35.

Applied on this heat pump R-290 showed generally lower capacities than R-407C (-7% to -15%). The SCOP showed a 9% increase in efficiency.

Looking into the test data declining capacity occurred during many of the tests. After defrost of the evaporator the capacities returned back to the higher level.

In order to illustrate the influence from the declining capacities the results were evaluated using shorter equalization and data acquisition periods than required in the standard (See appendix B). It showed higher capacities and better COPs. The data also seemed more consistent, but the comparison of refrigerants showed the same picture with lower capacities for all alternative refrigerants and lower SCOP for DR-3 and R-444B higher COP for R-290 compared to the R-407C.



## Appendix A: Test data forms.

### Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss

Manufacturer's Notation: DHP-AQ 16

<b>Basic Information</b>								
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)				DR3 (78,5% R-1234yf, 21,5% R-32)				
Alternative Lubricant Type and ISO Viscosity				n.a.				
Baseline Refrigerant and Lubricant				R407C / EMKARATE RL32-3MAF				
Make and Model of System				Danfoss DHP-AQ 16				
Nominal Capacity and Type of System				A7 W35 15,3kW; Air to water HP				
<b>Comparison Data</b>		<b>Base.</b>	<b>Alt.</b>	<b>SI Units</b>	<b>Base.</b>	<b>Alt.</b>	<b>IP Units</b>	<b>Ratio</b>
Heating Mode		App A12W35						
Compressor Type		ZH38K4E-TDF-524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	5	kg	11,464	11,02	lb	-3,87%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	12,0	12,0	C	53,6	53,6	F
		wb	11,0	11,01	C	51,81	51,83	F
Total Capacity		17956	17038	W	61270	58139	Btu/hr	-5,11%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3672	3494	W	3672	3494	W	-4,84%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		4,89	4,87					-0,4
<b>Other System Changes</b>								
n.a.								
<b>System Data</b>				<b>Base.</b>	<b>Alt.</b>	<b>Ratio</b>		
Degradation Coefficient – Cd				n.a.	n.a.	n.a.		
Seasonal Energy Efficiency Ratio - SEER				n.a.	n.a.	n.a.		
Heating Seasonal Performance Factor - HSPF				n.a.	n.a.	n.a.		

## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP

Alternate Refrigerant: DR3

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	12,00	12,00	C	53,6	53,6	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	42,27	L/min	11,95	11,16	gal/min	-6,61%
Inlet Temperature	29,36	29,26	C	84,85	84,68	F	
Outlet Temperature	35	34,99	C	95,00	94,99	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	62,34	1538	57,42	1462	144,22	223,17	135,36	212,13
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	31,12	1511	28,9	1433	88	219,2	84,13	207,95
Subcooling, at expan. device	3		3,38		5,4		6,08	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	9,19	568	9,55	553	48,55	82,42	49,2	80,3
Evaporator Superheat	3,02		3,5		5,43		6,3	

### Data Source(s) for Refrigerant Properties

REFPROP 9.1 with update on HMX.BNC file  
08.12.2014

### Additional Notes

Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss

Manufacturer's Notation: DHP-AQ 16

<b>Basic Information</b>								
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)			DR3 (78,5% R-1234yf, 21,5% R-32)					
Alternative Lubricant Type and ISO Viscosity			n.a.					
Baseline Refrigerant and Lubricant			R407C / EMKARATE RL32-3MAF					
Make and Model of System			Danfoss DHP-AQ 16					
Nominal Capacity and Type of System			A7 W35 15,3kW; Air to water HP					
<b>Comparison Data</b>		<b>Base.</b>	<b>Alt.</b>	<b>SI Units</b>	<b>Base.</b>	<b>Alt.</b>	<b>IP Units</b>	<b>Ratio</b>
Heating Mode		App A7W35						
Compressor Type		ZH38K4E- TDF-524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> /min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	5	kg	11,464	11,02	lb	-3,87%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	7,0	6,99	C	44,6	44,59	F
		wb	6,3	6,29	C	43,34	43,33	F
Total Capacity		15939	14890	W	54389	50807	Btu/hr	-6,58%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3593	3403	W	3593	3403	W	-5,28%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		4,43	4,37					-1,35
<b>Other System Changes</b>								
n.a.								
<b>System Data</b>				<b>Base.</b>	<b>Alt.</b>	<b>Ratio</b>		
Degradation Coefficient – Cd				n.a.	n.a.	n.a.		
Seasonal Energy Efficiency Ratio - SEER				n.a.	n.a.	n.a.		
Heating Seasonal Performance Factor - HSPF				n.a.	n.a.	n.a.		

## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP

Alternate Refrigerant: DR3

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	7,00	6,99	C	44,6	44,59	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	42,27	L/min	11,95	11,16	gal/min	-6,61%
Inlet Temperature	30,0	29,99	C	86,0	85,99	F	
Outlet Temperature	35,0	34,99	C	95,0	94,99	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	64,4	1531	58,48	1451	147,96	222,14	137,27	210,49
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	28,97	1510	28,0	1429	84,15	219,08	82,49	207,27
Subcooling, at expan. device	5,13		4,15		9,23		7,47	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	4,53	487	4,65	473	40,17	70,63	40,37	68,68
Evaporator Superheat	2,67		3,64		4,80		6,55	

### Data Source(s) for Refrigerant Properties

REFPROP 9.1 with update on HMX.BNC file  
08.12.2014

### Additional Notes

Refrigerant data are average from a stable condition minimum 30min. maximum 70min.

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

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Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	DR3 (78,5% R-1234yf, 21,5% R-32)
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A2W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> /min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	5	kg	11,464	11,02	lb	-3,87%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	2,0	1,99	C	35,6	35,59	F
		wb	1,01	0,99	C	33,82	33,78	F
Total Capacity		13788	12830	W	47047	43780	Btu/hr	-6,94%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3504	3352	W	3504	3352	W	-4,33%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		3,93	3,82					-2,79

<b>Other System Changes</b>				
n.a.				
<b>System Data</b>		<b>Base.</b>	<b>Alt.</b>	<b>Ratio</b>
Degradation Coefficient – Cd		n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER		n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF		n.a.	n.a.	n.a.

## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP

Alternate Refrigerant: DR3

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	2,00	1,99	C	35,6	35,59	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	42,28	L/min	11,95	11,16	gal/min	-6,61%
Inlet Temperature	30,7	30,69	C	87,26	87,25	F	
Outlet Temperature	35	34,99	C	95,0	94,99	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	67,11	1512	60,61	1449	152,8	219,33	141,1	210,23
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	27,88	1496	27,81	1432	82,19	217	82,06	207,7
Subcooling, at expan. device	5,84		4,48		10,51		8,06	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	-1,13	404	-0,73	398	29,95	58,72	30,68	57,82
Evaporator Superheat	1,83		2,73		3,29		4,91	

### Data Source(s) for Refrigerant Properties

REFPROP 9.1 with update on HMX.BNC file  
08.12.2014

### Additional Notes

Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	DR3(78,5% R-1234yf, 21,5% R-32)
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio	
Heating Mode		App A -7W35							
Compressor Type		ZH38K4 E-TDF- 524	n.a.						
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.	
Nominal Motor Size		5	n.a.	hp				n.a.	
Motor Speed		2900	n.a.	rpm				n.a.	
Expansion Device Type		Danfoss ETS6	n.a.						
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.	
Refrigerant Charge		5,2	5	kg	11,464	11,02	lb	-3,87%	
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.	
Composition, at compr. inlet if applicable			n.a.	% wt					
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F	
		wb	n.a.	n.a.	C	n.a.	n.a.	F	
	Outdoor	db	-6,99	-6,99	C	19,41	19,4	F	
		wb	-8,0	-8,01	C	17,48	17,57	F	
Total Capacity		10905	10029	W	37210	34223	Btu/hr	-8,02%	
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.	
Total System Power Input		3350	3196	W	3350	3196	W	-4,59	
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.	
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.	
Coeff. Of Performance (COP)		3,25	3,13					-3,69	

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.

Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.
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## **Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM**

Type of System: Air to water HP Alternate Refrigerant: DR3

(e.g., SSHP, window RAC, chiller, etc.) (and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	-6,99	-6,99	C	19,41	19,4	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	42,26	L/min	11,95	11,16	gal/min	-6,61%
Inlet Temperature	31,6	31,64	C	88,88	88,96	F	
Outlet Temperature	35	34,99	C	95	94,99	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	73,94	1518	65,72	1447	165,1	220,25	150,3	209,95
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	27,4	1507	27,73	1435	81,37	218,61	81,9	208,2
Subcooling, at expan. device	6,59		4,65		11,86		8,35	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	-9,86	306	-10,06	295	14,23	44,44	13,87	42,84
Evaporator Superheat	1,92		3,02		3,45		5,43	

