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P2004625 – SVAF II – Sea- and sewage water

Test program and manual

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1 Introduction

This document describes the test program that is to be conducted as a part of the SVAF project concerning the development and test of a sea and sewage water heat pump. The project is supported by the EUDP fund of the Danish Energy Agency.

The test facility will be used to test a sea and cleansed sewage water as individual heat sources. The overall goal is to test the energy efficiency (COP) and the operation expenses under different modes of operation in order to evaluate if the technology is competitive as a heat production technology supplying the larger Copenhagen area. Furthermore, a critical parameter is security of supply with regards to fouling of the heat exchanger and especially with regards low seawater temperatures in the winter, which is often influenced by specific factors such as depth, flow, and salinity and hence regional knowledge is the key.

The test is divided into three parts.

The first part describes the test which are part of the SAT (site acceptance test) test described in P2004625-SVAF-SAT test-Rev03.

The second part describes the test that have been named short-term test and are beyond SAT test. The measurements from both SAT and short time tests are used to verify the models made by DTU. The data are also used to define which control loops should be implemented in the automatic heat pump tuning module named HP AutoTune and will also be used as a basis data for the running analyses module named HP Doctor where it represents a reference case data.

The last part describes the long-term tests. The purpose of these tests is to verify the function of the HP AutoTune and HP Doctor over longer period. Here the running conditions are compared to the basic case and the adjustments of the HP AutoTune and HP Doctor evaluated.

The SAT test is expected to take fifteen days. The short term test is expected to cover a period of approximately two months and the main focus is testing COP under various modes of operation. The long term test is expected to last approximately two years. The issues investigated in this third stage covers automatic optimisation of COP (HP AutoTune) and operational expenses (HP Doctor) respectively with the help of models developed by the Technological University of Denmark (DTU) in cooperation with DTI.

2 SAT test

The SAT test is part of the delivery of the heat pump system from Innotherm. The test described here is to verify that the heat pump installation can run in the range described in the offer from the producer of the heat pump compressors GEA.

The SAT test consist of 11 tests described in the following. Starting with two performance test one for seawater and the other for sewage water. The performance test is required as part of the commissioning of the heat pumps. The following 9 tests are performed to verify that the heat pump can run in the running envelope described by GEA. If the heat pump is found not to be able to run in the total running envelope, a dialogue will follow with the contractor Innotherm as to how to solve this, but it is not an issue of not accepting the heat pump.

Name of test	2.1 Performance test - Seawater		
Purpose	The purpose of the test is to verify that the heat pump will give the stated COP _H and the heat load in the offer from GEA within permissible deviations.		
Short description	The heat pump is adjusted to factory settings i.e. the following points for the heat pump system is adjusted to the values in table below. The seawater flow to the evaporators is parallel connected.		
		Sensor	Value
	Adjustments		
	District heating inlet temperature	TT4250	50°C
	District heating outlet temperature	TT4223	80°C
	District heating flow	FT4261	144m ³ /h
	Seawater inlet temperature	TT4125	4,0°C
	Seawater outlet temperature	TT4223	0,5°C
	Seawater flow to each evaporator	FT4263+FT4162	471,6
	Requirements		
	Total COP _H minimum		2,88
	Maximum district heating load		5265kW
	Measurements	<ul style="list-style-type: none"> Measurements on the power intake to the heat pumps and the energy on the district heating site Calculation of the COP for both heat pump 1 and 2 and the total COP for both heat pumps The measurements should be logged at least every 10 sec (or as often as possible)	
Special equipment	The running conditions should be accepted by Innotherm, HOFOR and COWI.		
Expected duration	1 test. Running with 30 minutes for stabilising the system and 60 minutes for stable running condition without alarms where measurements are taken. Total 90 minutes.		
Horizont	Week 8		
Special conditions required	10 measurements are taken over the 60 minutes with 6 minutes' interval and the average of these 10 measurements used as the average COP.		
Coordination with other tests (?)			
Success criteria	The heat COP _H is above the one in the table above and the district heating load is lower than the one given in the table above.		
Participants	HOFOR, DTI, Innoterm, DTU MEK		
Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI		
Comments			

Name of test	2.2 Performance test – Sewage water																																									
Purpose	The purpose of the test is to verify that the heat pump will give the stated COP _H and the heat load in the offer from GEA within permissible deviations.																																									
Short description	<p>The heat pump is adjusted to factory settings i.e. the running conditions for the heat pump system is adjusted to the values in table below. The sewage water flow to the evaporators is serial connected.</p> <table border="1"> <thead> <tr> <th></th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td colspan="3">Adjustments</td> </tr> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>District heating flow</td> <td>FT4261</td> <td>141m³/h</td> </tr> <tr> <td>Seawater inlet temperature HP1</td> <td>TT4127</td> <td>7,0°C</td> </tr> <tr> <td>Seawater outlet temperature HP1</td> <td>TT4128</td> <td>4,0°C</td> </tr> <tr> <td>Seawater inlet temperature HP2</td> <td>TT4125</td> <td>10,0°C</td> </tr> <tr> <td>Seawater outlet temperature HP2</td> <td>TT4125</td> <td>7,0°C</td> </tr> <tr> <td>Seawater flow to evaporators</td> <td>FT4162</td> <td>550,8 m³/h</td> </tr> <tr> <td colspan="3">Requirements</td> </tr> <tr> <td>Total COP_H minimum</td> <td></td> <td>3,06</td> </tr> <tr> <td>Maximum district heating load</td> <td></td> <td>5146kW</td> </tr> </tbody> </table>				Sensor	Value	Adjustments			District heating inlet temperature	TT4250	50°C	District heating outlet temperature	TT4223	80°C	District heating flow	FT4261	141m ³ /h	Seawater inlet temperature HP1	TT4127	7,0°C	Seawater outlet temperature HP1	TT4128	4,0°C	Seawater inlet temperature HP2	TT4125	10,0°C	Seawater outlet temperature HP2	TT4125	7,0°C	Seawater flow to evaporators	FT4162	550,8 m ³ /h	Requirements			Total COP _H minimum		3,06	Maximum district heating load		5146kW
	Sensor	Value																																								
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Seawater flow to evaporators	FT4162	550,8 m ³ /h																																								
Requirements																																										
Total COP _H minimum		3,06																																								
Maximum district heating load		5146kW																																								
Measurements	<ul style="list-style-type: none"> Measurements on the power intake to the heat pumps and the energy on the district heating site Calculation of the COP for both heat pump 1 and 2 and the total COP for both heat pumps <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																																									
Special equipment	The running conditions should be accepted by Innotherm, HOFOR and COWI.																																									
Expected duration	1 test. Running with 30 minutes for stabilising the system and 60 minutes for stable running condition without alarms where measurements are taken. Total 90 minutes.																																									
Horizon	Week 8																																									
Special conditions required	10 measurements are taken over the 60 minutes with 6 minutes' interval and the average of these 10 measurements used as the average COP.																																									
Coordination with other tests (?)																																										
Success criteria	The heat COP _H is above the one in the table above and the district heating load is lower than the one given in the table above.																																									
Participants	HOFOR, DTI, Innoterm, DTU MEK																																									
Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI																																									
Comments																																										