<b>Data Source(s) for Refrigerant Properties</b>
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

<b>Additional Notes</b>
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_



## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss

Manufacturer's Notation: DHP-AQ 16

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	DR3(78,5% R-1234yf, 21,5% R-32)
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A -15W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> /min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	5	kg	11,464	11,02	lb	-3,87%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	-14,99	-14,99	C	5,0	5,00	F
		wb	-15,51	-15,37	C	4,07	4,31	F
Total Capacity		8813	8243	W	30072	28127	Btu/hr	-6,46%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3180	3046	W	3180	3046	W	-4,21%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		2,77	2,7					-2,52

<b>Other System Changes</b>
n.a.

<b>System Data</b>	<b>Base.</b>	<b>Alt.</b>	<b>Ratio</b>
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Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.

## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP \_\_\_\_\_ Alternate Refrigerant: DR3 \_\_\_\_\_

(e.g., SSHP, window RAC, chiller, etc.) (and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	-14,99	-14,99	C	5,0	5,0	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	42,27	L/min	11,95	11,16	gal/min	-6,61%
Inlet Temperature	32,27	32,25	C	90,0	90,0	F	
Outlet Temperature	35	34,99	C	95	94,99	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	80,43	1518	71,63	1453	176,7	220,29	160,93	210,86
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	27,0	1510	27,53	1444	80,7	219,0	81,56	209,51
Subcooling, at expan. device	7,02		5,11		12,63		9,19	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	-18,25	221	-17,18	217	-0,85	35,0	1,06	31,48
Evaporator Superheat	1,27		1,82		2,28		3,27	

<b>Data Source(s) for Refrigerant Properties</b>
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

<b>Additional Notes</b>
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

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Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R-444B (48,5% R-1234ze, 41,5% R-32, 10% R-152A)
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio	
Heating Mode		App A12W35							
Compressor Type		ZH38K4 E-TDF- 524	n.a.						
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.	
Nominal Motor Size		5	n.a.	hp				n.a.	
Motor Speed		2900	n.a.	rpm				n.a.	
Expansion Device Type		Danfoss ETS6	n.a.						
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	Lb	n.a.	
Refrigerant Charge		5,2	4,6	kg	11,464	10,14	Lb	-11,5%	
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.	
Composition, at compr. inlet if applicable			n.a.	% wt					
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F	
		wb	n.a.	n.a.	C	n.a.	n.a.	F	
	Outdoor	db	12,0	12,01	C	53,6	53,62	F	
		wb	11,0	11,0	C	51,81	51,81	F	
Total Capacity		17956	18056	W	61270	61612	Btu/hr	0,55%	
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.	
Total System Power Input		3672	3588	W	3672	3588	W	-2,28%	
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.	
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.	
Coeff. Of Performance (COP)		4,89	5,03					2,86%	

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.

Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.

## **Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM**

Type of System: Air to water HP

Alternate Refrigerant: R444B

(e.g., SSHP, window RAC, chiller, etc.) (and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	12,00	12,01	C	53,6	53,62	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	41,57	L/min	11,95	10,98	gal/min	-8,11%
Inlet Temperature	29,36	28,84	C	84,85	83,92	F	
Outlet Temperature	35	35,02	C	95,00	95,05	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T [C]	P [kPa]	T [C]	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	62,34	1538	68,16	1510	144,22	223,17	154,69	219,0
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	31,12	1511	27,93	1489	88	219,2	82,27	216,0
Subcooling, at expan. device	3		4,34		5,4		7,81	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	9,19	568	9,38	545	48,55	82,42	48,89	79,05
Evaporator Superheat	3,02		3,97		5,43		7,14	

<b>Data Source(s) for Refrigerant Properties</b>
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

<b>Additional Notes</b>
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R444B (48,5% R-1234ze, 41,5% R-32, 10% R-152A)
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A7W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	4,6	kg	11,464	10,14	lb	-11,5%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	7,0	7,00	C	44,6	44,6	F
		wb	6,3	6,3	C	43,34	43,36	F
Total Capacity		15939	15232	W	54389	51974	Btu/hr	-4,44%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3593	3479	W	3593	3479	W	-3,17%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		4,43	4,37					-1,35%

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.

Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.