Name of test	2.3 District heating maximum temperature																	
Purpose	The purpose of the test is to verify that the heat pump can operate at the maximum temperature on water into the district heating system with seawater as a source.																	
Short description	<p>The heat pump is adjusted to factory settings. Then the temperature set point of the HP2 will be set to the highest possible i.e. 90°C with other parameters as described in the table beneath. The temperature on the source is the one available when the test is conducted. The heat pump source for this test is seawater. And the flow on the seawater side is parallel.</p> <table border="1"> <thead> <tr> <th></th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>57°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>74°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>90°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>5000kW</td> </tr> </tbody> </table>				Sensor	Value	District heating inlet temperature	TT4250	57°C	District heating intermediate temperature	TT4227	74°C	District heating outlet temperature	TT4223	90°C	Heat pump system load	02EM4262	5000kW
	Sensor	Value																
District heating inlet temperature	TT4250	57°C																
District heating intermediate temperature	TT4227	74°C																
District heating outlet temperature	TT4223	90°C																
Heat pump system load	02EM4262	5000kW																
Measurements	<ul style="list-style-type: none"> Measurements on the district heating outlet temperature Measurements of total COP and COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																	
Special equipment	No special equipment required																	
Expected duration	2 test. Each with 30 minutes for stabilising the system and 30 minutes for stable running condition without alarms. Total 120 minutes.																	
Horizon	Week 8																	
Special conditions required	No special conditions required																	
Coordination with other tests (?)	Coordinated with tests 3.1																	
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																	
Participants	HOFOR, DTI, Innoterm, DTU MEK																	
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																	
Comments																		

Name of test	2.4 District heating minimum temperature																	
Purpose	The purpose of the test is to verify that the heat pump can operate at the minimum temperature on water into the district heating system with seawater as a source.																	
Short description	<p>The heat pump is adjusted to factory settings. Then the temperature set point of the HP2 will be set to the lowest possible i.e. 66°C with other parameters as described in table beneath.</p> <table border="1"> <thead> <tr> <th></th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>44°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>56°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>66°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>5000kW</td> </tr> </tbody> </table>				Sensor	Value	District heating inlet temperature	TT4250	44°C	District heating intermediate temperature	TT4227	56°C	District heating outlet temperature	TT4223	66°C	Heat pump system load	02EM4262	5000kW
	Sensor	Value																
District heating inlet temperature	TT4250	44°C																
District heating intermediate temperature	TT4227	56°C																
District heating outlet temperature	TT4223	66°C																
Heat pump system load	02EM4262	5000kW																
Measurements	<ul style="list-style-type: none"> Measurements of DH outlet temperature Measurements of total COP and COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																	
Special equipment	No special equipment required																	
Expected duration	2 test. Each with 30 minutes for stabilising the system and 30 minutes for stable running condition without alarms. Total of 120 minutes.																	
Horizon	Week 8																	
Special conditions required	No special conditions required																	
Coordination with other tests (?)	Coordinated with test 3.1																	
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																	
Participants	HOFOR, DTI, Innoterm, DTU MEK																	
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																	
Comments																		

Name of test	2.5 District heating intermediate temperature limits																	
Purpose	The purpose of the test is to verify that the heat pump system can run with set point to the HP1 that can be varied within the limits expected.																	
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the district heating intermediate temperature is changed i.e. the temperature set point to HP1. First, the temperature set point is increased until highest available value is reached. This value is reached when HP2 is running on its lowest capacity. Then the system runs for 30 min with stable running conditions without alarms. Then the temperature set point is reduced until the HP1 is running on lowest set point available and the let the system run for 30 min on stable running conditions. This condition is reached when HP1 is running on lowest capacity. The temperature set point for HP1 is changed by changing the distribution factor that determines the HP1 set point. The heat pump source is seawater.</p> <table border="1"> <thead> <tr> <th></th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>60/70°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>3000kW</td> </tr> </tbody> </table>				Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	60/70°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	3000kW
	Sensor	Value																
District heating inlet temperature	TT4250	50°C																
District heating intermediate temperature	TT4227	60/70°C																
District heating outlet temperature	TT4223	80°C																
Heat pump system load	02EM4262	3000kW																
Measurements	<ul style="list-style-type: none"> Measurement of the intermediate DH temperature in between HP1 and HP2 Measurements of total COP, COP for both heat pump 1 and 2 Mass flow, temperatures, pressure and levels in the HP cycle <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																	
Special equipment	No special equipment required																	
Expected duration	2 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.																	
Horizon	Week 8																	
Special conditions required	No special conditions required																	
Coordination with other tests (?)	Coordinated with test 3.3																	
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																	
Participants	HOFOR, DTI, Innoterm, DTU MEK																	
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																	
Comments																		

Name of test	2.6 Saturated temperature limit on intermediate stage																							
Purpose	The purpose of the test is to verify that the HP1 and HP2 can run with intermedium temperature within the limits expected.																							
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the load distribution factor between LS and HS for HP1 and HP2 is changed. This will change the intermediate temperature from the lowest available to the highest available. First, the intermediate temperature is moved to the highest available value by moving more load over to the LS compressor. When the highest value is reached then the system should run for 30 min with stable running conditions without alarms. Then the intermediate temperature is reduced to the lowest value by shifting the load to the HS compressor. The system should run for 30 min on stable running conditions. The source for this test is seawater.</p> <table border="1"> <thead> <tr> <th></th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Compressors intermediate temperature HP1</td> <td>TT500.01</td> <td>25-40°C</td> </tr> <tr> <td>Compressors intermediate temperature HP2</td> <td>TT550.01</td> <td>25-40°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>2500kW</td> </tr> </tbody> </table>				Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Compressors intermediate temperature HP1	TT500.01	25-40°C	Compressors intermediate temperature HP2	TT550.01	25-40°C	Heat pump system load	02EM4262	2500kW
	Sensor	Value																						
District heating inlet temperature	TT4250	50°C																						
District heating intermediate temperature	TT4227	68°C																						
District heating outlet temperature	TT4223	80°C																						
Compressors intermediate temperature HP1	TT500.01	25-40°C																						
Compressors intermediate temperature HP2	TT550.01	25-40°C																						
Heat pump system load	02EM4262	2500kW																						
Measurements	<ul style="list-style-type: none"> Measurement of the saturated intermediate temperature for both HP1 and HP2 Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																							
Special equipment	No special equipment required																							
Expected duration	4 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 360 min.																							
Horizon	Week 9																							
Special conditions required	No special conditions required																							
Coordination with other tests (?)	Coordinated with test 3.3																							
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																							
Participants	HOFOR, DTI, Innoterm, DTU MEK																							
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																							
Comments																								