## **Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM**

Type of System: Air to water HP

Alternate Refrigerant: R444B

(e.g., SSHP, window RAC, chiller, etc.) (and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	7,00	7,00	C	44,6	44,6	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	41,59	L/min	11,95	10,98	gal/min	-8,11%
Inlet Temperature	30,0	29,7	C	86,0	85,58	F	
Outlet Temperature	35,0	34,97	C	95,0	94,95	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	64,4	1531	70,58	1496	147,96	222,14	159	217
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	28,97	1510	27,52	1481	84,15	219,08	81,53	214,83
Subcooling, at expan. device	5,13		4,53		9,23		8,15	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	4,53	487	2,55	449	40,17	70,63	36,6	65,21
Evaporator Superheat	2,67		2,74		4,80		4,93	

<b>Data Source(s) for Refrigerant Properties</b>
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

<b>Additional Notes</b>
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss

Manufacturer's Notation: DHP-AQ 16

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R444B (48,5% R-1234ze, 41,5% R-32, 10% R-152A)
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A2W35						
Compressor Type		ZH38K4 E-TDF-524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> /min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	4,6	kg	11,464	10,14	lb	-11,5%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	2,0	2,00	C	35,6	35,6	F
		wb	1,01	1,01	C	33,82	33,8	F
Total Capacity		13788	13167	W	47047	44929	Btu/hr	-4,5%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3504	3429	W	3504	3429	W	-2,14%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		3,93	3,83					-2,54%

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.

## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP

Alternate Refrigerant: R444B

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	2,00	2,00	C	35,6	35,6	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	41,58	L/min	11,95	10,98	gal/min	-8,11%
Inlet Temperature	30,7	30,49	C	87,26	86,89	F	
Outlet Temperature	35	34,98	C	95,0	94,97	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	67,11	1512	74,94	1505	152,8	219,33	166,89	218,41
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	27,88	1496	27,17	1493	82,19	217	80,91	216,61
Subcooling, at expan. device	5,84		5,2		10,51		9,36	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	-1,13	404	-2,56	380	29,95	58,72	27,37	55,2
Evaporator Superheat	1,83		1,56		3,29		2,8	

<b>Data Source(s) for Refrigerant Properties</b>
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

<b>Additional Notes</b>
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_



## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R444B (48,5% R-1234ze, 41,5% R-32, 10% R-152A)
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A -7W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	4,6	kg	11,464	10,14	lb	-11,5%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	-6,99	-6,98	C	19,41	19,42	F
		wb	-8,0	-8,26	C	17,48	17,12	F
Total Capacity		10905	10374	W	37210	35389	Btu/hr	-4,89%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3350	3296	W	3350	3296	W	-1,61%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		3,25	3,14					-3,38%

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.

Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.
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## **Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM**

Type of System: Air to water HP

Alternate Refrigerant: R444B

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	-6,99	-6,98	C	19,41	19,42	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	41,58	L/min	11,95	10,98	gal/min	-8,11%
Inlet Temperature	31,6	31,47	C	88,88	88,64	F	
Outlet Temperature	35	34,99	C	95	94,99	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	73,94	1518	84,84	1518	165,1	220,25	184,71	220,22
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	27,4	1507	26,15	1509	81,37	218,61	79,07	218,91
Subcooling, at expan. device	6,59		6,64		11,86		11,95	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	-9,86	306	-10,51	286	14,23	44,44	13,0	41,56
Evaporator Superheat	1,92		2,48		3,45		4,46	

<b>Data Source(s) for Refrigerant Properties</b>
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

<b>Additional Notes</b>
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R444B (48,5% R-1234ze, 41,5% R-32, 10% R-152A)
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A -15W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	Lb	n.a.
Refrigerant Charge		5,2	4,6	kg	11,464	10,14	Lb	-11,5%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	-14,99	-15,00	C	5,0	4,99	F
		wb	-15,51	-15,48	C	4,07	4,12	F
Total Capacity		8813	8407	W	30072	28685	Btu/hr	-4,61%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3180	3138	W	3180	3138	W	-1,32%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		2,77	2,67					-3,61%

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.

## **Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM**

Type of System: Air to water HP

Alternate Refrigerant: R444B

(e.g., SSHP, window RAC, chiller, etc.) (and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	-14,99	-15,0	C	5,0	4,99	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	41,58	L/min	11,95	10,98	gal/min	-8,11%
Inlet Temperature	32,27	32,15	C	90,0	89,99	F	
Outlet Temperature	35	35,0	C	95	95,0	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	80,43	1518	93,84	1535	176,7	220,29	200,92	222,65
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	27,0	1510	25,81	1527	80,7	219,0	78,47	221,6
Subcooling, at expan. device	7,02		7,46		12,63		13,42	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	-18,25	221	-17,48	213	-0,85	35,0	0,53	30,99
Evaporator Superheat	1,27		1,93		2,28		3,47	

Data Source(s) for Refrigerant Properties
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

Additional Notes
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R290
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A12W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	2,6	kg	11,464	5,73	lb	-50%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	12,0	12,00	C	53,6	53,6	F
		wb	11,0	11,00	C	51,81	51,8	F
Total Capacity		17956	15779	W	61270	53841	Btu/hr	-12,12%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3672	3009	W	3672	3009	W	-18,0%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		4,89	5,24					7,15%

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.

## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP \_\_\_\_\_

Alternate Refrigerant: R290 \_\_\_\_\_

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	12,00	12,00	C	53,6	53,6	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	40,68	L/min	11,95	10,74	gal/min	-10,12%
Inlet Temperature	29,36	29,47	C	84,85	85	F	
Outlet Temperature	35	34,99	C	95,00	94,99	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	62,34	1538	51,26	1245	144,22	223,17	124,28	180,6
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	31,12	1511	32,53	1226	88	219,2	90,55	177,8
Subcooling, at expan. device	3		2,75		5,4		4,95	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	9,19	568	8,66	5,46	48,55	82,42	47,59	79,24
Evaporator Superheat	3,02		3,71		5,43		6,67	

Data Source(s) for Refrigerant Properties
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

Additional Notes
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R290
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A7W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	2,6	kg	11,464	5,73	lb	-50%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	7,0	7,00	C	44,6	44,6	F
		wb	6,3	6,31	C	43,34	43,36	F
Total Capacity		15939	14285	W	54389	48745	Btu/hr	-10,37%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3593	2973	W	3593	2973	W	-17,25%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		4,43	4,8					8,35%

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.



## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP \_\_\_\_\_

Alternate Refrigerant: R290 \_\_\_\_\_

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	7,00	7,00	C	44,6	44,6	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	40,68	L/min	11,95	10,74	gal/min	-10,12%
Inlet Temperature	30,0	30	C	86,0	86,02	F	
Outlet Temperature	35,0	35	C	95,0	95	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	64,4	1531	51,95	1243	147,96	222,14	125,52	180
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	28,97	1510	29,67	1228	84,15	219,08	85,4	178,18
Subcooling, at expan. device	5,13		5,69		9,23		10,24	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	4,53	487	3,74	476	40,17	70,63	38,74	69,15
Evaporator Superheat	2,67		3,18		4,80		5,72	

**Data Source(s) for Refrigerant Properties**

REFPROP 9.1 with update on HMX.BNC file  
08.12.2014

**Additional Notes**

Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R290
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A2W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	2,6	kg	11,464	5,73	lb	-50%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	2,0	2,0	C	35,6	35,6	F
		wb	1,01	0,98	C	33,82	33,77	F
Total Capacity		13788	12573	W	47047	42901	Btu/hr	-8,81%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3504	2951	W	3504	2951	W	-15,78
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		3,93	4,25					8,14%

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.

## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP \_\_\_\_\_

Alternate Refrigerant: R290 \_\_\_\_\_

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	2,00	2,00	C	35,6	35,6	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	40,68	L/min	11,95	10,74	gal/min	-10,12%
Inlet Temperature	30,7	30,6	C	87,26	87,12	F	
Outlet Temperature	35	35	C	95,0	95,0	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T [C]	P [kPa]	T [C]	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	67,11	1512	53,54	1244	152,8	219,33	128,38	180,49
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	27,88	1496	28,0	1232	82,19	217	82,45	178,69
Subcooling, at expan. device	5,84		7,45		10,51		13,41	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	-1,13	404	-1,54	403	29,95	58,72	29,21	58,5
Evaporator Superheat	1,83		2,33		3,29		4,19	

Data Source(s) for Refrigerant Properties
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

Additional Notes
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R290
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A -7W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	2,6	kg	11,464	5,73	lb	-50%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	-6,99	-6,98	C	19,41	19,41	F
		wb	-8,0	-8,0	C	17,48	17,43	F
Total Capacity		10905	10180	W	37210	34738	Btu/hr	-6,64%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3350	2922	W	3350	2922	W	-12,77%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		3,25	3,48					7,0%

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.

## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP \_\_\_\_\_

Alternate Refrigerant: R290 \_\_\_\_\_

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	-6,99	-6,98	C	19,41	19,4	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	40,67	L/min	11,95	10,74	gal/min	-10,12%
Inlet Temperature	31,6	31,46	C	88,88	88,63	F	
Outlet Temperature	35	35	C	95	95	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T [C]	P [kPa]	T [C]	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	73,94	1518	57,83	1243	165,1	220,25	136,1	180,4
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	27,4	1507	27,31	1234	81,37	218,61	81,17	179,0
Subcooling, at expan. device	6,59		8,24		11,86		14,83	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	-9,86	306	-10,17	315	14,23	44,44	13,68	45,77
Evaporator Superheat	1,92		1,56		3,45		2,8	

### Data Source(s) for Refrigerant Properties

REFPROP 9.1 with update on HMX.BNC file  
08.12.2014

### Additional Notes

Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

## Low GWP AREP SYSTEM DROP-IN TEST DATA FORM

Manufacturer: Danfoss \_\_\_\_\_

Manufacturer's Notation: DHP-AQ 16 \_\_\_\_\_

<b>Basic Information</b>	
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)	R290
Alternative Lubricant Type and ISO Viscosity	n.a.
Baseline Refrigerant and Lubricant	R407C / EMKARATE RL32-3MAF
Make and Model of System	Danfoss DHP-AQ 16
Nominal Capacity and Type of System	A7 W35 15,3kW; Air to water HP

Comparison Data		Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Heating Mode		App A -15W35						
Compressor Type		ZH38K4 E-TDF- 524	n.a.					
Compressor Displacement		0,24	n.a.	m <sup>3</sup> /min	8,475	n.a.	ft <sup>3</sup> min	n.a.
Nominal Motor Size		5	n.a.	hp				n.a.
Motor Speed		2900	n.a.	rpm				n.a.
Expansion Device Type		Danfoss ETS6	n.a.					
Lubricant Charge		1,9	n.a.	kg	4,18	n.a.	lb	n.a.
Refrigerant Charge		5,2	2,6	kg	11,464	5,73	lb	-50%
Refrigerant Mass Flow Rate		n.a.	n.a.	kg/min	n.a.	n.a.	lb/min	n.a.
Composition, at compr. inlet if applicable			n.a.	% wt				
Ambient Temps.	Indoor	db	n.a.	n.a.	C	n.a.	n.a.	F
		wb	n.a.	n.a.	C	n.a.	n.a.	F
	Outdoor	db	-14,99	-15,00	C	5,0	4,99	F
		wb	-15,51	-15,44	C	4,07	4,19	F
Total Capacity		8813	8370	W	30072	28562	Btu/hr	-5,0%
Sensible Capacity		n.a.	n.a.	W	n.a.	n.a.	Btu/hr	n.a.
Total System Power Input		3180	2811	W	3180	2811	W	-11,6%
Compressor Power Input		n.a.	n.a.	W	n.a.	n.a.	W	n.a.
Energy Efficiency Ratio (EER)		n.a.	n.a.	W/W	n.a.	n.a.	Btuh/W	n.a.
Coeff. Of Performance (COP)		2,77	2,97					7,22%

<b>Other System Changes</b>
n.a.

System Data	Base.	Alt.	Ratio
Degradation Coefficient – Cd	n.a.	n.a.	n.a.
Seasonal Energy Efficiency Ratio - SEER	n.a.	n.a.	n.a.
Heating Seasonal Performance Factor - HSPF	n.a.	n.a.	n.a.

## Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: Air to water HP \_\_\_\_\_

Alternate Refrigerant: R290 \_\_\_\_\_

(e.g., SSHP, window RAC, chiller, etc.)