Name of test	2.7 District heating capacity limit																	
Purpose	The purpose of the test is to verify lowest and highest capacity of the heat pump system.																	
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the heating capacity limit is tested by entering the lowest value in the SCADA system until the heat pump system is on lowest capacity. This is reached when all compressors are running on lowest capacity. Then the flow is adjusted upwards until the maximum capacity is reached. This is reached when all compressors are at 100% capacity. The heat source for this test is seawater.</p> <table border="1"> <thead> <tr> <th></th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4257</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load (min/max)</td> <td>02EM4262</td> <td>Min/5200kW</td> </tr> </tbody> </table>				Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4257	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load (min/max)	02EM4262	Min/5200kW
	Sensor	Value																
District heating inlet temperature	TT4250	50°C																
District heating intermediate temperature	TT4257	68°C																
District heating outlet temperature	TT4223	80°C																
Heat pump system load (min/max)	02EM4262	Min/5200kW																
Measurements	<ul style="list-style-type: none"> Measurement of the heat pump capacity and district heating flow Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																	
Special equipment	No special equipment required																	
Expected duration	2 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.																	
Horizon	Week 9																	
Special conditions required	No special conditions required																	
Coordination with other tests (?)	Coordinated with test 3.2																	
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																	
Participants	HOFOR, DTI, Innoterm, DTU MEK																	
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																	
Comments																		

Name of test	2.8 Source side capacity limit																						
Purpose	The purpose of the test is to verify that the heat pump can run in the source flow range specified.																						
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the flow limits on the source side i.e. the seawater and sewage water is changed by changing the flow from minimum to maximum. This is done by changing the set point for the pumps i.e. the Δt over the source side. The bigger the Δt the lower the flow. Start with high Δt that represents minimum flow. Thereafter increase the flow by decreasing the Δt until maximum flow is reached. When the flow through the heat exchangers working in series is lower than recommended, the flow is changed to parallel. Two temperatures are tested one for the seawater which represents a low temperature and another for sewage water which represents warmer temperatures. The heat source is both seawater and sewage water.</p> <table border="1"> <thead> <tr> <th></th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4257</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>3000kW</td> </tr> <tr> <td>Seawater flow (min/max)</td> <td>FT4162+FT4163</td> <td>78/310(m³/h)</td> </tr> <tr> <td>Sewage water flow (min/max)</td> <td>FT4162</td> <td>78/155(m³/h)</td> </tr> </tbody> </table>			Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4257	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	3000kW	Seawater flow (min/max)	FT4162+FT4163	78/310(m ³ /h)	Sewage water flow (min/max)	FT4162	78/155(m ³ /h)
	Sensor	Value																					
District heating inlet temperature	TT4250	50°C																					
District heating intermediate temperature	TT4257	68°C																					
District heating outlet temperature	TT4223	80°C																					
Heat pump system load	02EM4262	3000kW																					
Seawater flow (min/max)	FT4162+FT4163	78/310(m ³ /h)																					
Sewage water flow (min/max)	FT4162	78/155(m ³ /h)																					
Measurements	<ul style="list-style-type: none"> Measurement of the source side flow Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																						
Special equipment	No special equipment required																						
Expected duration	4 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 360 min.																						
Horizon	Week 9																						
Special conditions required	No special conditions required																						
Coordination with other tests (?)	Coordinated with test 3.5																						
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																						
Participants	HOFOR, DTI, Innoterm, DTU MEK																						
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																						
Comments																							

Name of test	2.9 Source side capacity distribution																							
Purpose	The purpose of the test is to verify that the heat pump can vary the flow distribution on the source side between the evaporators for HP1 and HP2.																							
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the flow is running in parallel through the evaporators and the capacity distribution between HP1 and HP2 on the source side is changed by changing the distribution through the evaporators. The flow through HP2 evaporator is increased by changing the flow distribution factor in SCADA until the HP2 is running on 100% capacity. Then the flow is decreased until HP2 is running on lowest capacity. The source for this test is sewage water.</p> <table border="1"> <thead> <tr> <th></th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4257</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>3000kW</td> </tr> <tr> <td>Sewage water flow</td> <td>FT4162+FT4163</td> <td>145(m³/h)</td> </tr> <tr> <td>Sewage water flow through HP2</td> <td>FT4162</td> <td>Min/Max%</td> </tr> </tbody> </table>				Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4257	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	3000kW	Sewage water flow	FT4162+FT4163	145(m ³ /h)	Sewage water flow through HP2	FT4162	Min/Max%
	Sensor	Value																						
District heating inlet temperature	TT4250	50°C																						
District heating intermediate temperature	TT4257	68°C																						
District heating outlet temperature	TT4223	80°C																						
Heat pump system load	02EM4262	3000kW																						
Sewage water flow	FT4162+FT4163	145(m ³ /h)																						
Sewage water flow through HP2	FT4162	Min/Max%																						
Measurements	<ul style="list-style-type: none"> Measurement of the source side flow through each evaporator Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																							
Special equipment	No special equipment required																							
Expected duration	2 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.																							
Horizon	Week 9																							
Special conditions required	No special conditions required																							
Coordination with other tests (?)	Coordinated with tests ?? and ??																							
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																							
Participants	HOFOR, DTI, Innoterm, DTU MEK																							
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																							
Comments																								

Name of test	2.10 Heat exchangers limits		
Purpose	The purpose of the test is to verify that the heat exchangers for superheat, sub cooling and oil can operate in their flow range.		
Short description	The heat pump is adjusted to factory settings. Then in this test, the various limits for the heat exchangers for super heat, sub cooling and oil are tested. The flow through each heat exchanger is tested on min and max flow and tested if the heat pump can work in the area without running into capacity limitations or warnings. The min and max flows are reached by changing the set points for each loop accordingly. The heat source is seawater.		
	Test 2.10	Sensor	Value
	District heating inlet temperature	TT4250	50°C
	District heating intermediate temperature	TT4257	68°C
	District heating outlet temperature	TT4223	80°C
	Heat pump system load	FT4261	3000kW
	Desuperheater HP1 LS flow	FT4269	3,5/8,8(m ³ /h)
	Desuperheater HP2 LS flow	FT4271	3,5/8,8(m ³ /h)
	Desuperheater HP1 HS flow	FT4254	0,3/6,7(m ³ /h)
	Desuperheater HP2 HS flow	FT4266	4,5/11(m ³ /h)
	Oil cooler HP1 LS flow	FT4267	2,7/3,3(m ³ /h)
	Oil cooler HP2 LS flow	FT4270	2,7/3,3(m ³ /h)
	Oil cooler HP1 HS flow	FT4268	1,9/2,3(m ³ /h)
	Oil cooler HP2 HS flow	FT4272	4,1/5,0(m ³ /h)
	Subcooler HP1 HS flow	FT4263	2,2/6,7(m ³ /h)
Subcooler HP2 HS flow	FT4265	3,5/17,0(m ³ /h)	
Measurements	<ul style="list-style-type: none"> ▪ Measurement of the source side flow through each heat exchanger ▪ Measurements of total COP, COP for both heat pump 1 and 2 The measurements should be logged at least every 10 sec (or as often as possible)		
Special equipment	No special equipment required		
Expected duration	20 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 1200 min.		
Horizon	Week 10		
Special conditions required	No special conditions required		
Coordination with other tests (?)	Coordinated with tests 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15 and 3.16		
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.		
Participants	HOFOR, DTI, Innoterm, DTU MEK		

Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI
Comments	

Name of test	2.11 Start up and shut down times																	
Purpose	The purpose of the test is to measure the actual start up and shut down times of the heat pump system and the average COP during that process to be able to estimate possible reduction.																	
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the compressor runs on stable running condition described in the table below. The stop button is pressed and during shut down the system is monitored and the COP measured. The time until the heat pump system has come to a complete stop is measured. The system is kept stopped for 30 min and then the start button is pressed. The system is monitored during start up and until stable running condition is established again. The heat source is seawater.</p> <table border="1"> <thead> <tr> <th></th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4257</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>5000kW</td> </tr> </tbody> </table>				Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4257	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	5000kW
	Sensor	Value																
District heating inlet temperature	TT4250	50°C																
District heating intermediate temperature	TT4257	68°C																
District heating outlet temperature	TT4223	80°C																
Heat pump system load	02EM4262	5000kW																
Measurements	<ul style="list-style-type: none"> Measurements of start-up and shut down times Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																	
Special equipment	No special equipment required																	
Expected duration	1 tests. Each with 30 min for reaching stable condition and then estimated 30 minutes for stopping the system. Then with 30 minutes delay until start again and therefrom estimated 30 minutes start up time and 30 minutes for stable running conditions. Total 150 min.																	
Horizon	Week 10																	
Special conditions required	No special conditions required																	
Coordination with other tests (?)																		
Success criteria																		
Participants	HOFOR, DTI, Innoterm, DTU MEK																	
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																	
Comments																		

3 Short term test

In the short term test, expected to last approximately two months, focus is on testing the COP under various modes of operation. The effect of the different control loops that are a part of the HP AutoTune is tested. The data from this test is also used in the basis case for the HP Doctor and to verify the statistical model of the heat pump. In the SAT test the limit points are measured and here the remaining intermediate points from are measured. By combining them the total range for the measured points is reached.

Name of test	3.1 DH temperature sensitivity on COP		
Purpose	The purpose of the test is to get a graph over the sensitivity of the heat pump set point i.e. the temperature on the district heating water into the net on the COP.		
Shot description	The heat pump is adjusted to factory settings. Then the temperature set point of the HP2 will be set to the values stated in the table below. After changing the set point the system is allowed to stabilize and then run for 30 minutes for each measuring points. This test is conducted with seawater as source.		
		Sensor	Value
	District heating inlet temperature	TT4250	50°C
	District heating intermediate temperature	TT4227	According to distribution factor
	District heating outlet temperature set point	TT4223	74/82°C
	Heat pump system load	02EM4262	5000kW
Measurements	<ul style="list-style-type: none"> Measurements of the district heating outlet temperature set point Measurements of total COP, COP for both heat pump 1 and 2 The measurements should be logged at least every 10 sec (or as often as possible)		
Special equipment	No special equipment required		
Expected duration	2 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.		
Horizon	Week 10		
Special conditions required	No special conditions required		
Coordination with other tests (?)	Should be conducted with tests 2.3 and 2.4 which is the min and max measurements where here the intermediate points area measured.		
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.		
Participants	HOFOR, DTI, Innoterm, DTU MEK		
Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI		
Comments			

Name of test	3.2 Capacity sensitivity on COP																	
Purpose	The purpose of the test is to get a graph over the sensitivity of the heat pump capacity on the COP.																	
Short description	<p>The heat pump is adjusted to factory settings. Then the capacity of the HP2 will be set to the values stated in the table below. After changing the set point the system is allowed to stabilize and then run for 30 minutes for each measuring points. This test is conducted with seawater as source.</p> <table border="1"> <thead> <tr> <th>Test 3.2</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature set point</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>2000/3000/4000kW</td> </tr> </tbody> </table>			Test 3.2	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature set point	TT4223	80°C	Heat pump system load	02EM4262	2000/3000/4000kW
Test 3.2	Sensor	Value																
District heating inlet temperature	TT4250	50°C																
District heating intermediate temperature	TT4227	68°C																
District heating outlet temperature set point	TT4223	80°C																
Heat pump system load	02EM4262	2000/3000/4000kW																
Measurements	<ul style="list-style-type: none"> Measurements of the heat pumps system capacity Measurements of the district heating outlet temperature set point <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																	
Special equipment	No special equipment required																	
Expected duration	2 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.																	
Horizon	Week 10																	
Special conditions required	No special conditions required																	
Coordination with other tests (?)	Should be conducted with tests 2.3 and 2.4 which is the min and max measurements where here the intermediate points area measured.																	
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																	
Participants	HOFOR, DTI, Innoterm, DTU MEK																	
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																	
Comments																		