(and composition as charged, % weight, if not proprietary)

Air/Water Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	n.a.	n.a.	L/min	n.a.	n.a.	gal/min	n.a.
Inlet Temperature	-14,99	-15	C	5,0	5,0	F	
Outlet Temperature	n.a.	n.a.	C	n.a.	n.a.	F	
Condenser							
Heat Exchange Fluid	Water	Water					
Flow Rate (gas)	n.a.	n.a.	m <sup>3</sup> /min	n.a.	n.a.	ft <sup>3</sup> /min	n.a.
Flow Rate (liquid)	45,25	40,67	L/min	11,95	10,74	gal/min	-10,12%
Inlet Temperature	32,27	32,0	C	90,0	89,77	F	
Outlet Temperature	35	34,99	C	95	94,98	F	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Compressor Discharge	80,43	1518	61,8	1244	176,7	220,29	143,24	180,5
Condenser Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Condenser Outlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Expansion Device Inlet	27,0	1510	26,98	1236	80,7	219,0	80,56	179,34
Subcooling, at expan. device	7,02		8,65		12,63		15,57	
Evaporator Inlet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Evaporator Outlet	-18,25	221	-18,38	243	-0,85	35,0	-1,1	35,25
Evaporator Superheat	1,27		1,08		2,28		1,94	

Data Source(s) for Refrigerant Properties
REFPROP 9.1 with update on HMX.BNC file 08.12.2014

Additional Notes
Refrigerant data are average from a stable condition minimum 30min. maximum 70min..

Submitted by: \_\_\_\_\_

**Appendix B: Analyse of the results with 30 min equilibrium time and 30 min data acquisition time – not according to standard.**

Capacity	R-407C	DR3		R-444B		R-290	
	kW	kW	%	kW	%	kW	%
A12W35	17,96	17,04	-5,1	18,06	+0,6	15,78	-12,1
A7W35	15,94	14,89	-6,6	15,23	-4,4	14,29	-10,4
A2W35	13,79	12,83	-6,9	13,17	-4,5	12,57	-8,8
A-7W35	10,91	10,03	-8,0	10,37	-4,9	10,18	-6,6
A-15W35	8,81	8,24	-6,5	8,41	-4,6	8,37	-5,0

Table A2.1: Capacities measured with fixed outlet water temperature and fixed water flow with deviation from base line refrigerant. This table is based on same data as table 5.

COP	R-407C	DR3		R-444B		R-290	
			%		%		%
A12W35	4,89	4,87	-0,4%	5,03	2,9%	5,24	7,2%
A7W35	4,43	4,37	-1,4%	4,38	-1,1%	4,80	8,4%
A2W35	3,93	3,83	-2,5%	3,84	-2,3%	4,26	8,4%
A-7W35	3,25	3,13	-3,7%	3,14	-3,4%	3,48	7,1%
A-15W35	2,77	2,71	-2,2%	2,68	-3,2%	2,98	7,6%

Table A2.2: COP measured with fixed outlet water temperature and fixed water flow with deviation from base line refrigerant. This table is based on same data as table 6.



Capacity	R-407C	DR3		R-444B		R-290	
	kW	kW	%	kW	%	kW	%
A12WA35	17,48	16,38	-6,3	17,46	-0,1	15,18	-13,1
A7WA35	15,84	14,55	-8,1	15,26	-3,6	14,00	-11,6
A2WA35	13,82	12,79	-7,5	12,99	-6,0	12,56	-9,2
A-7WA35	10,91	10,03	-8,0	10,37	-4,9	10,18	-6,6
A-15WA35	8,82	8,28	-6,1	8,37	-5,1	8,44	-4,2

Table A2.3: Measured capacities for SCOP calculations with deviation from base line refrigerant. This table is based on same data as table 8.

COP	R-407C	DR3		R-444B		R-290	
			%		%		%
A12WA35	4,39	4,34	-1,1	4,44	+1,1	4,66	+6,2
A7WA35	4,15	4,07	-1,9	4,11	-1,0	4,43	+6,7
A2WA35	3,83	3,70	-3,4	3,66	-4,4	4,16	+8,6
A-7WA35	3,25	3,13	-3,7	3,14	-3,4	3,48	+7,1
A-15WA35	2,87	2,78	-3,1	2,78	-3,1	3,11	+8,4

Table A2.4: Measured and calculated COP's for SCOP calculations with deviation from base line refrigerant. This table is based on same data as table 9.

	R-407C	DR3		R-444B		R-290	
			%		%		%
Design capacity, kW	12,33	11,34	-8,1	11,73	-4,9	11,51	-6,7
SCOP	3,70	3,60	-2,7	3,55	-4,1	3,97	+7,3

Table A2.5: Design capacity and SCOP with deviations from base line refrigerant calculated with fixed bivalent point of -7C and fixed outlet water temperature for heating season average and low temperature application according to EN14825. This table is based on same data as table 10.