Name of test	3.3 Intermediate saturated temperature COP sensitivity for HP1 and HP2																							
Purpose	The purpose of the test is to get a graph over the sensitivity of the intermediate temperature on the COP.																							
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, we change the load distribution factor between LS and HS for HP1 and HP2. This will change the intermediate temperature from the lowest allowable to the highest allowable. First, we move the intermediate temperature to the highest available value by moving more load over to the LS compressor. When the highest value is reached then the system should run for 30 min with stable running conditions without alarms. Then the intermediate temperature is reduced in steps of 5°C until the lowest value is reached by shifting the load to the HS compressor. The system should run for 30 min on stable running conditions for each measuring point.</p> <table border="1"> <thead> <tr> <th>Test 3.3</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Compressors intermediate temperature HP1</td> <td>PT400.01</td> <td>35/30°C</td> </tr> <tr> <td>Compressors intermediate temperature HP2</td> <td>PT450.01</td> <td>35/30°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>2500kW</td> </tr> </tbody> </table>			Test 3.3	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Compressors intermediate temperature HP1	PT400.01	35/30°C	Compressors intermediate temperature HP2	PT450.01	35/30°C	Heat pump system load	02EM4262	2500kW
Test 3.3	Sensor	Value																						
District heating inlet temperature	TT4250	50°C																						
District heating intermediate temperature	TT4227	68°C																						
District heating outlet temperature	TT4223	80°C																						
Compressors intermediate temperature HP1	PT400.01	35/30°C																						
Compressors intermediate temperature HP2	PT450.01	35/30°C																						
Heat pump system load	02EM4262	2500kW																						
Measurements	<ul style="list-style-type: none"> HP1 and HP2 intermediate saturated temperature Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																							
Special equipment	No special equipment required																							
Expected duration	4 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 360 min.																							
Horizon	Week 10																							
Special conditions required	No special conditions required																							
Coordination with other tests (?)	Should be conducted with tests 2.6. Test 2.6 is the min and max measurements where here the intermediate points area measured.																							
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																							
Participants	HOFOR, DTI, Innoterm, DTU MEK																							
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																							
Comments																								

Name of test	3.4 HP1 set point sensitivity on COP																	
Purpose	The purpose of the test is to get a graph over the sensitivity of the set point adjustment for HP1 on the overall COP.																	
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the district heating intermediate temperature is changed i.e. the temperature set point to HP1. Starting from the highest available set point value. This value is reached when HP2 is running on its lowest capacity. Then the system runs for 30 min with stable running conditions without alarms. Then the temperature set point is reduced in steps until the HP1 is running on lowest set point available. After changes the system is allowed to stabilize and then kept running for 30 min on stable conditions. This is repeated until minimum set point is reached. This condition is reached when HP1 is running on lowest capacity.</p> <p>The heat source is seawater.</p> <table border="1"> <thead> <tr> <th>Test 3.4</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>63/65/67°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>3000kW</td> </tr> </tbody> </table>			Test 3.4	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	63/65/67°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	3000kW
Test 3.4	Sensor	Value																
District heating inlet temperature	TT4250	50°C																
District heating intermediate temperature	TT4227	63/65/67°C																
District heating outlet temperature	TT4223	80°C																
Heat pump system load	02EM4262	3000kW																
Measurements	<ul style="list-style-type: none"> Measurements of the district heating intermediate temperature Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																	
Special equipment	No special equipment required																	
Expected duration	3 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 270 min.																	
Horizon	Week 10																	
Special conditions required	No special conditions required																	
Coordination with other tests (?)	Should be conducted with tests 2.5 Test 2.5 is the min and max measurements where here the intermediate points area measured.																	
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																	
Participants	HOFOR, DTI, Innoterm, DTU MEK																	
Responsible for test	<p>Planning: Johannes, DTI</p> <p>Operation: Jógvan HOFOR</p> <p>Reporting/follow up after test: DTI</p>																	
Comments																		

Name of test	3.5 Seawater pump flow sensitivity on COP																				
Purpose	The purpose of the test is to get a graph over the sensitivity of the changes to flow on the source side on the overall COP.																				
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the flow sensitivity for the COP on the source side i.e. the seawater is changed by changing the flow from minimum to maximum in steps. This is done by changing the set point for the pumps i.e. the Δt over the source side. The bigger the Δt the lower the flow. Start with high Δt that represents minimum flow in the table or flow close to the recommended. Thereafter increase the flow in steps by decreasing the Δt until maximum flow in the table is reached.</p> <p>The heat source is seawater connected in parallel through the test.</p> <table border="1"> <thead> <tr> <th>Test 3.5</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>3000kW</td> </tr> <tr> <td>Seawater flow</td> <td>FT4263+FT4262</td> <td>100/150/200/250(m³/h)</td> </tr> </tbody> </table>			Test 3.5	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	3000kW	Seawater flow	FT4263+FT4262	100/150/200/250(m ³ /h)
Test 3.5	Sensor	Value																			
District heating inlet temperature	TT4250	50°C																			
District heating intermediate temperature	TT4227	68°C																			
District heating outlet temperature	TT4223	80°C																			
Heat pump system load	02EM4262	3000kW																			
Seawater flow	FT4263+FT4262	100/150/200/250(m ³ /h)																			
Measurements	<ul style="list-style-type: none"> Measurement of the sweater flow Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																				
Special equipment	No special equipment required																				
Expected duration	4 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 360 min.																				
Horizon	Week 11																				
Special conditions required	No special conditions required																				
Coordination with other tests (?)	Should be conducted with tests 2.8 which is the min and max measurements where here the intermediate points area measured.																				
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																				
Participants	HOFOR, DTI, Innoterm, DTU MEK																				
Responsible for test	<p>Planning: Johannes, DTI</p> <p>Operation: Jógvan HOFOR</p> <p>Reporting/follow up after test: DTI</p>																				
Comments																					

Name of test	3.6 Seawater flow distribution sensitivity on COP																							
Purpose	The purpose of the test is to get a graph over the sensitivity of the source flow distribution through heat exchanger on HP1 and HP2 on the overall COP.																							
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the flow is running in parallel through the evaporators and the capacity distribution between HP1 and HP2 on the source side is changed by changing the distribution through the evaporators. The flow through HP2 evaporator is increased by changing the flow distribution factor in SCADA according to the table below. The heat source for this test is sewage water.</p> <table border="1"> <thead> <tr> <th>Test 3.6</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>3000kW</td> </tr> <tr> <td>Sewage flow</td> <td>FT4263+FT4262</td> <td>145(m³/h)</td> </tr> <tr> <td>Sewage flow through HP2</td> <td>FT4262</td> <td>30/50/70%</td> </tr> </tbody> </table>			Test 3.6	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	3000kW	Sewage flow	FT4263+FT4262	145(m ³ /h)	Sewage flow through HP2	FT4262	30/50/70%
Test 3.6	Sensor	Value																						
District heating inlet temperature	TT4250	50°C																						
District heating intermediate temperature	TT4227	68°C																						
District heating outlet temperature	TT4223	80°C																						
Heat pump system load	02EM4262	3000kW																						
Sewage flow	FT4263+FT4262	145(m ³ /h)																						
Sewage flow through HP2	FT4262	30/50/70%																						
Measurements	<ul style="list-style-type: none"> Total sewage water flow and flow through evaporators for HP1 and HP2 Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																							
Special equipment	No special equipment required																							
Expected duration	3 tests. Each with 60 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 270 min.																							
Horizon	Week 11																							
Special conditions required	No special conditions required																							
Coordination with other tests (?)	Should be conducted with tests 2.9 which is the min and max measurements where here the intermediate points area measured.																							
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																							
Participants	HOFOR, DTI, Innoterm, DTU MEK																							
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																							
Comments																								

Name of test	3.7 HP1-LS: Desuperheater DH flow sensitivity on COP																				
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the desuperheater on the overall COP.																				
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the desuperheater on LS of HP1 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps according to the table and the corresponding flow measured. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source is seawater.</p> <table border="1"> <thead> <tr> <th>Test 3.7</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>5000kW</td> </tr> <tr> <td>Desuperheater HP1 LS flow</td> <td>FT4243</td> <td>5,0/6,0/7,0 (m³/h)</td> </tr> </tbody> </table>			Test 3.7	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	5000kW	Desuperheater HP1 LS flow	FT4243	5,0/6,0/7,0 (m ³ /h)
Test 3.7	Sensor	Value																			
District heating inlet temperature	TT4250	50°C																			
District heating intermediate temperature	TT4227	68°C																			
District heating outlet temperature	TT4223	80°C																			
Heat pump system load	02EM4262	5000kW																			
Desuperheater HP1 LS flow	FT4243	5,0/6,0/7,0 (m ³ /h)																			
Measurements	<ul style="list-style-type: none"> Measurements of the flow through the HP1 LS desuperheater Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																				
Special equipment	No special equipment required																				
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.																				
Horizon	Week 11																				
Special conditions required	No special conditions required																				
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.																				
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																				
Participants	HOFOR, DTI, Innoterm, DTU MEK																				
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																				
Comments																					

Name of test	3.8 HP2-LS: Desuperheater DH flow sensitivity on COP		
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the desuperheater on the overall COP.		
Short description	The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the desuperheater on LS of HP2 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps according to the table and the corresponding flow measured. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source is seawater.		
	Test 3.8	Sensor	Value
	District heating inlet temperature	TT4250	50°C
	District heating intermediate temperature	TT4227	68°C
	District heating outlet temperature	TT4223	80°C
	Heat pump system load	02EM4262	5000kW
	Desuperheater HP2 LS flow	FT4249	5/6/7(m ³ /h)
Measurements	<ul style="list-style-type: none"> Measurements of the flow through the HP2 LS desuperheater Measurements of total COP, COP for both heat pump 1 and 2 The measurements should be logged at least every 10 sec (or as often as possible)		
Special equipment	No special equipment required		
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.		
Horizon	Week 12		
Special conditions required	No special conditions required		
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.		
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.		
Participants	HOFOR, DTI, Innoterm, DTU MEK		
Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI		
Comments			

Name of test	3.9 HP1-HS: Desuperheater DH flow sensitivity on COP		
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the desuperheater on the overall COP.		
Short description	The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the desuperheater on HS of HP1 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps according to the table and the corresponding flow measured. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source is seawater.		
	Test 3.9	Sensor	Value
	District heating inlet temperature	TT4250	50°C
	District heating intermediate temperature	TT4227	68°C
	District heating outlet temperature	TT4223	80°C
	Heat pump system load	02EM4262	5000kW
	Desuperheater HP1 HS flow	FT4264	1/3/5(m ³ /h)
Measurements	<ul style="list-style-type: none"> Measurements of the flow through the HP1 HS desuperheater Measurements of total COP, COP for both heat pump 1 and 2 The measurements should be logged at least every 10 sec (or as often as possible)		
Special equipment	No special equipment required		
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.		
Horizon	Week 12		
Special conditions required	No special conditions required		
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.		
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.		
Participants	HOFOR, DTI, Innoterm, DTU MEK		
Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI		
Comments			

Name of test	3.10 HP2-HS: Desuperheater DH flow sensitivity on COP		
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the desuperheater on the overall COP.		
Short description	The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the desuperheater on HS of HP2 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps according to the table and the corresponding flow measured. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source is seawater.		
	Test 3.10	Sensor	Value
	District heating inlet temperature	TT4250	50°C
	District heating intermediate temperature	TT4227	68°C
	District heating outlet temperature	TT4223	80°C
	Heat pump system load	02EM4262	5000kW
	Desuperheater HP2 HS flow	FT4266	6/8/10(m ³ /h)
Measurements	<ul style="list-style-type: none"> Measurements of the flow through the HP2 HS desuperheater Measurements of total COP, COP for both heat pump 1 and 2 The measurements should be logged at least every 10 sec (or as often as possible)		
Special equipment	No special equipment required		
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.		
Horizon	Week 12		
Special conditions required	No special conditions required		
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.		
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.		
Participants	HOFOR, DTI, Innoterm, DTU MEK		
Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI		
Comments			

Name of test	3.11 HP1-LS: Oil cooler DH flow sensitivity on COP																				
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the oil cooler on the overall COP.																				
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the oilcooler on LS of HP1 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps and measuring the corresponding flow. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source for this test is seawater.</p> <table border="1"> <thead> <tr> <th>Test 3.11</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>5000kW</td> </tr> <tr> <td>Oil cooler HP1 LS flow</td> <td>FT4267</td> <td>2,8/3,0/3,2(m³/h)</td> </tr> </tbody> </table>			Test 3.11	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	5000kW	Oil cooler HP1 LS flow	FT4267	2,8/3,0/3,2(m ³ /h)
Test 3.11	Sensor	Value																			
District heating inlet temperature	TT4250	50°C																			
District heating intermediate temperature	TT4227	68°C																			
District heating outlet temperature	TT4223	80°C																			
Heat pump system load	02EM4262	5000kW																			
Oil cooler HP1 LS flow	FT4267	2,8/3,0/3,2(m ³ /h)																			
Measurements	<ul style="list-style-type: none"> Measurement of the HP1 LS oil cooler flow Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																				
Special equipment	No special equipment required																				
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.																				
Horizon	Week 13																				
Special conditions required	No special conditions required																				
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.																				
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																				
Participants	HOFOR, DTI, Innoterm, DTU MEK																				
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																				
Comments																					

Name of test	3.12 HP2-LS: Oil cooler DH flow sensitivity on COP		
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the oil cooler on the overall COP.		
Short description	The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the oilcooler on LS of HP2 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps and measuring the corresponding flow. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source for this test is seawater.		
	Test 3.12	Sensor	Value
	District heating inlet temperature	TT4250	50°C
	District heating intermediate temperature	TT4227	68°C
	District heating outlet temperature	TT4223	80°C
	Heat pump system load	02EM4262	5000kW
	Oil cooler HP1 LS flow	FT4270	2,8/3,0/3,2(m ³ /h)
Measurements	<ul style="list-style-type: none"> Measurement of the HP2 LS oil cooler flow Measurements of total COP, COP for both heat pump 1 and 2 The measurements should be logged at least every 10 sec (or as often as possible)		
Special equipment	No special equipment required		
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.		
Horizon	Week 13		
Special conditions required	No special conditions required		
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.		
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.		
Participants	HOFOR, DTI, Innoterm, DTU MEK		
Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI		
Comments			

Name of test	3.13 HP1-HS: Oil cooler DH flow sensitivity on COP																				
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the oil cooler on the overall COP.																				
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the oilcooler on HS of HP1 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps and measuring the corresponding flow. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source for this test is seawater.</p> <table border="1"> <thead> <tr> <th>Test 3.13</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>5000kW</td> </tr> <tr> <td>Oil cooler HP1 LS flow</td> <td>FT4268</td> <td>2,0/2,1/2,2(m³/h)</td> </tr> </tbody> </table>			Test 3.13	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	5000kW	Oil cooler HP1 LS flow	FT4268	2,0/2,1/2,2(m ³ /h)
Test 3.13	Sensor	Value																			
District heating inlet temperature	TT4250	50°C																			
District heating intermediate temperature	TT4227	68°C																			
District heating outlet temperature	TT4223	80°C																			
Heat pump system load	02EM4262	5000kW																			
Oil cooler HP1 LS flow	FT4268	2,0/2,1/2,2(m ³ /h)																			
Measurements	<ul style="list-style-type: none"> Measurement of the HP1 HS oil cooler flow Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																				
Special equipment	No special equipment required																				
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.																				
Horizon	Week 13																				
Special conditions required	No special conditions required																				
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.																				
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																				
Participants	HOFOR, DTI, Innoterm, DTU MEK																				
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																				
Comments																					

Name of test	3.14 HP2-HS: Oil cooler DH flow sensitivity on COP																				
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the oil cooler on the overall COP.																				
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the oilcooler on HS of HP2 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps and measuring the corresponding flow. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source for this test is seawater.</p> <table border="1"> <thead> <tr> <th>Test 3.14</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>5000kW</td> </tr> <tr> <td>Oil cooler HP2 HS flow</td> <td>FT4272</td> <td>4,2/4,5/4,8(m³/h)</td> </tr> </tbody> </table>			Test 3.14	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	5000kW	Oil cooler HP2 HS flow	FT4272	4,2/4,5/4,8(m ³ /h)
Test 3.14	Sensor	Value																			
District heating inlet temperature	TT4250	50°C																			
District heating intermediate temperature	TT4227	68°C																			
District heating outlet temperature	TT4223	80°C																			
Heat pump system load	02EM4262	5000kW																			
Oil cooler HP2 HS flow	FT4272	4,2/4,5/4,8(m ³ /h)																			
Measurements	<ul style="list-style-type: none"> Measurement of the HP2 HS oil cooler flow Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																				
Special equipment	No special equipment required																				
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.																				
Horizon	Week 13																				
Special conditions required	No special conditions required																				
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.																				
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																				
Participants	HOFOR, DTI, Innoterm, DTU MEK																				
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																				
Comments																					

Name of test	3.15 HP1-HS: Subcooler DH flow sensitivity on COP																				
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the subcooler on the overall COP.																				
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the subcooler on HS of HP1 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps and measuring the corresponding flow. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source for this test is seawater.</p> <table border="1"> <thead> <tr> <th>Test 3.15</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>5000kW</td> </tr> <tr> <td>Subcooler HP1 HS flow</td> <td>FT4263</td> <td>3/4/6(m³/h)</td> </tr> </tbody> </table>			Test 3.15	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	5000kW	Subcooler HP1 HS flow	FT4263	3/4/6(m ³ /h)
Test 3.15	Sensor	Value																			
District heating inlet temperature	TT4250	50°C																			
District heating intermediate temperature	TT4227	68°C																			
District heating outlet temperature	TT4223	80°C																			
Heat pump system load	02EM4262	5000kW																			
Subcooler HP1 HS flow	FT4263	3/4/6(m ³ /h)																			
Measurements	<ul style="list-style-type: none"> Measurement of the HP1 HS oil cooler flow Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																				
Special equipment	No special equipment required																				
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and 180 min.																				
Horizon	Week 14																				
Special conditions required	No special conditions required																				
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.																				
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																				
Participants	HOFOR, DTI, Innoterm, DTU MEK																				
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																				
Comments																					

Name of test	3.16 HP2-HS: Subcooler DH flow sensitivity on COP																				
Purpose	The purpose of the test is to get a graph over the sensitivity of the district heating flow through the subcooler on the overall COP.																				
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the DH flow through the subcooler on HS of HP2 is investigated to be able to draw a graph of the COP vs. flow. The flow is changed by changing the set point for the control loop in steps and measuring the corresponding flow. After changing the set point the system is allowed to stabilize and then run for 30 min for each measuring point. The heat source for this test is seawater.</p> <table border="1"> <thead> <tr> <th>Test 3.16</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>5000kW</td> </tr> <tr> <td>Subcooler HP2 HS flow</td> <td>FT4265</td> <td>5/10/15(m³/h)</td> </tr> </tbody> </table>			Test 3.16	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	5000kW	Subcooler HP2 HS flow	FT4265	5/10/15(m ³ /h)
Test 3.16	Sensor	Value																			
District heating inlet temperature	TT4250	50°C																			
District heating intermediate temperature	TT4227	68°C																			
District heating outlet temperature	TT4223	80°C																			
Heat pump system load	02EM4262	5000kW																			
Subcooler HP2 HS flow	FT4265	5/10/15(m ³ /h)																			
Measurements	<ul style="list-style-type: none"> Measurement of the HP2 HS oil cooler flow Measurements of total COP, COP for both heat pump 1 and 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																				
Special equipment	No special equipment required																				
Expected duration	3 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 180 min.																				
Horizon	Week 14																				
Special conditions required	No special conditions required																				
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.																				
Success criteria	The heat pump can run for 30 minutes with stable running condition and without alarms.																				
Participants	HOFOR, DTI, Innoterm, DTU MEK																				
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																				
Comments																					

Name of test	3.17 HP1: Liquid level in liquid separator for evaporator																				
Purpose	The purpose of the test is to get a graph over the sensitivity of the liquid level in the liquid separator on the overall COP.																				
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the liquid level in the liquid separator is investigated to be able to draw a graph of the COP vs. the level. The level is changed in three steps for three capacities. After changing the level the system can stabilize and then run for 30 min for each measuring point. The heat source for this test is seawater.</p> <table border="1"> <thead> <tr> <th>Test 3.16</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>1000/3000/5000kW</td> </tr> <tr> <td>Liquid level</td> <td>LT100.01</td> <td>?/?/?(%)</td> </tr> </tbody> </table>			Test 3.16	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	1000/3000/5000kW	Liquid level	LT100.01	?/?/?(%)
Test 3.16	Sensor	Value																			
District heating inlet temperature	TT4250	50°C																			
District heating intermediate temperature	TT4227	68°C																			
District heating outlet temperature	TT4223	80°C																			
Heat pump system load	02EM4262	1000/3000/5000kW																			
Liquid level	LT100.01	?/?/?(%)																			
Measurements	<ul style="list-style-type: none"> Measurement of the level in the separator Measurements of total COP and COP for both heat pump 1 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																				
Special equipment	No special equipment required																				
Expected duration	9 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 540 min.																				
Horizon	Week 14																				
Special conditions required	No special conditions required																				
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.																				
Success criteria	The heat pump can run for 30 minutes with stable COP.																				
Participants	HOFOR, DTI, Innoterm, DTU MEK																				
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																				
Comments																					

Name of test	3.18 HP2:- Liquid level in liquid separator for evaporator																				
Purpose	The purpose of the test is to get a graph over the sensitivity of the liquid level in the liquid separator on the overall COP.																				
Short description	<p>The heat pump is adjusted to factory settings. Then in this test, the sensitivity of the liquid level in the liquid separator is investigated to be able to draw a graph of the COP vs. the level. The level is changed in three steps for three capacities. After changing the level the system can stabilize and then run for 30 min for each measuring point. The heat source for this test is seawater.</p> <table border="1"> <thead> <tr> <th>Test 3.16</th> <th>Sensor</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>District heating inlet temperature</td> <td>TT4250</td> <td>50°C</td> </tr> <tr> <td>District heating intermediate temperature</td> <td>TT4227</td> <td>68°C</td> </tr> <tr> <td>District heating outlet temperature</td> <td>TT4223</td> <td>80°C</td> </tr> <tr> <td>Heat pump system load</td> <td>02EM4262</td> <td>1000/3000/5000kW</td> </tr> <tr> <td>Liquid level</td> <td>LT150.01</td> <td>?/?/?(%)</td> </tr> </tbody> </table>			Test 3.16	Sensor	Value	District heating inlet temperature	TT4250	50°C	District heating intermediate temperature	TT4227	68°C	District heating outlet temperature	TT4223	80°C	Heat pump system load	02EM4262	1000/3000/5000kW	Liquid level	LT150.01	?/?/?(%)
Test 3.16	Sensor	Value																			
District heating inlet temperature	TT4250	50°C																			
District heating intermediate temperature	TT4227	68°C																			
District heating outlet temperature	TT4223	80°C																			
Heat pump system load	02EM4262	1000/3000/5000kW																			
Liquid level	LT150.01	?/?/?(%)																			
Measurements	<ul style="list-style-type: none"> Measurement of the level in the separator Measurements of total COP and COP for both heat pump 2 <p>The measurements should be logged at least every 10 sec (or as often as possible)</p>																				
Special equipment	No special equipment required																				
Expected duration	9 tests. Each with 30 min for reaching the adjusted set points and for stabilising the system and 30 minutes for stable running without alarms. Total 540 min.																				
Horizon	Week 14																				
Special conditions required	No special conditions required																				
Coordination with other tests (?)	Should be conducted with tests 2.10 which is the min and max measurements where here the intermediate points area measured.																				
Success criteria	The heat pump can run for 30 minutes with stable COP.																				
Participants	HOFOR, DTI, Innoterm, DTU MEK																				
Responsible for test	<p>Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI</p>																				
Comments																					

4 Long term test

In the long term test, the automatic function of the HP AutoTune and HP Doctor are tested regarding optimising COP and costs related to operation and maintenance.

At this stage of the test, the impact of fouling is also expected to become more evident and the effect of various modes and frequencies of cleaning will be tested with input from HP Doctor. For the HP AutoTune the heat pump system will be running with the factory settings for a period of time and then the HP AutoTune is allowed to adjust the heat pump and run for the same time period. Then the average COP for both situations is compared.

For the HP Doctor the heat pump system is running with the HP Doctor on and the data for selected surveillance parts are monitored and compared to the HP Doctors evaluation of the situation.

Name of test	4.1 HP AutoTune		
Purpose	The purpose of the test is to find the difference in average COP for the heat pump running first with factory settings on all control loops and then with HP AutoTune switched on. The conditions on the warm side is fixed.		
Short description	First the heat pump runs with factory settings on all control loops for 2 days. Then the HP AutoTune is switch on and the heat pump is released from factory settings and runs for 5 days. This is done for three conditions on the warm site and three capacities.		
	The heat source for this test is seawater and the seawater temperature is the temperature available at the time of testing.		
	Test 3.16	Sensor	Value
	District heating inlet temperature	TT4250	44/55/57°C
	District heating outlet temperature	TT4223	68/80/90°C
	Heat pump system load	02EM4262	1000/3000/5000kW
Measurements	<ul style="list-style-type: none"> Measurement of the district heating inlet and outlet temperatures and capacities. Measurements of total COP and COP for both heat pump 1 The measurements should be logged at least every 10 sec (or as often as possible)		
Special equipment	No special equipment required		
Expected duration	9 tests. Each taking 7 days. Total 63 days.		
Horizon	Week 15 to 27		
Special conditions required	No special conditions required		
Coordination with other tests (?)	Not connected to other tests.		
Success criteria	That the average COP for heat pump optimized by HP AutoTune is higher than the one without.		
Participants	HOFOR, DTI, Innoterm, DTU MEK		
Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI		
Comments			

Name of test	4.2 HP Doctor		
Purpose	The purpose of the test is to follow the selected functions in HP Doctor and compare to data from the data acquisition system.		
Short description	The heat pump runs for 6 months with seawater as heat source. Then the heat source is changed to sewage water and the heat pump runs for 12 months. Then the heat pump runs again with seawater for 6 months and . This is done to have whole year of running on both heat source.		
	Test 3.16	Sensor	Value
Measurements	<ul style="list-style-type: none"> ▪ Measurement of the district heating inlet and outlet temperatures and capacities. ▪ Measurements of total COP and COP for both heat pumps The measurements should be logged at least every 10 sec (or as often as possible)		
Special equipment	No special equipment required		
Expected duration	3 tests. In total taking 2 years.		
Horizon	Week 28 in 2019 to 48 in 2020		
Special conditions required	No special conditions required		
Coordination with other tests (?)	Not connected to other tests.		
Success criteria	That the HP Doctor can detect the running condition of the heat pump.		
Participants	HOFOR, DTI, Innoterm, DTU MEK		
Responsible for test	Planning: Johannes, DTI Operation: Jógvan HOFOR Reporting/follow up after test: DTI		
Comments			

5 Appendix

